project overview

living lab: lighting the future

The Living Lab Demonstration Project tests multiple advanced lighting control systems to address barriers and help bring these technologies to scale.

project goals

The Living Lab seeks to identify the most cost-effective lighting control systems for retrofits, and the tools and processes that ensure their successful implementation. These lighting systems provide the highest quality interior environment by responding to daylight, occupancy, electricity demand, and various needs of the users. Shading is a key component to optimizing daylight harvesting, maximizing views to the outside, and reducing glare. The project will look beyond simple energy savings to outline processes and provide resources that ease installation, calibration, and maintenance. The Living Lab will:

- **Install, commission, and monitor multiple advanced lighting control systems and fixtures**
- **Identify solutions to technical and institutional barriers**
- **Identify opportunities to accelerate the adoption of technologies**
- **Match technology capabilities with different retrofit situations**
- **Provide education, training, and other resources based on outcomes**

project partners

200 West Street
Goldman Sachs Headquarters

One Bryant Park
Bank of America Tower

the project

The Living Lab Demonstration Project addresses barriers by carefully documenting the process, vetting technology, and monitoring the savings of multiple technologies. These lessons will be captured in multiple forms, including this exhibit, forthcoming technical training, online tools, case studies, and many other resources.

education and outreach lead

be ex
building energy exchange

technical lead

BERKELEY LAB
Lawrence Berkeley National Laboratory

Project funded by the US Department of Energy, NYSERDA, and the Scherman Foundation

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project partners

Goldman Sachs
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technology partners

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controls save money & energy

Installing advanced lighting controls saves money and energy, but careful management is required to ensure success.

the case

NYC Commercial Building Electricity Usage

26%	Interior Lighting
6%	Exterior Lighting
17%	Cooling
15%	Ventilation
8%	Office Equipment
3%	Space Heating
25%	Other

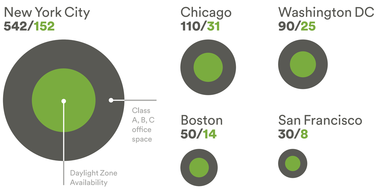
Source: Con Edison 2010 Energy Efficiency Potential Study

credit: Randy Lemoine

- Lighting uses one third of all electricity in commercial buildings
- Local Law 88 requires 1.25 billion square feet of commercial office space in New York City to upgrade their lighting to meet code by 2025

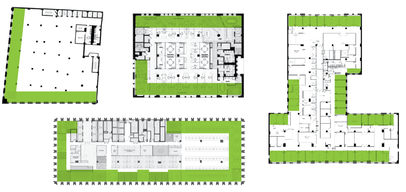
the opportunity

Office Space in Major U.S. Central Business Districts (million square feet) Source: BEEx Analysis, Let There Be Daylight, 2012



Daylight Zone Area for Typical Buildings

Source: BEEx Analysis, Let There Be Daylight, 2012

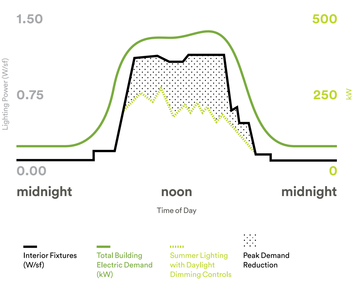


- NYC is the largest commercial real estate market nationally, an opportunity to both save energy and demonstrate leadership
- Many New York City buildings are designed to maximize daylight
- Costs of systems are decreasing rapidly

the potential for advanced lighting controls

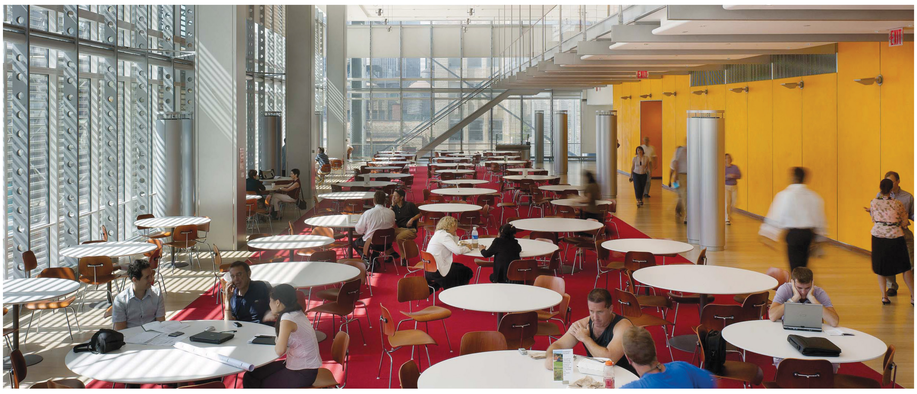
- $70 million annual cost savings
- 60% of energy use from lighting can be reduced using advanced controls
- Reduce citywide peak energy demand by as much as 160 megawatts, about 16 Empire State Buildings
- Buildings can manage their electric loads more effectively and participate in demand response programs

Impact of Advanced Daylight Controls



Source: BEEx Analysis, Let There Be Daylight, 2012

the context



credits: Michel Denance

A pleasant and comfortable dining space in the New York Times building is just one example of the benefits of properly managed daylighting.

To learn more, visit:
be-exchange.org/resources/case-studies

The New York Times Building

Completed in 2007, the New York Times Building is a 1.5 million square foot office tower located in Midtown, Manhattan, designed with several innovative energy features. These include a dynamic shading system and state of the art dimmable lighting system intended to maximize daylight harvesting and provide task-level tuning. A one-year post-occupancy study found that the building achieved 43% lighting savings and 24% overall energy savings, while providing high levels of lighting quality and comfort.

The Time Warner Center

Related Companies, developer of the Time Warner Center, completed in 2003, decided to retrofit their two floors in the building with advanced lighting controls in 2012. The system includes occupancy sensors throughout the space, daylight sensors in perimeter offices, and wirelessly controlled continuously dimmable digital ballasts in overhead fluorescent fixtures. This retrofit reduced Related's energy consumption by 56% and had a three-year return on investment.

building energy exchange connects the New York real estate and design communities to energy and lighting efficiency solutions through exhibitions, education, technology demonstrations, and research. We identify opportunities, navigate barriers to adoption, broker relationships, and showcase best practices at our resource center in the Surrogate's Courthouse.

be-exchange.org

process

anatomy of a retrofit

Successful lighting retrofits require careful technology selection, broad user engagement, and continual oversight.

the facts

Today's lighting control systems feature myriad options, including real time scheduling, occupancy and daylight response, and automated shading. Projects that successfully improve the office environment and save energy will choose the right functions for their specific needs and will assign a project manager to oversee the entire retrofit process.

The keys to a successful retrofit include:

- **Establishing clear goals and requirements**
- **Proper technology selection**
- **Involvement of all stakeholders**
- **Careful, consistent oversight**
- **Meaningful commissioning**

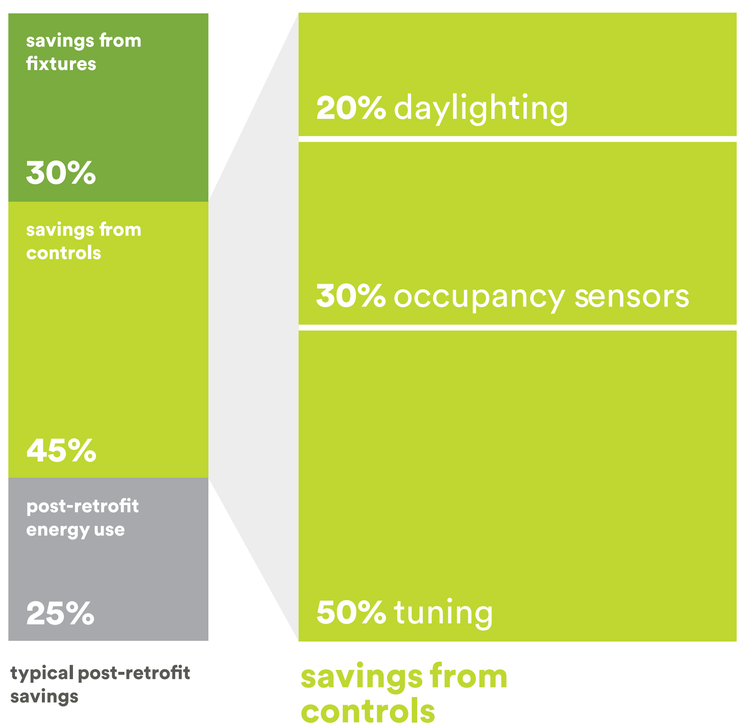
the benefits

An advanced lighting control system better responds to users' needs while saving money by reducing wasteful lighting use when enough daylight is available, dimming lights when spaces are not occupied, and tuning lights to specific needs.

demand management

Electricity pricing is typically set by peak usage, so trimming peak demand reduces the cost of every kilowatt. Advanced systems can benefit from demand management incentives and allow users to enroll in demand response programs.

potential energy savings



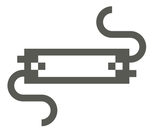
Source: Lawrence Berkeley National Laboratory

Learn more about the Living Lab and the anatomy of a successful retrofit below.

components of a lighting controls system

Each piece of a lighting control system helps optimize energy savings and occupant comfort. Throughout the exhibit, you will see these icons used to illustrate the opportunities and applications of lighting control systems.

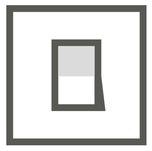
data collection



ballast/driver
Fluorescent ballasts and LED drivers communicate with sensors and system software to control fixture power levels and in some cases send usage data back to the energy management system.

occupancy sensor
Occupancy and vacancy sensors are used to determine whether a space is occupied, reducing the wasteful lighting of empty spaces.

daylight sensor
Daylight sensors, or photo sensors, measure the amount of daylight in a space, allowing the system to dim electric lighting when it is unnecessary.



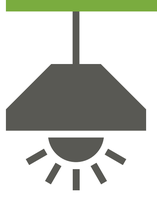
wall switch
Wall mounted light switches provide individual control of lights, and often include dimming and pre-set lighting scenes.

data management

energy manager
Energy managers, also called gateways or “Energy Control Units,” collect and send information between both wired and wireless components and pass it on to the system server, ensuring smooth function.

server
The server receives and stores data from the energy manager and connects with the graphic user interface.

data response

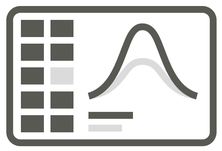


fixture
Fixture refers to the entire light fixture, including the housing (or base), lamp sockets, optics (or lenses) as well as the lamps themselves (whether LED or fluorescent.) Some include integrated junction boxes for power connection, or battery packs in the case of emergency fixtures. High efficiency fixtures will be dimmable and may have ballasts or drivers and/or sensors installed within the unit, or attached remotely.

automated shading
Automated shades determine their position by a combination of software and sensors. These can integrate with the lighting system and are designed to allow the maximum comfortable daylight into a space with minimal glare.

data visualized

graphic user interface
A GUI visualizes lighting system data via a smartphone app or desktop computer software, typically indicating in real time which lights are in use, how much energy is being drawn from the electrical grid, and alerting managers to maintenance issues like lamp replacements.



The graphic user interface can be used to schedule when lights are on, tune light levels in individual spaces for specific needs, and participate in demand response programs.

credit: Canadian Pacific/Flickr

1.

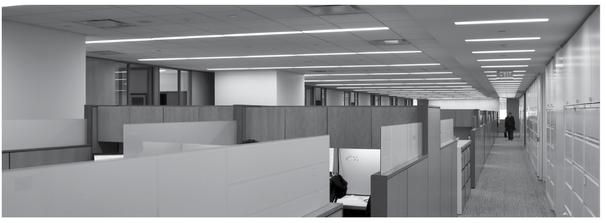
identify

- Area of retrofit
- Budget and schedule
- Lighting system needs/functions
- Energy savings goals
- Project manager

2.

select technology

While exploring the options for a retrofit, it is important to assess the needs of the space and the organization. This includes energy saving goals, budget, current and anticipated use of the space, as well as current occupant concerns. Working with your project team to answer these questions can better help you determine the functions you want in a system. We recommend working with a lighting designer and a lighting controls manufacturer or distributor to ensure appropriate system selection.



credit: Building Energy Exchange

controls:
±45% savings

A control system is the crux of the retrofit, ensuring functionality and integration. These can be adapted to suit your construction and end-use needs.

Control systems features include:

- scheduling & tuning
- wireless components
- daylight harvesting
- sensors
- interactive controls
- DALI
- 0–10 dimming

Drivers or ballasts may either operate on a digital system, referred to as a "Digitally Addressable Lighting Interface (DALI)," or an analog system, referred to as "0-10 dimming."

fixtures & lamps:
±30% savings

Incorporating higher efficiency lamps or fixtures can result in significant savings, especially if changing to LEDs.

LED systems are typically far more efficient than fluorescent. There are several ways to incorporate LEDs into an existing space, including:

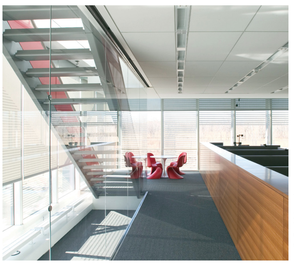
Relamping: For example, replacing existing fluorescent T12 or T8 tubes with a linear LED lamp designed for this purpose.

Fixture Retrofit: Leave the housing in place and reconfigure the interior of a fixture with an LED array and improved optics, typically sold as a kit.

Fixture Replacement: For best performance and improved optics, replacing a fixture entirely can provide significant energy savings and an updated aesthetic.

daylighting:
±10% savings

Automated shades determine their position by a combination of software and sensors. These allow maximum comfortable daylight into a space while minimizing glare and decreasing cooling loads. They also can be integrated with the lighting system.

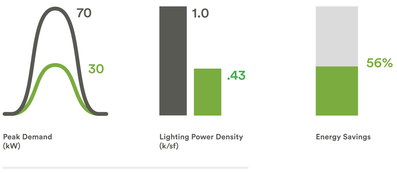


credit: David Joseph

3.

invest & finance

Nationally, average lighting retrofit costs are from $4-$6/SF. In New York City higher costs are mitigated by existing rate-payer incentives, and ROI is improved by the relatively high cost of electricity, especially during peak demand periods. Most lighting retrofits pay back within 3-5 years. Payback of advanced lighting systems can be significantly improved by accessing demand management incentives. Further savings can be achieved through ongoing participation in demand response programs.



4.

install & commission

It is imperative that a project manager oversee the installation process and ensure that systems are properly commissioned prior to full operation. Installation oversight is critical to avoiding some of the most common retrofit pitfalls, and commissioning by a trained professional will ensure that the system is performing effectively and occupants are comfortable. Systems should be periodically monitored, tuned, and maintained to ensure that they continue to function correctly.

5.

educate

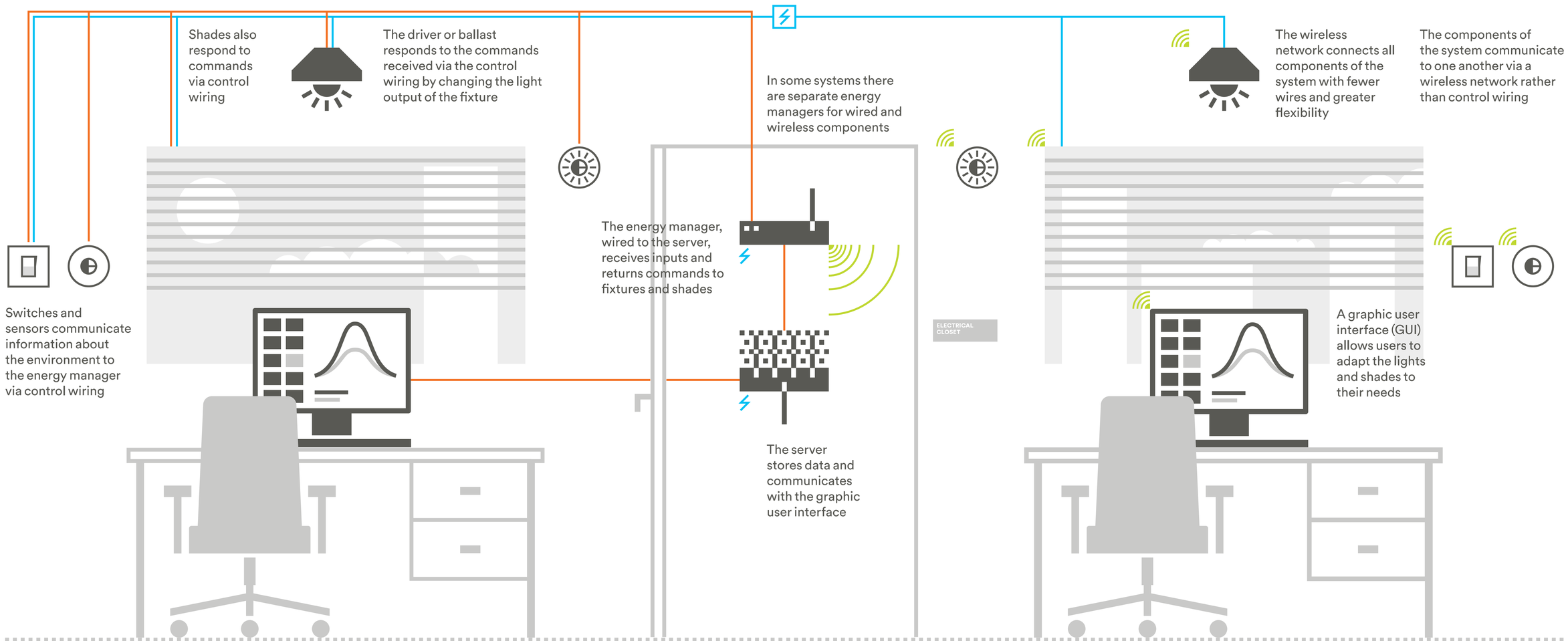
To learn more about lighting retrofit examples, visit: be-exchange.org

Close cooperation with occupants is critical to successful retrofits. Maintenance personnel, facility managers, and the office occupants themselves must be involved in the installation process and educated on system operation. Engaging end-users throughout the entire process reduces misunderstandings that can derail projects, ensures a smooth transition, and creates project advocates.

credit: Alivar Canaria

more function, less fuss

Wireless systems provide a full spectrum of features in a secure, cost-effective package.



the facts

Wireless lighting controls eliminate wiring from switches, sensors, and gateways, while providing a high-level of system security via encryption. Though hardware costs are similar, a wireless network reduces both disruption and installation costs, while retaining features and reliability similar to fully wired systems. The communication range of wireless components must be carefully considered, including dense obstructions like elevator cores.

how it works

In a wired system, the components of the control system communicate via low voltage wiring, also called “data” or “control” wiring. However, in a wireless system, these components communicate via a wireless network. Both wired and wireless systems require that fixtures, shades, and the server be powered through line voltage, and the energy manager is typically connected to the server with control wiring.

benefits

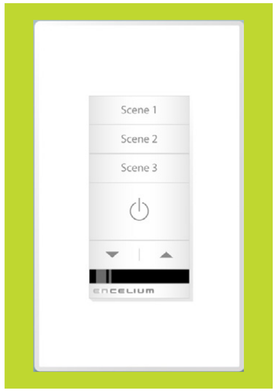
- Wireless systems can be used in both new construction and retrofit applications.
- Wired and wireless components can be used in combination to meet the needs of the space.
- Installation of a wireless system provides greater flexibility and reduces disruption to employees.
- Wireless systems typically have lower install costs than a wired system.
- Wireless can be easier to install in “hard-to-reach” locations.

system components

daylighting & occupancy sensor

wireless manager

control module



wallstation

fixture neoray

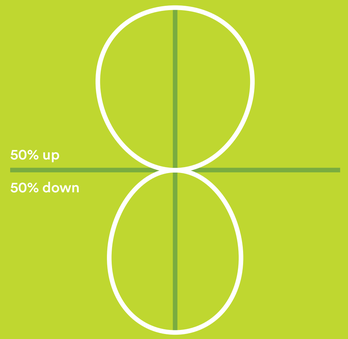
The *Series 23* suspended luminaire features optics that reduce glare and maximize efficacy, producing even lighting throughout the space. The fixture has separate dimming for the uplight and downlight components, and can be deployed individually or in continuous rows. Companion recessed and surface mount versions provide a complete family of fixtures.

look up!

uplight

downlight

lighting distribution



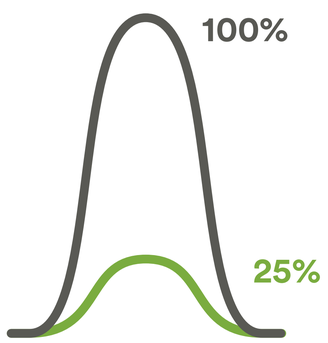
living lab link

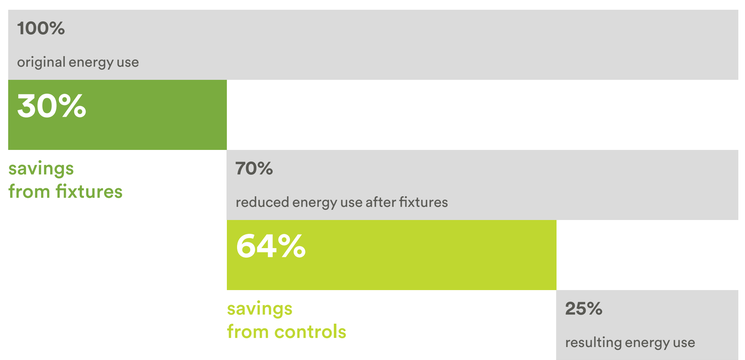
ENCELIUM OSRAM

The project partners were very interested in exploring the benefits of cutting edge wireless controls and determining whether they were a good fit for both new construction and retrofits. Osram's Encelium system represents a flexible, cost-effective option that can gather data from a range of lighting component suppliers to tailor lighting usage with changing requirements, preparing offices for future changes and reducing the costs of churn.

system features

■ installed at living lab ■ capability





peak demand reduction 75%

energy savings

The Neoray fixture reduces the lighting energy use by 30% in the Living Lab space. The Encelium controls are estimated by the manufacturer to reduce the decreased energy use by an additional 64%. The resulting energy use is 25% of the original.

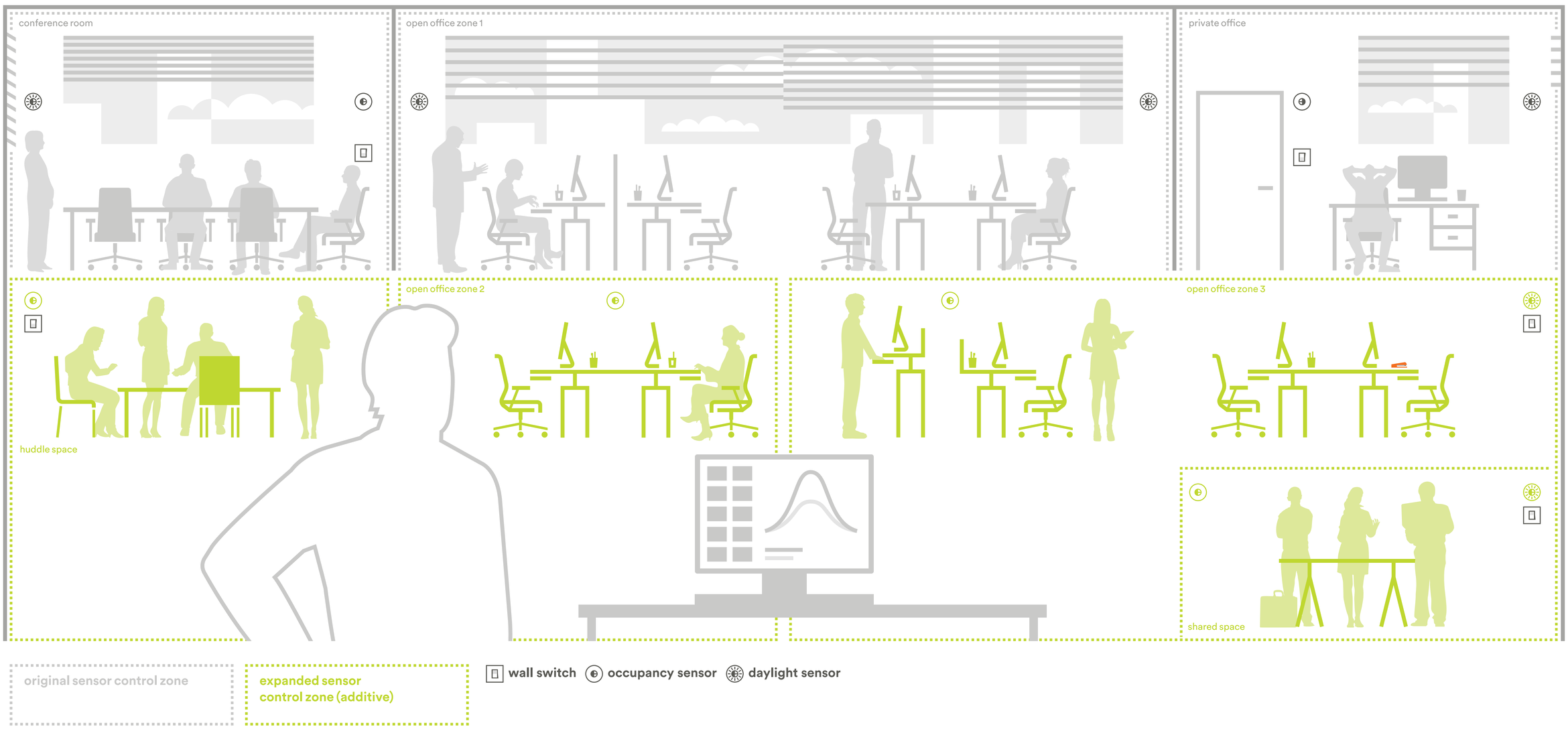
the bottom line

A wireless network is a simple and secure way to quickly implement an energy efficient lighting retrofit.

to learn more visit
be-exchange.org

expandable solutions

Today’s solutions allow users to upgrade existing systems as a comprehensive retrofit or in careful phases of any scale.



the facts

Many cost-effective upgrades are available for clients working with limited budgets or a wish to limit disruptions in working offices. Such a project may include adding dimmable ballasts to existing fluorescent fixtures and introducing a limited number of sensors. These features allow for remote operation, including tuning light levels to specific space needs, dimming in response to available daylight, and peak period demand response.

how it works

Many manufacturers can retro-commission existing lighting systems to ensure energy savings and improve functionality. The amount of savings and granularity of control is directly related to the number of fixtures that are rendered dimmable and the number of daylighting and occupancy sensors installed. Upgrades also allow for remote operation and integration with energy management systems.

benefits

- Upgrading an existing system is the simplest form of lighting retrofit.
- System selection is easier and disruption to occupied office space is heavily reduced.
- Both the hard and soft costs of a retrofit are reduced.
- Updated software and hardware components can allow for improved functionality and remote integration with energy management systems.

system components

occupancy sensor

daylighting sensor

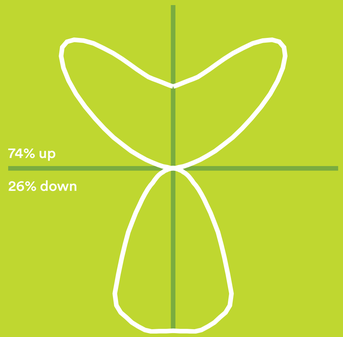
wall switch

fixture selux

look up!

This linear pendant fixture includes an uplight with a diffuse satin lens and batwing distribution. The fixtures featured here includes a microprism lens over the downlight component, raising the efficacy of a fixture suitable for a wide variety of applications. Companion recessed and surface mount versions provide a complete family of fixtures.

lighting distribution



living lab link

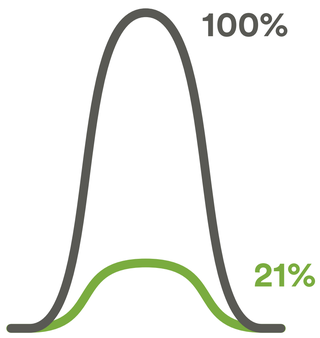
LUTRON®

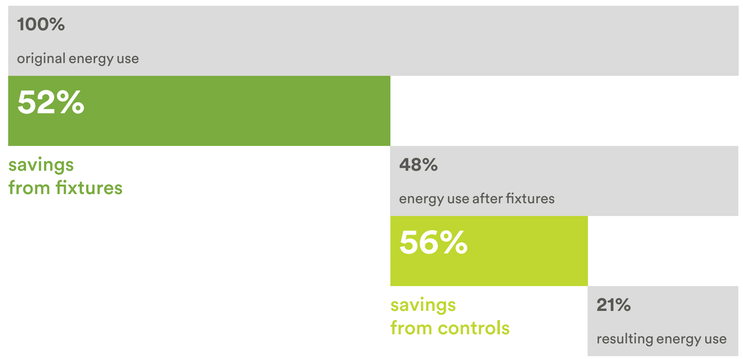
Both project partners had previously installed Lutron systems and are using the Living Lab to explore improvements in performance, functionality, and costs achieved over the last decade.

The Quantum Total Light management system that was installed at the Living Lab includes both wired and wireless components. Additionally, the system integrates with their Hyperion automated shade system, LED fixtures, and the building's energy management system. A Lutron control system can be easily scaled to suit any size building or space.

system features

■ installed at living lab ■ capability





peak demand reduction

79%

energy savings

The Selux fixture reduces lighting energy use by 52% on the Living Lab floor. An additional estimated 56% of energy savings is possible with lighting controls. The estimated reduction in energy use is 79%.

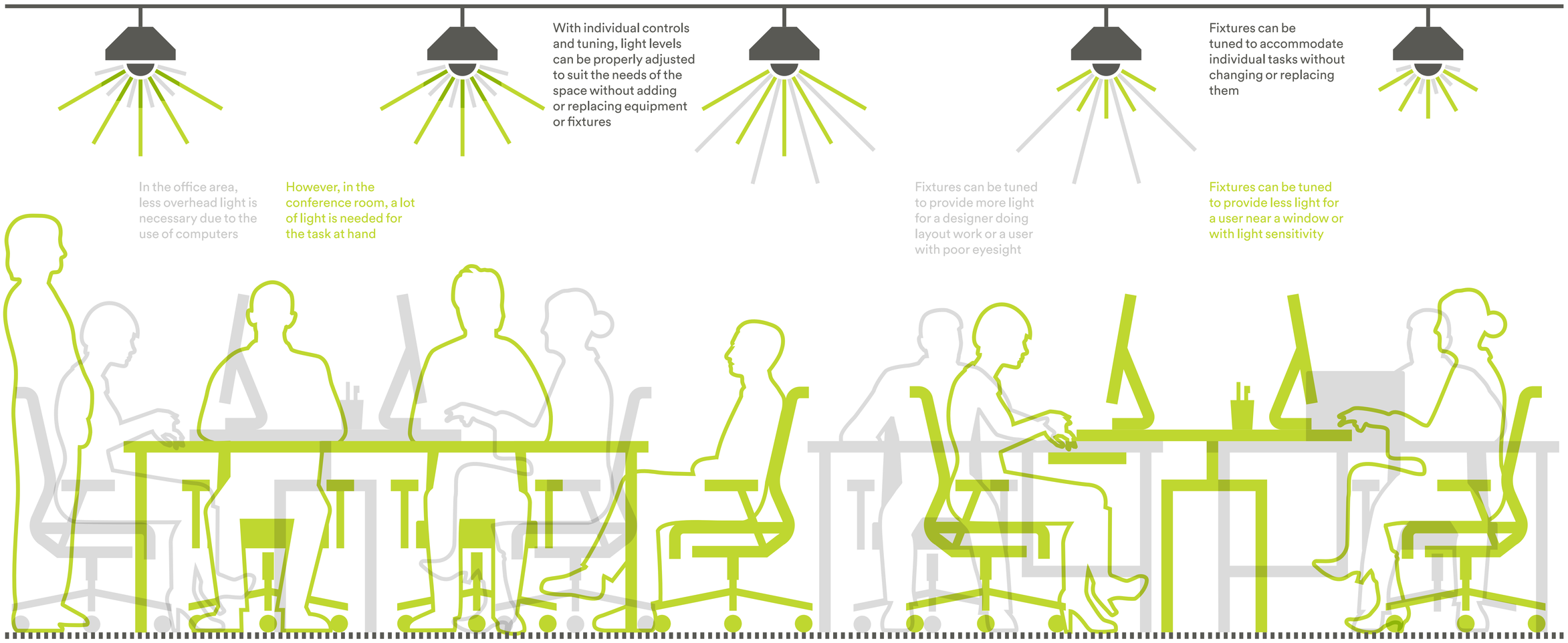
the bottom line

Investing in your lighting controls during new construction and ensuring proper commissioning is the best way to capture savings. As systems age, it is possible to update software and hardware to capture advances in technology and continue to maximize savings and functionality.

to learn more visit
be-exchange.org

convenience & flexibility

Digital systems can separately address each light fixture and be configured to suit many needs, eliminating the expense of serial retrofits.



original configuration

alternative configuration

the facts

A properly selected and installed Digital Addressable Lighting Interface (DALI) system can accommodate change and growth. When choosing a lighting system for either a retrofit or new construction, it is important to consider how the system may need to change over time. DALI systems provide deep flexibility as the needs of users change.

how it works

A properly programmed digital lighting control system allows the system manager to set zones, and even fixtures, individually. With an intuitive interface, it is simple to adjust settings to maximize energy savings and occupant needs.

benefits

- Once a DALI system and high performance LED fixtures are installed, future retrofits will consist primarily of installing new software instead of new hardware.
- Greater flexibility to adapt a space to the changing needs of the employees.
- System can expand at any time.

system components

occupancy sensor

wall switch

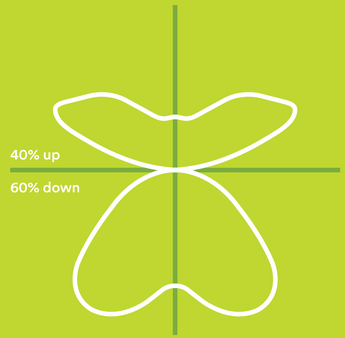
control touch panel

fixture FLUXWERX

look up!

Profile is a suspended linear lighting system that features a luminous interior with no horizontal lenses or diffusers. The fixture has unique optics that eliminate any direct or indirect view of the LED light source, reducing glare while providing an optimal lighting distribution for general area lighting using a 40/60 breakdown of uplight/downlight.

lighting distribution



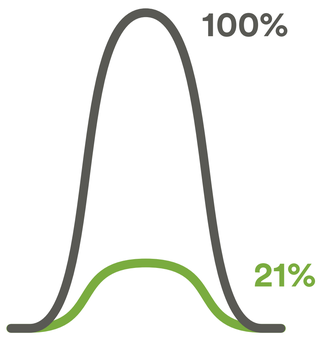
living lab link

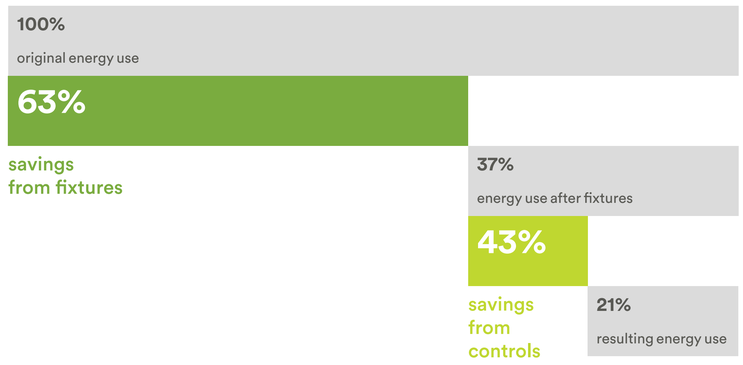
CRESTRON®

As with all customers, Crestron worked directly with the Living Lab team to develop a custom solution that meets the specific needs of each space, while retaining easy integration with enterprise-wide monitoring, management, and control. The DALI-based system affords maximum flexibility to the users while improving efficiency and scalability. The system can easily reconfigure lighting zones after installation, monitors individual fixture and lamp status, and offers discrete personal control where desired. The Crestron system is controlled with an easy to use graphic interface that integrates directly with popular software like Microsoft Outlook.

system features

■ installed at living lab ■ capability





peak demand reduction 79%

energy savings

The Fluxwerx fixture is calcualted to provide a 63% reduction in lighting energy in the Living Lab. The Crestron controls will further reduce energy use by 43%, as predicted by the manufacturer.

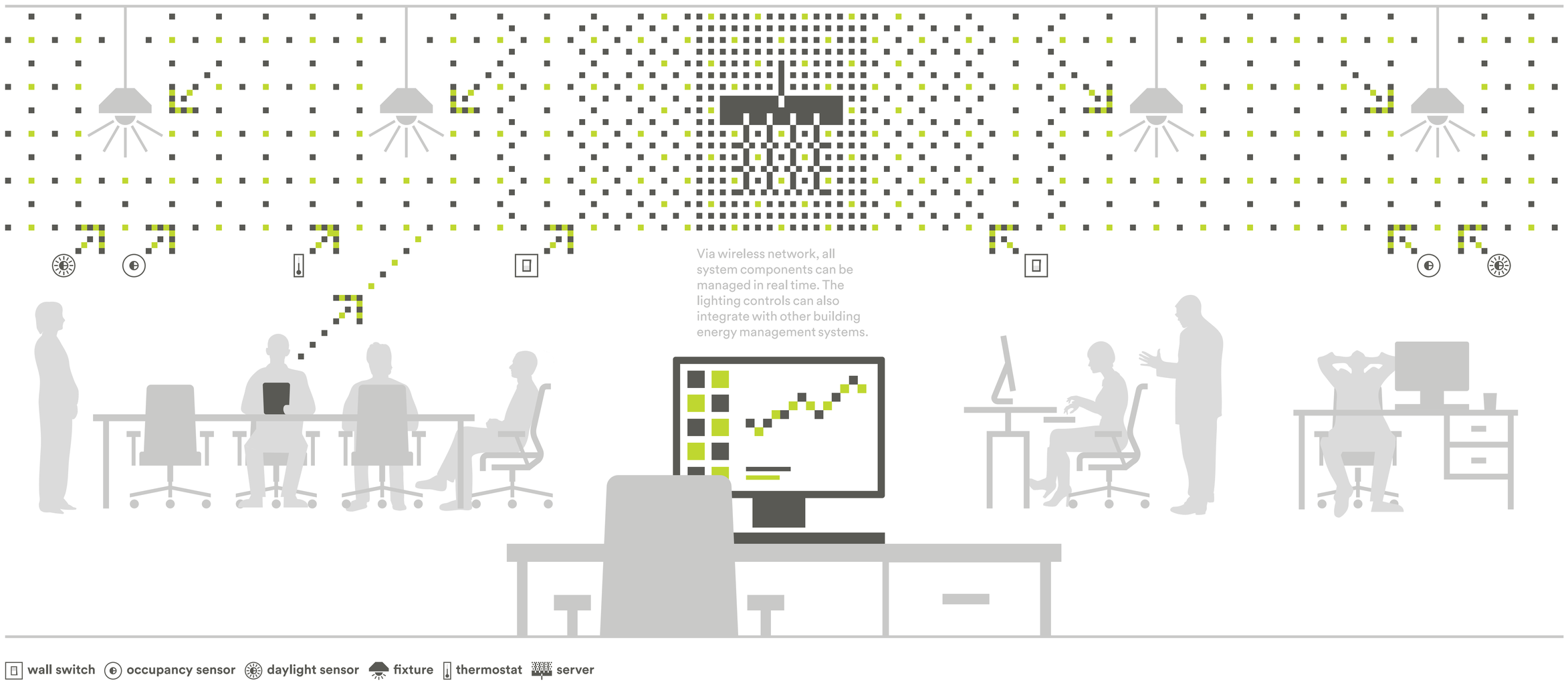
the bottom line

With DALI technology, energy-saving lighting control systems can be flexible and easy to use, expediting the successful implementation of a lighting retrofit.

to learn more visit
be-exchange.org

sensing the future

An advanced sensor network can capture energy savings along with occupancy patterns and other data.



the facts

By embracing the “internet of things” movement, advanced lighting control systems can harness real-time data on occupancy, temperature, and daylight to control lighting levels and also communicate with other systems like energy management, vertical transportation, and room scheduling.

A properly programmed system allows the system manager to set zones and even fixtures individually. An intuitive interface allows settings to be adjusted to maximize energy savings and the occupant experience.

how it works

Advanced sensors collect occupancy, ambient light, temperature, and energy consumption data.

The energy manager uses these inputs to adjust settings, monitor and analyze energy savings, and other collected data. The lighting controls can also integrate with HVAC, security, demand response, and other space management applications.

benefits

- A facilities manager can use the data to quantify savings, ensure the comfort of occupants in the space, and provide baselines for space planning.
- Settings and zones can be easily manipulated remotely through web-based system software.
- Roughly half of the savings from the installation of an advanced lighting controls system can come from occupancy and daylight sensors.

system components

fixture
mount
sensor

gateway

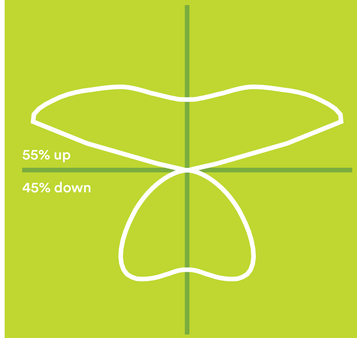
wall switch

fixture PHILIPS

The Philips TruGroove fixture offers a combination of lighting control and brightness to create a balanced luminous environment. These high-performance architectural-grade fixtures maintain gradients of light throughout the space.

look up!

lighting distribution

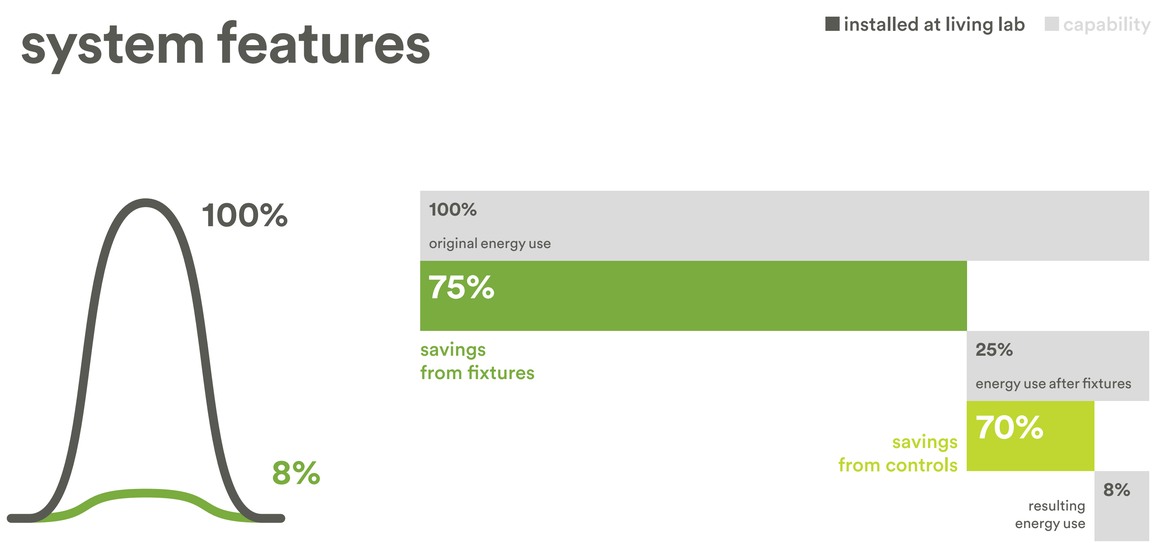


living lab link

enlighted

The Living Lab project partners were interested in using lighting system data to better understand both their lighting, HVAC, space utilization, and other needs. The Enlighted system provides advanced sensors embedded within the light fixtures that communicate minute-by-minute data and use software to drive the lighting system and provide real time information to the building managers. A single sensor unit for occupancy, daylight, and temperature is pre-installed in every fixture, reducing hardware costs, accelerating installation time, and enabling granular data collection.

system features



peak demand reduction

92%

energy savings

The Phillips TruGroove, if it were to be installed in the Living Lab would save 75% of energy from the original fixture. The Enlighted controls system is predicted by the manufacturer to save an additional 70% after the reduction from fixtures.

the bottom line

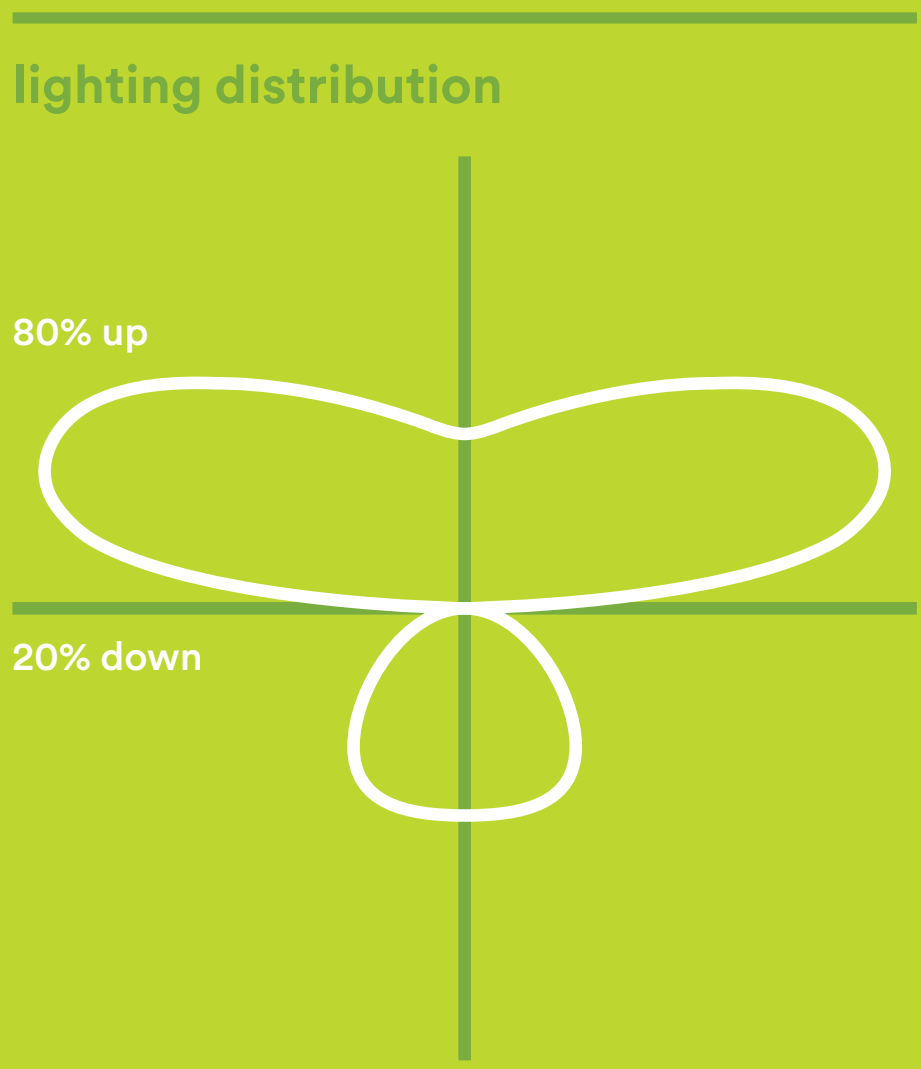
Advanced sensors enable detailed data collection while ensuring an efficient lighting controls system.

to learn more visit
be-exchange.org

fixture Peerless

look up!

This unique pendant fixture is very efficient, significantly reduces both the quantity of light fixtures and the total energy consumed by the lighting, while delivering a large amount of light. This custom Living Lab model is a 20%/80% direct/indirect luminaire. This fixture family includes recessed and linear fixtures that can be applied in a multitude of settings.



integrating daylight

Automated shading systems combine software and sensors to maximize views and useful daylight while mitigating glare and saving energy.

direct sun
Shades lower to keep direct sun from penetrating the work area

reflected sun
Shades lower to block reflections from large surfaces and to block reflected glare

overcast/dark
Shades rise to maximize views and available daylight when overcast or when in shadow

bright sky
Shades move to a predetermined position to minimize the contrast from the bright sky

the facts

With no one responsible for their operation, manual shades often remain in the “down” position, eliminating views, blocking daylight, and generally reducing the quality of the interior environment. With automated shading, sensors and algorithms ensure that the position of the shade maximizes daylight in the space and makes views available whenever feasible, while controlling for glare and solar heat gain. Automated shades can be integrated with lighting control and energy management systems to maintain optimal comfort.

benefits

- Shades are tuned to optimize the desirable amount of daylight, and lighting systems follow suit by dimming necessary electric lighting.
- Since automated shades are open far more often than manual shades, they maximize views and connect users with the outdoors.
- Software and sensors work together to reduce glare, including reflected glare from adjacent buildings.
- Properly commissioned automated shading systems enable energy savings by dimming electric lighting and can reduce the need for heating and cooling.

Taken together, the benefits of an automated shading system contribute to the highest quality office environment.

the bottom line

Though automated shading systems are a large investment, they are the most effective means of integrating daylight, reducing glare and heat gain, and maximizing occupant comfort.

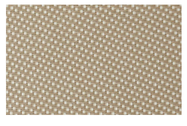
to learn more visit
be-exchange.org

look left to see the performance of Lutron's residentially focused, battery-powered roller shading in action. The Living Lab installation is the Hyperion automated system.

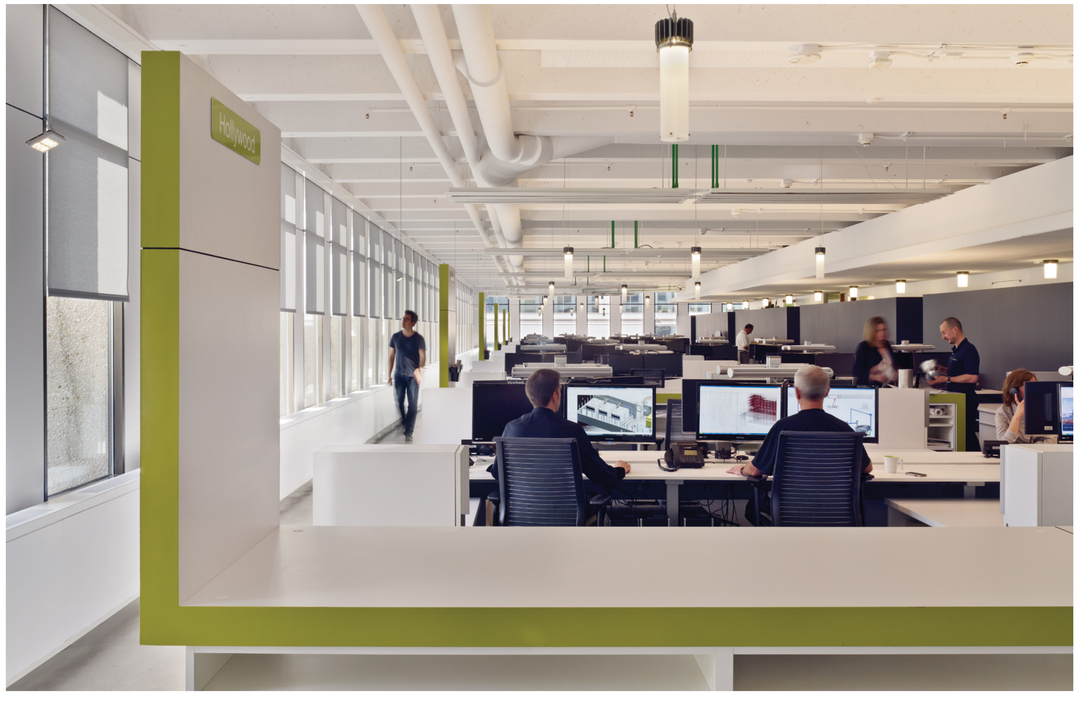
software & sensors

LUTRON®

The Lutron Hyperion shading system uses local wireless sensors that read sky conditions and communicate with a central interface to modify shade position —balancing glare, daylight, and views.



A wide variety of fabrics are available to ensure the right mix of light penetration, heat gain mitigation, and design needs.

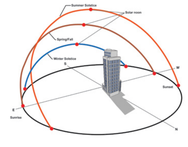


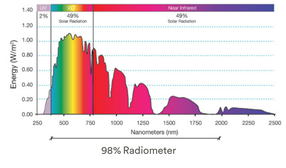
credit: Bruce Damonte

look right to see the MechoSystem's SolarTrac System in action.

modeling & radiometers

MechoSystems
Design with light.®

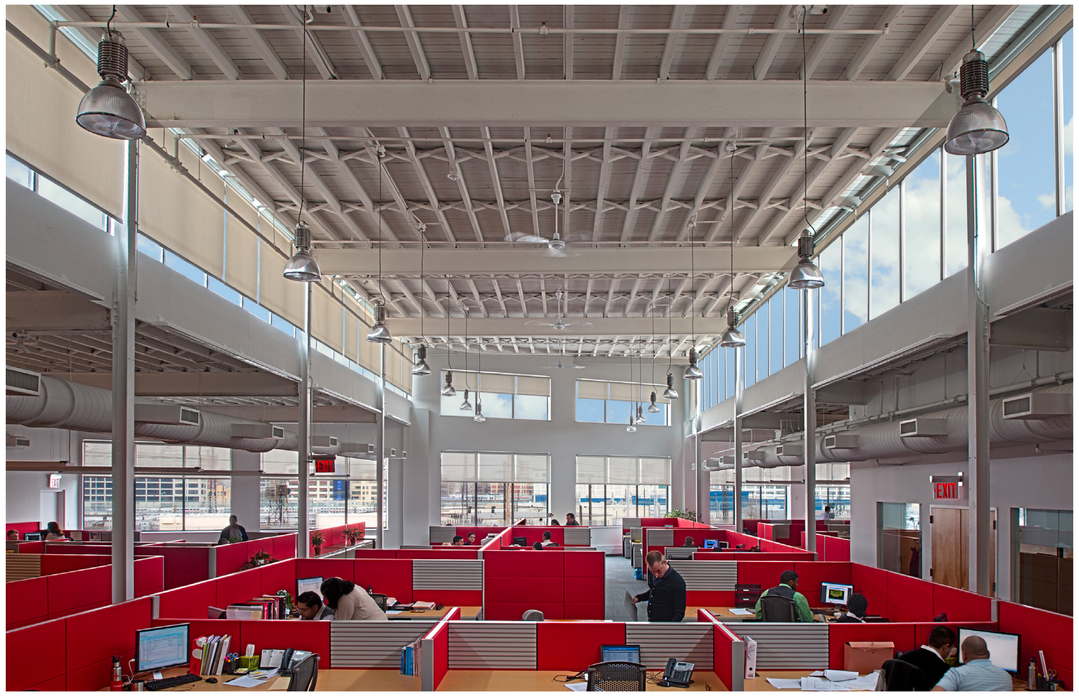




98% Radiometer

MechoSystems' SolarTrac system employs predictive modeling that utilizes a building's unique location, orientation, and architectural features to calculate the heat load on the glazing, as well as the depth of solar penetration—for every minute of every day, all year.

Visible light represents less than half the radiation spectrum. A radiometer collects data on 98% of the radiation spectrum, allowing the total solar condition to influence optimal shade positions with regard to heat gain as well as light levels and glare.



credit: MechoSystems

shade LUTRON

look up!

Battery-powered shades, such as the one exhibited here, are appropriate for many different types of retrofits as they can be easily installed and maintainted. These shades can standalone or be incorporated into an advanced lighting control system to maximize energy savings and occupant comfort.

shade SolarTrac

look up!

SolarTrac is an advanced shading control system that automatically adjust shades to optimize the penetration of daylight and heat load on a building.

MechoSystems
Design with light.®

solartrac system