LAWRENCE BERKELEY NATIONAL LABORATORY'S GETTING BEYOND WIDGETS PROJECT: ENABLING UTILITY INCENTIVE PROGRAMS FOR COMMERCIAL BUILDING SYSTEMS

PROJECT SUMMARY

Since 2014, Lawrence Berkeley National Laboratory's (LBNL's) Getting Beyond Widgets[1] project has been developing tools and resources to help utilities and regulators support utility incentive programs that go beyond component-level upgrades to achieve deeper energy savings from systems-level approaches. The project initially set out to:

- Evaluate the cost and energy savings of three integrated systems retrofits compared to "widget"-based retrofits to quantify the value of systems-level retrofit approaches.
- Perform a study to understand the current state of systems efficiency measures deployed in the market, focusing on U.S. utility custom incentive programs, large scale retrofit programs such as those related to the Department of Energy's Federal Energy Management Program (DOE/FEMP) and the U.S. General Services Administration (GSA), and projects implemented by energy service companies (ESCOs). The study is intended to inform future systems research and development (R&D).

The initial budget for the project amounted to $2.9 million,[2] including:

- $2.3 million contributed by DOE
- $550,000 (including in-kind support) of cost sharing with key partners, which included Commonwealth Edison (ComEd), Xcel Energy (CO, MN), the Northern California Power Agency (NCPA), and the Southern California Public Power Authority (SCPPA).

During the first phase of the project, LBNL conducted a study – with the support of measured performance data from its FLEXLAB[3] test facility – to estimate the energy and cost savings achieved by using three different types of integrated lighting system packages within office and/or school buildings. LBNL developed and studied each system in collaboration with an associated utility partner:

- Automated shading and daylight dimmable lighting (with ComEd)
- Workstation specific lighting with daylight dimming (with Xcel MN and CO)

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[1] Lawrence Berkeley National Laboratory (2020), Getting Beyond Widgets: Enabling Utility Incentive Programs for Commercial Building Systems

[2] Regnier, C., Lawrence Berkeley National Laboratory (2018), Getting Beyond Widgets – Integrated Systems for Commercial Buildings

[3] Lawrence Berkeley National Laboratory (2020), FLEXLAB

- Task/ambient lighting integrated with plug load occupancy controls (with California Public Owned Utilities through NCPA and SCPPA)

For each lighting system package, LBNL also developed two resources tailored to the utilities' associated markets:

1. System Program Manuals provide details on estimated energy savings for utility incentive program participants, market analysis on total potential savings in their service territories, site criteria for participant selection, and implementation guidance.
2. Assessment Methodologies offer spreadsheet tools for estimating energy savings for each participant.

Although the primary audiences for the System Program Manuals and Assessment Methodologies are the participating utilities' incentive program staff, these resources also may be used by other utilities to develop similar incentive programs, or by the design and contracting community to aid in their application. The energy savings potential offered by each of the three integrated systems packages – compared to traditional component-level upgrades – would likely be appealing to any customer: All three integrated system packages reduced lighting energy use intensity by 49% or more compared to a simple LED retrofit.[4]

FINDINGS

Upgrade Option	Lighting Energy Use Intensity in Tested Zones (kWh/sf/yr)	Lighting Energy Savings Relative to Component-based Retrofit in Tested Zones
Component-based Retrofit (simple LED)	1.48	N/A
Automated Shading & Daylighting (tested in perimeter, daylit zone)	0.61	58.8%
Workstation-Specific & Daylighting (tested in perimeter, daylit zone)	0.27	81.9%
Task/Ambient & Occupancy Controls (tested in interior, non-daylit zone)	0.75	49.3%

Key aspects of each system's potential for energy savings are as follows:

- Automated Shades with Daylight Dimming Controls System
  - The automated (versus manual) control of shading was a critical driver for savings. Shades can reduce solar gain by 50%, but daylight by 80%, so when they are used unnecessarily they may reduce daylight availability and increase lighting energy use by up to two thirds. Automated shades help maximize useful daylight while minimizing solar gain and glare.
  - Testing at FLEXLAB found lighting annual energy savings in perimeter, daylit zones for offices and schools ranging from 12% to 30% from automated shading paired with

[4] Regnier, C. et al., Lawrence Berkeley National Laboratory (2018), "Energy Cost Savings of Systems-Based Building Retrofits: A Study of Three Integrated Lighting Systems in Comparison with Component Based Retrofits."

daylight dimming alone; i.e., not including LED retrofit savings. In office and school market segments in ComEd's service territory, the total technical potential for savings was estimated at 519-633 GWh.

- The Total Resource Cost (TRC) criterion[5] – which determines a utility program's cost effectiveness – was 0.25-0.28 for ComEd's retrofit scenario and 0.44-0.53 for the Replace on Burnout scenario. The relatively low TRC was largely due to the current high cost of automated shades and also low utility rates in the service area.

- Workstation Specific Lighting System with Daylight Dimming Control System
  - Testing at FLEXLAB found lighting annual energy savings of 82%, relative to a simple LED retrofit, in south-facing daylit perimeter zones for large and medium office buildings. Savings are driven by the combination of a high-resolution sensor network and workstation-specific LED lighting in open-plan offices.
  - Localized daylight harvesting to dim individual lights has the potential to deliver 35% additional energy savings compared to using a single sensor for an entire daylighting zone.[6]
  - The simple payback period for this system (see Table 1) is shorter than the payback period for an LED-only fixture retrofit, but longer than an LED-only fixture implementation for new construction.
- Task/Ambient Lighting with Plug Load Occupancy Controls System
  - Before testing, LBNL estimated 46% or more lighting energy savings for this system in small and large office buildings. Testing in FLEXLAB found savings of 30% to 38% in lighting and plug load annual energy consumption across small and large commercial buildings.
  - The simple payback period (see Table 1) is shorter than the payback period for an LED-only fixture installation for both retrofits and new construction.

Table 1. Cost-effectiveness of component- vs. systems-based energy efficiency measures; *assuming a flat utility rate of $0.11 per kWh*

Scenario	Energy Efficiency Measure	Estimated Installation Cost per ft² for Tested Zones	Annual Energy Cost per ft² for Tested Zones	Annual Cost Savings per ft² for Tested Zones	Simple Payback for Tested Zones
-	*Baseline: fluorescent lighting with scheduled control*	*$3.32*	*$0.44*	-	-
Retro fit	*LED lighting only*	*$5.00*	*$0.16*	*$0.28*	*17.8 years*
	Automated Shading & Daylighting (tested in perimeter, daylit zone)	$10.18	$0.07	$0.37	27.3 years

[5] The TRC ratio measures the cost-effectiveness of an energy efficiency program by comparing the monetary savings from reduced energy use to the costs of operating the program. A system is typically considered cost-effective if the TRC ratio is greater than or equal to 1.0. Lawrence Berkeley National Laboratory (2017), "Better Buildings Residential Energy Efficiency Cost-Effectiveness Tool Version 2.0: Introduction and Demonstration"

[6] An overhead LED light fixture dedicated to a workstation, controlled to provide 400 lux per desk, achieved 79% energy savings compared to a code-compliant baseline system.

	Workstation-Specific & Daylighting (tested in perimeter, daylit zone)	$6.52	$0.03	$0.41	15.9 years
	Task/Ambient & Occupancy (tested in interior, non-daylit zone)	$5.07	$0.08	$0.36	14.1 years
Major Renovation, ROB, New Construction	*LED lighting only*	*$0.61*	*$0.16*	*$0.28*	*2.2* years
	Automated Shading & Daylighting (tested in perimeter, daylit zone)	$4.06	$0.07	$0.37	10.9 years
	Workstation-Specific & Daylighting (tested in perimeter, daylit zone)	$2.14	$0.03	$0.41	5.2 years
	Task/Ambient & Occupancy (tested in interior, non-daylit zone)	$0.68	$0.08	$0.36	1.9 years

LOOKING FORWARD

LBNL's Getting Beyond Widgets project is continuing to explore opportunities for utility incentive programs to achieve deeper savings through systems-level solutions. Upcoming analysis will identify new systems to be developed into program manuals and assessment tools, and will include:

- Incorporating the value of peak demand savings into systems-level incentive programs.
- Assessing demand response strategies as well as time-of-use rate impacts within systems-level incentive programs to support the emerging development of grid-interactive efficient buildings.

Table 2 provides the timeline and geographical scope for the various analysis.

Table 2. Timeline Overview for LBNL's Beyond Widgets Project

Project	Getting Beyond Widgets
Timeline	• 2016: Systems specifications and descriptions of applicable customer sites made available • 2017: Systems Program Manuals & Assessment Methods published • 2018: First three systems test results and final report published • 2020: "System Retrofit Trends in Commercial Buildings" study published • 2020/21: Next systems identified, testing and analysis
Location of Utility Partners	• ComEd, Illinois • California Public Owned Utilities, NCPA and SCPPA, California • NYSERDA, New York • Pacific Gas and Electric Company, California • Southern California Edison, California • Xcel Energy, Minnesota & Colorado