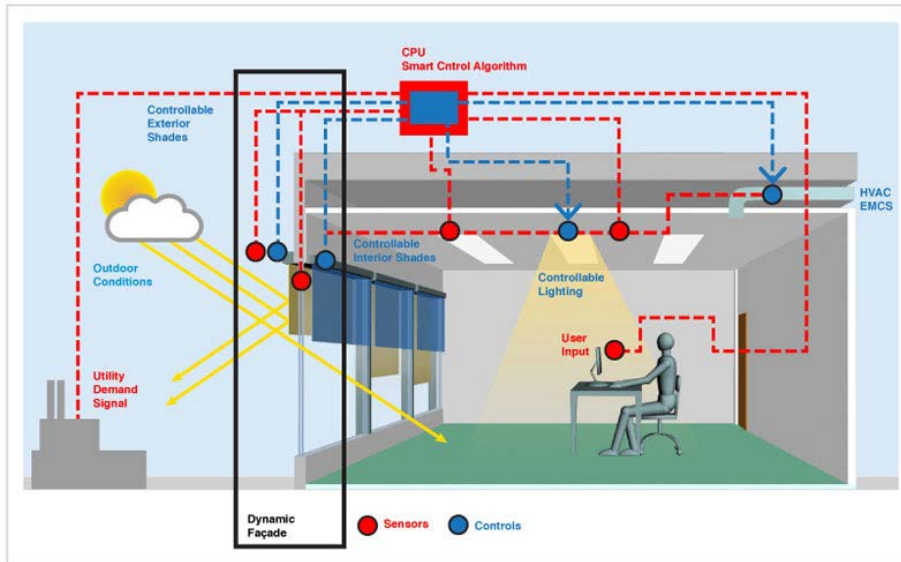
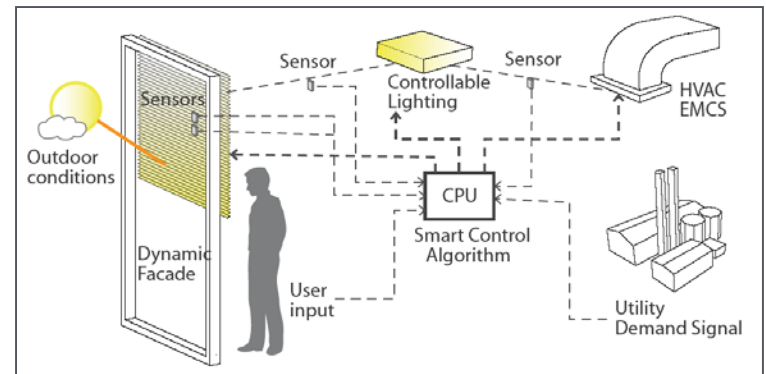


'Beyond Widgets' – Systems EE for Utilities

2017 Building Technologies Office Peer Review



<http://www.sunproject.com/sustainable-design/dynamic-facades-and-shading>



Project Summary

Timeline:

Start date: Oct. 1, 2014

Planned end date: Sept. 30, 2017

Key Milestones

1. Test results for all 3 systems; March 31, 2017
2. Completed Program Manuals for 3 systems; June 30, 2017

Budget:

Total Project \$ to Date:

- DOE: \$1.9M
- Cost Share: \$450k (including in-kind)

Total Project \$:

- DOE: \$2.2M
- Cost Share: \$450k (including in-kind)

Key Partners:

ComEd Illinois
Northern California Power Agency
Southern California Public Power Authority
Xcel Minnesota
Xcel Colorado

Project Outcome:

Working with at least 3 utilities, three systems have been developed and validated for Demand Side Management incentive programs.

Primary deliverable is a comprehensive Program package used by utilities to develop systems incentive programs. Results of systems testing indicate that each system provides energy savings as predicted and is cost effective for its target market.

Purpose and Objectives – Problem and Audience

Problem Statement: Utility incentive programs are a highly effective means of deploying building technologies to scale. However, these programs have been largely limited to component-based products (e.g., lamps, RTUs), and many utilities under increasingly stringent code baselines are finding it difficult to find more cost-effective technologies to incentivize. *Utilities have expressed that systems are highly desirable for their programs, but they lack the knowledge, methodologies, and controlled testing environment to engage in this area with the level of accuracy and confidence in the savings required.*

Target Market and Audience: Utilities with commercial Demand Side Management programs. Both Investor Owner and Public Utilities are included as target markets. System selection anticipated to cover both small/medium and large commercial applications.

Purpose and Objectives

Problem Statement:

- Utility portfolios currently set up for widget-based incentive programs
 - Technical Reference Manual doesn't cover systems
 - Deemed savings approaches are currently suited towards 'widget' technologies only
- M&V potential costly endeavor with systems
- Subset of cost-effective energy-saving component technologies are becoming smaller
- Systems technologies assessments are difficult under current pilot demonstration approach
- Field demonstration model makes it very difficult to provide true apples-to-apples comparisons of systems

"NCPA member utilities have been committed to energy efficiency for years. The 'Beyond Widgets' project lays an essential foundation for future programs aimed at unlocking deeper energy savings from integrated systems."

- Jonathan Changus, NCPA



Photo Courtesy of: Shenzhen HSG LED Lighting Co., Ltd.



Purpose and Objectives

Target Market: Specific sub-sectors of the commercial building market, according to requirements of each of the 3 utility partners.

- ComEd – Commercial offices (medium-large) and K-12 education
- Xcel – Commercial offices (medium-large)
- CA POU – Commercial offices

Impact of Project: Three energy efficient systems DSM programs will be launched through 3 utilities, expected for roll out in 2018/19.

Near-term and intermediate term will depend on the number of utility partners – test results indicate significant contribution to achieving 20% whole building savings in existing buildings.

Long-term impact (3yrs+) will be measured by the results of the systems EE DSM programs implemented by the partner utilities, and the number of other utilities launching similar efforts.



Purpose and Objectives

Impact of Project

- Total technical energy savings potential in just the market areas of the current utility partners was originally estimated at 0.015 Quads through detailed market analysis undertaken by a third party consultant (DNV). Assuming a 20% incentive uptake in all 3 utility areas and average whole-building energy savings of 20% - total annual direct energy savings = 600 Billion Btus. At commercial electricity rates of \$0.16/kWh, annual energy cost savings of approximately \$27.5 million.
- Testing of all three systems for all three utilities supports initial estimates of cost-effectiveness under market conditions

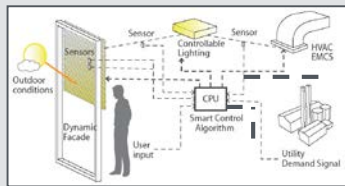
Relative to BTO Strategic Goals

- *Demonstrate and validate new, highly energy efficient and integrated design solutions* – Tested systems indicating potential savings of up to 25% at the whole building level. Significant contribution toward the 30% EUI improvement for existing buildings, and 50% EUI improvement for new construction

Approach

Developed validated Building Systems Packages for utility energy efficiency incentive programs:

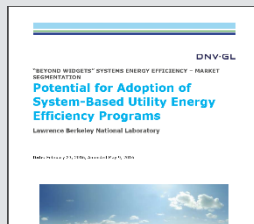
- Partnered with 3 utility groups
- Developed and tested packages for 3 integrated systems



Expand rebate-qualified specifications to include systems



Savings & performance metrics



Quantify Market Impact

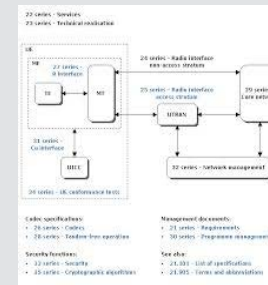
Building Systems DSM Package



FLEXLAB Savings and Data to 'deem' System savings



Systems-appropriate M&V options analysis



Savings persistence guidance for customers



Program implementation guidelines, training

FLEXLAB – Facility for Low Energy Experiments in Buildings

- **FLEXLAB** at LBNL, DOE’s unique facility dedicated to:
 - Developing & validating solutions for highly-efficient, **integrated building systems under realistic operating conditions**
 - Focus includes:
 - ◆ Systems integration at end use, whole building & grid interaction levels
 - ◆ End-use integration & component interactions (e.g., HVAC, lighting, windows, envelope, plug loads control systems)
 - ◆ Controls hardware & sensors
 - ◆ Simulation & tools for design through operations
- Commercial buildings focus, with applications relevant to office, retail, educational, multi-family
- **High accuracy, very granular power measurement, sensing & instrumentation**
- Energy efficiency studies, including thermal & visual comfort & occupant engagement



Approach

Key Issues:

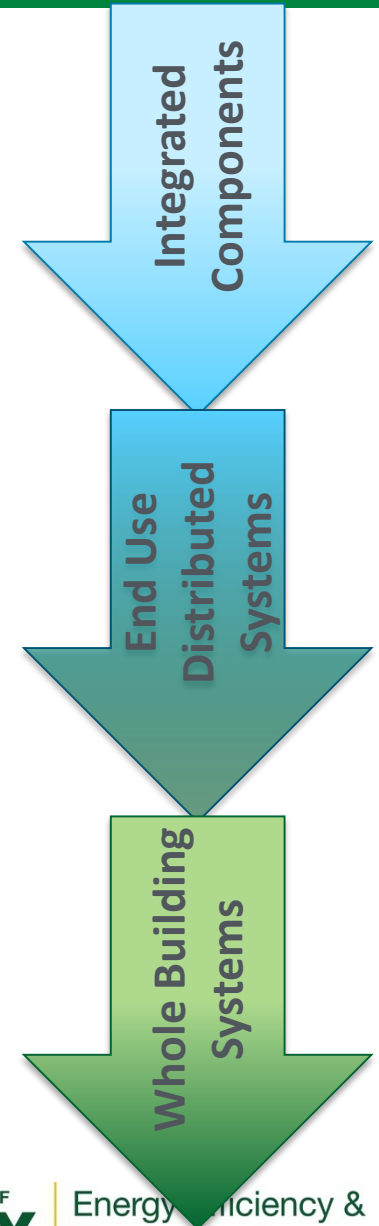
- Finalizing results of testing for all 3 systems
- Analysis of M&V methods to determine savings uncertainty associated with proposed methods and impact on rebates offered.
- Development of training and implementation guidelines for utilities and their customers for effective program roll-out.

Distinctive Characteristics:

- Utility DSM programs traditionally use field assessments to verify EE technologies' energy savings for various market sectors. These ex-post evaluations typically engage their evaluators in an expensive, high customer touch involvement using a variety of means to evaluate program efficiency.
- This **traditional approach is not viable for systems EE opportunities**, where a much higher degree of variables are present that are extremely difficult to isolate & monitor without intensive capital investment in submetering & sensing.
- **FLEXLAB** presents an innovative system technologies assessment opportunity, enabling a variety of use cases (climate conditions, ventilation loads, etc.) to be run that provides high accuracy, validated data that can streamline empirical approaches to systems EE delivery.

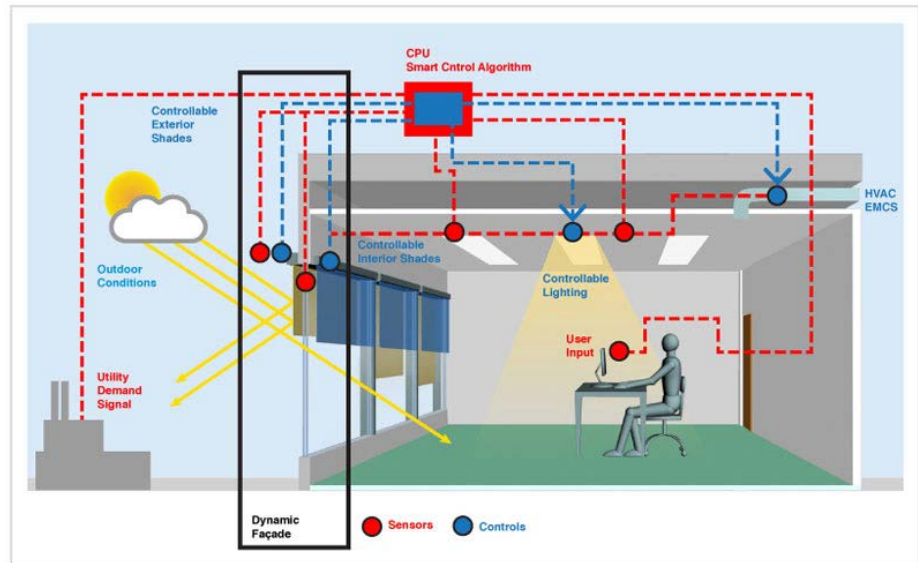
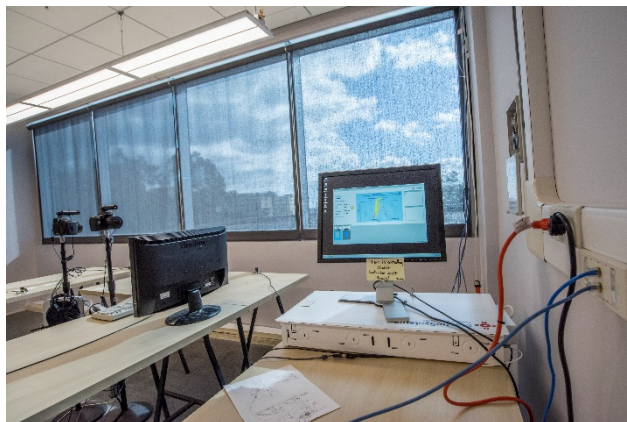
What is a System?

- **Multiple components** coupled together with controls:
 - Rooftop units coupled with energy recovery ventilators
 - Dimmable lighting system controls coupled with automated shades
- **End use distributed systems** (HVAC, lighting, etc.)
 - Zonal lighting systems
 - HVAC airside distribution systems –
 - ◆ Air handlers, ducts, terminal units, dampers, diffusers
 - HVAC wet-side distribution systems –
 - ◆ Pumps, valves, coils
 - HVAC central plants –
 - ◆ Cooling tower & pumps
 - ◆ Chiller & pumps
 - ◆ Cooling tower coupled with chillers
- **Whole building systems integration**
 - HVAC systems integrated with automated shades & occupancy controls



Integrated End-use System 1 – ComEd partner utility

- Automated shading integrated with daylight dimming
 - Target markets: commercial office, education (K-12)
 - Provision of electric lighting according to available natural light
 - Automatic shades for glare control
 - Multiple office configurations, façade orientations, and seasons
- Potential interactive effects with HVAC systems
- Existing building condition baseline
- Predicted whole building energy savings between 9 - 23%

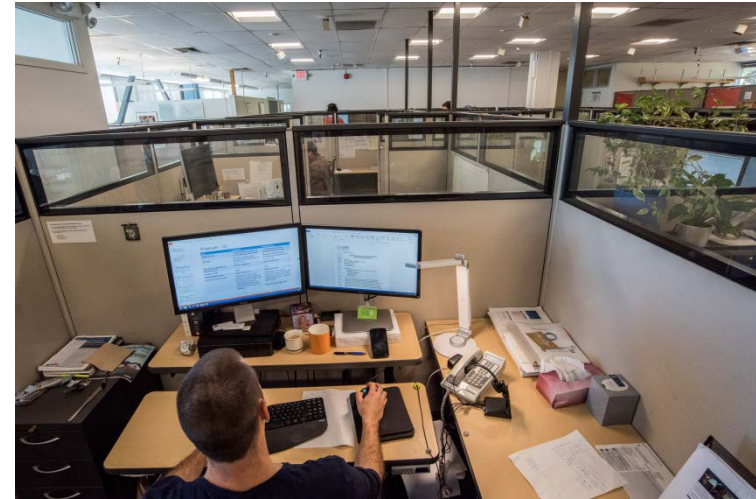


<http://www.sunproject.com/sustainable-design/dynamic-facades-and-shading>

- Measured energy savings
 - Electric lighting: seasonal savings of 30% - 90% depending on façade orientation and daylit zone depth
 - Spot analysis of test data suggests whole building savings within predicted range
 - Negligible HVAC impact

Integrated End-use System 2 – California POUs

- Integrated task/ambient lighting with occupancy-based plug load controls
 - Target market: Commercial offices
 - Reduced output from overhead lighting
 - Desktop task lighting to augment work space lighting levels
 - Occupancy control of power to non-computer desktop loads, including task light
- Existing building and Title 24 baselines
- Predicted energy savings (whole building) of 16 – 21% against existing building condition



- Measured energy savings (annualized)
 - Overhead electric lighting: 70% - ~90% against measured baseline / existing building condition; 25% - ~50% against Title 24 baseline
 - Plug load savings of 5-10% despite inclusion of additional task lighting
 - Whole building energy savings of 15-25% (existing) and 6-11% (T24)

Integrated End-use System 3 – Xcel (MN and CO)

- Workstation-specific lighting integrated with daylight dimming
 - Target market: medium-large commercial office
 - Daylight dimming¹
 - Provision of lighting according to need
 - Glare mitigation via manual blinds
 - Enterprise-level intelligent lighting system controls



- Assessed against existing building conditions
- Existing building condition baseline
- Predicted energy savings (whole building) between 18 – 33%
- Measured energy savings
 - Electric lighting: seasonal savings of 65% - ~90%
 - Spot analysis of test data suggests whole building savings within predicted range



1. Additional savings likely when occupancy controls are also included

Progress and Accomplishments

Accomplishments:

- Measured results indicates systems achieving deep energy savings at levels predicted

Market Impact:

- Existing project in final year of 3 years, testing completed, final analysis under way
- All three utilities intending to roll out as part of wider DSM program
- In talks with other utilities regarding launch of similar initiatives

Awards/Recognition: N/A

Lessons Learned:

- Tuning of light levels important for energy savings
- Involvement of multiple trades in some systems may require program design to also target system delivery methods for success
- The level of technical assistance and design costs required to implement a good window film solution is beyond current rebate program administrative costs
- Occupant survey currently under way for insights on operations
- Lessons learned during procurement, installation and testing
- Project schedule timed with utility regulatory cycles



Project Integration & Collaboration

Project Integration:

- With active utility partners (3 groups) through regular meetings
- With other relevant energy efficiency programs at conferences and working groups

Partners, Subcontractors, and Collaborators:

- As a member of the Consortium for Energy Efficiency (CEE), LBNL has shared results with the CEE lighting committee - project has alignment with their work plans / objectives.

Communications:

- Presented at CEE Summer & Winter Meetings, (Lighting Working Group) and provided updates at key project stages
- ACEEE (American Council for an Energy Efficient Economy) Summer Study paper and presentation
- In regular communications with utility partners that will be deploying these systems as part of their DSM program

Ongoing Support of Utility Partners

“The measured savings data from FLEXLAB is invaluable as we look to incorporate integrated systems into our energy efficiency offerings.”

- Travis Nelson, ComEd Illinois



“SCPPA is pleased to be directly involved in the "The 'Beyond Widgets' research project with LBNL. The work to-date has validated for our utility members' belief that integrated systems can be cost-effective and technically sound means to save energy. We look forward to completing this work with LBNL staff and sharing the positive results with Members and other utilities in the state and around the nation.”

- Bryan Cope, SCPPA



Next Steps & Future Plans

Next Steps & Future Plans:

- **Complete energy savings analysis of results for all 3 systems** and update Program documentation.
- **Undertake assessment of potential M&V approaches for all 3 systems** to appropriately value post installation measurement methods and resulting uncertainty-adjusted rebates
- **Develop assessment methodology for all 3 systems** to support appraisal of customer sites for inclusion within a systems-based rebate program.
- **Review Program Manuals with utility partners** for compatibility with current and future rebate programs and **assist with launch of utility DSM programs**
- **Deliver final Program package to partner utilities** incorporating comments and feedback
- **Submit final Program package** to DOE as final project deliverable.
- **Develop broader strategy for systems deployment with utilities**

REFERENCE SLIDES

Project Budget

Project Budget:

- \$2.2M

Variances:

- None to date. Utility partners cost share is being developed as they engage with the project & systems selection occurs. Cost share includes their providing equipment for FLEXLAB systems testing, in-kind cost share & other.

Cost to Date:

- \$1,890K to end of Jan 2017

Additional Funding: N/A

Budget History

Previous Years Spending			FY2017 (to date)		FY2017 (planned)	
DOE FY2015	DOE FY2016	FY16 Cost Share	DOE	Cost-share	DOE	Cost-share
\$420K	\$1,050K	\$250k	\$420K	\$50k	\$265K	\$150k

Project Plan & Schedule

- Project started Oct. 1, 2014, completion projected Sept. 30, 2017
- FY17 schedule: confirmation of ongoing utilities support following test results, final Program package with test results, program implementation findings.
- Go/no-go confirmation of utility support following of system test results for CA POU systems somewhat delayed, but provided in Q1. Results for other 2 systems currently being processed, for deliver end Q2.
- Current work and future work includes completion of testing, development of assessment methods for potential customer sites, evaluation of M&V techniques in relation to uncertainty and rebate levels setting, and completion of Program package for handover to partner utilities and delivery to DOE.

Project Schedule							
Project Start: Oct 1, 2014		Completed Work					
Projected End: Sept 30, 2017		Active Task (in progress work)					
	◆	Milestone/Deliverable (Originally)					
	◆	Milestone/Deliverable (Actual)					
		FY2016			FY2017		
Task		Q3 (Apr-Jun)	Q4 (Jul-Sep)	Q1 (Oct-Dec)	Q2 (Jan-Mar)	Q3 (Apr-Jun)	Q4 (Jul-Sep)
Past Work							
Q4 Milestone: Final system 1&2 package with test results				◆			
Q1 Go/no-go: Confirmation of utility support following test results					◆		
Current/Future Work							
Q2 Milestone: Final system 3 package with test results						◆	
Q3 Milestone: Program Manual Final Draft							◆
Q4 Milestone: Program implementation findings							◆