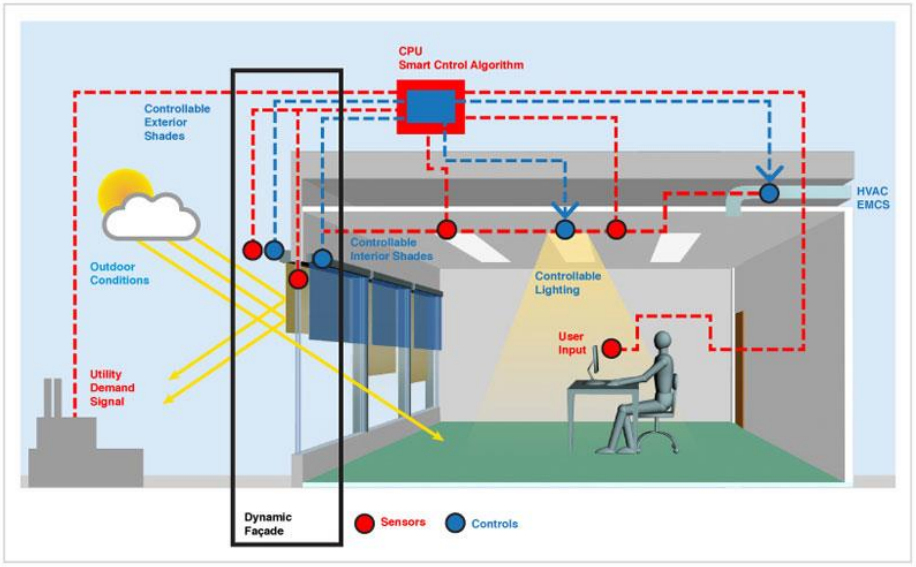
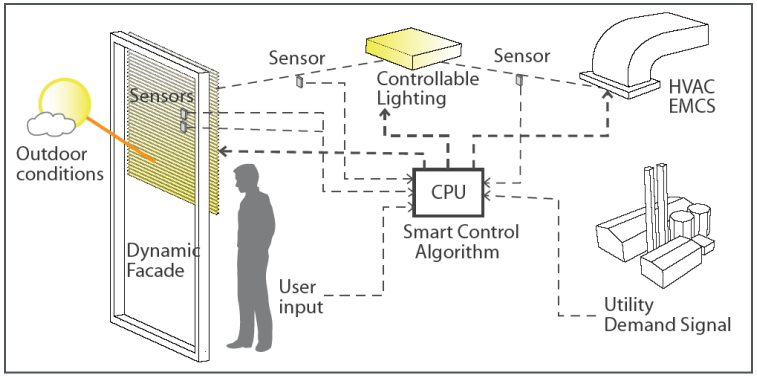
‘Beyond Widgets’ – Systems EE for Utilities

2015 Building Technologies Office Peer Review



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



U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

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Project Summary (New Project)

Timeline:

Start date: Oct. 1, 2014 (NEW PROJECT)

Planned end date: Sept. 30, 2017

Key Milestones

1. Identify and process for obtaining commitment from utility industry organization; Jan 31, 2015
2. Initial commitments from partner Utilities; Feb 28, 2015

Budget:

Total DOE $ to date: $700k

Total future DOE $: $2M

Target Market/Audience:

Utility DSM programs, both Investor Owned Utilities (IOUs) and Public Owner Utilities (POUs), less advanced DSM programs, including their regulators and evaluators.

Key Partners:

ComEd	CEE
NCPA	ASE
SCPPA	(National Grid?)
Xcel MN	
Xcel CO	

Project Goal:

Working with at least 3 utilities, three systems will be targeted for development into Demand Side Management incentive programs. Barriers to the development and implementation of systems EE programs will be identified and addressed, working with regulators and evaluators. Systems will be validated for energy savings and implementation through testing in FLEXLAB, a test facility designed to study systems and systems integration.

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.

Assuming the utility partners have 10% of commercial sector energy use, the system EE program addresses 25% of territory, an incentive uptake of 20% and average savings of 30% - total direct savings = 26 Tbtu

Challenges for Utilities

- Portfolios currently set up for widgets
  - Technical Reference Manual doesn't cover systems (engineered/calc measures, TRM for each region)
  - Deemed savings approaches are suited towards 'widget' technologies
- Most systems-based measures lack consistent M&V protocols
- Subset of cost-effective energy-saving component technologies are becoming smaller with increasingly more stringent code
- 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 with robust data to enable extension to other customer conditions

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

Purpose and Objectives - Impact

Impact of Project: Three energy efficient systems will be launched through at least 3 utilities, with validated energy savings and an implementation package to enable deployment to other utilities. The impact path will include both the deployment of these programs through the partner utilities, but also through the uptake generated through engagement with others, e.g. through the CEE working groups. Near-term and intermediate term impact is tracked by the number of utility partners on board >= 3. 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.

ComEd
An Exelon Company

A PUBLIC AGENCY
NCPA
NORTHERN CALIFORNIA POWER AGENCY

SCPPA

Xcel Energy℠

LA DWP
Los Angeles Department of Water & Power

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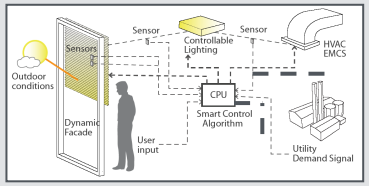
Approach

Approach: Develop validated Building Systems Packages for utility energy efficiency incentive programs

- Partner with at least 3 utilities
- Develop packages for at least 3 systems

Building Systems DSM Package



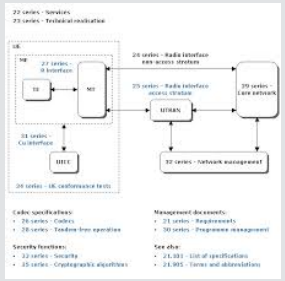
System specifications for market

Savings & performance metrics

M&V specifications

FLEXLAB Test Protocol - Validated Savings and Data

Controlled testing and validation of systems



Savings persistence guidance

Program implementation guidelines, training

Approach

Key Issues:

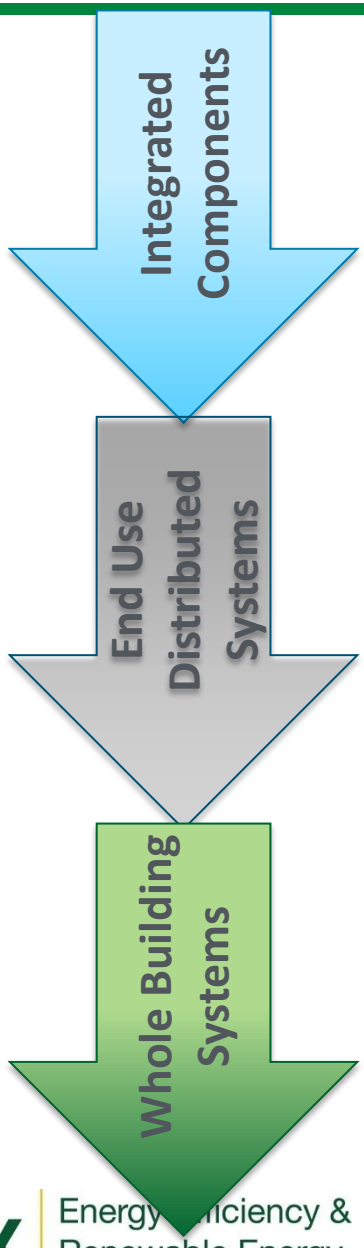
- System selection needs to meet the project's 'system' definition & be market viable (i.e. existing commercialized technology).
  Discussions with utilities include examples of appropriate system types.

Distinctive Characteristics:

- Utility DSM programs traditionally use field assessments to verify EE technologies' energy savings & to validate their approaches for customer deployment into 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 & understand without intensive capital investment in submetering, monitoring equipment & 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.

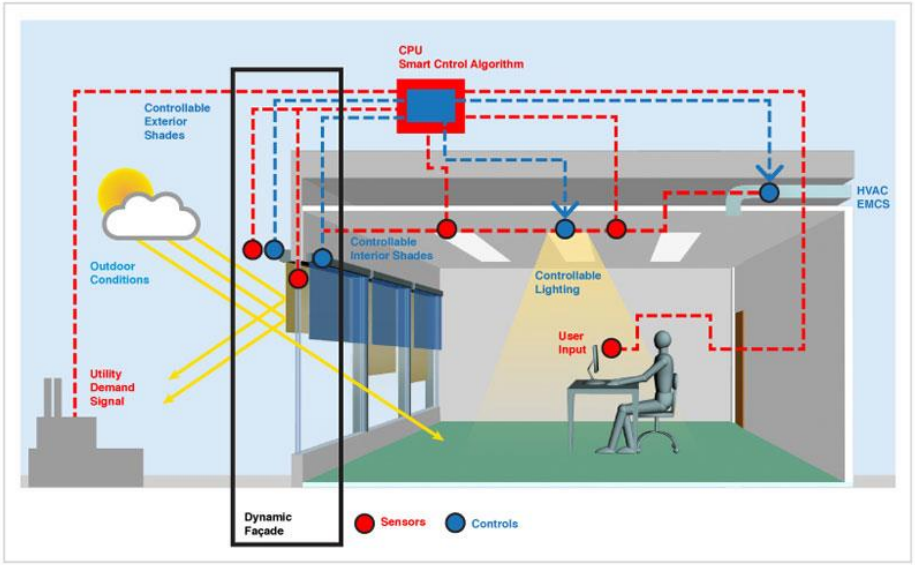
What is a System?

- **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 wetside 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



Potential Systems – Integrated End-use Systems

- Interconnected automated shading & HVAC system
  - Occupancy based controls, two-way control - e.g. in unoccupied cooling mode, shading down
- Any load reduction strategy (lighting or envelope) coupled with HVAC retrofit for part load efficiency right sizing & optimization, may include:
  - Fan motor downsizing
  - Static pressure reset
  - Controls modifications to reduce cycling
  - Aerosol-based technology for internal sealing of air distribution systems (Reducing leakage from 20% to 5% reduces fan power by about 20 to 25%)

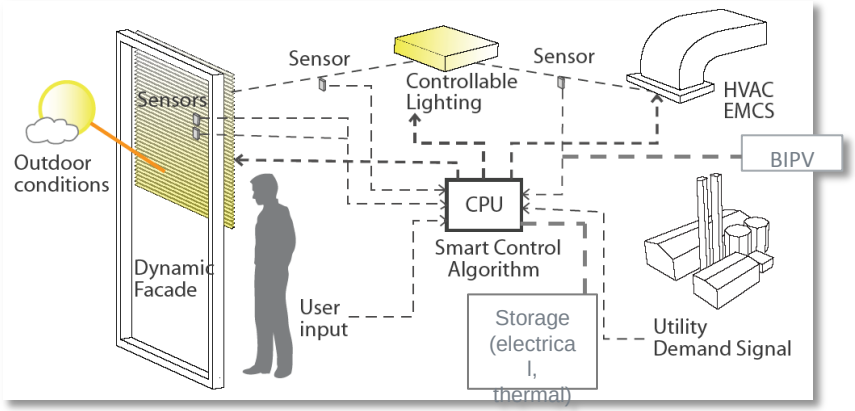


http://www.sunproject.com/sustainable-design/dynamic-facades-and-shading

- VAV conversion via wireless energy management system overlay, to include temp., humidity & pressure sensors
- Convert energy-wasting, constant-air-volume systems to VAV w/out incurring terminal boxes' installation capital cost
- Optimized duct static pressure control
- Save 25-30% of fan power

Potential Systems – Integrated End-use Systems

- Interconnected/integrated lighting & HVAC control systems
  - Occupancy-based controls, scheduling, auto-DR
  - Stand-alone lighting controls systems
  - Enterprise-level intelligent lighting system controls
  - Energy management systems
- Meso-optic window film retrofit & deep daylight dimming
- Interconnected lighting & plug load control systems
  - Occupancy-based controls



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**
  - Research 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
  - New construction & retrofit
- **High accuracy, very granular power measurement, sensing & instrumentation**
- Energy efficiency studies, including thermal & visual comfort & occupant engagement

Progress and Accomplishments

Lessons Learned:

- Project schedule will need to be timed with some utility regulatory cycles in order to ensure timely application into approved DSM program.

Accomplishments:

- Exceeded 3 utility commitment minimum, including IOUs & traditionally underserved POU market, formed into 3 utility groups:
  1. ComEd (Chicago); (National Grid?)
  2. A consortium of dozens of Public Owned Utilities (POUs) in California covering Northern and Southern territories, including LADWP
  3. Xcel (MN & CO)

Market Impact: (New Project)

- New project in early initiation phase; measured impacts are expected in later implementation phase.
- Early successful outreach efforts through utility community (dozens through conferences, meetings & one-on-one engagement) achieved commitments. This project will continue to 'bring along' utility community by engaging with key stakeholders like CEE, & align ourselves to influence systems policy, codes & standards development through participation in ASE's systems working groups.

Awards/Recognition: N/A

Project Integration & Collaboration

Project Integration:

- Project integration occurs both with the active utility partners (3 groups) through regular meetings, & with the additional partners, CEE & ASE at conferences & working group meetings.

Partners, Subcontractors, and Collaborators:

- Consortium for Energy Efficiency (CEE) is a project partner – our project developments & results will be disseminated to their working groups at key points. CEE represents dozens of additional utilities across the U.S.. This project has been identified as in key alignment with their working groups' workplans & objectives.
- The Alliance to Save Energy (ASE) is also conducting a scoping study on barriers & opportunities for systems-based, energy efficiency deployment through market mechanisms, including utility programs & codes & standards. Project team members will check in with ASE project managers on periodic intervals with relevant updates.

Project Integration and Collaboration

Communications:

- Presented at CEE Summer & Winter Meetings, (Lighting Working Group)
- Coordination plan developed with CEE for checkins & presentations for input at various project stages. Provides a deployment opportunity to dozens of additional utilities.

- Coordination with ASE on their scoping study for systems EE. Will be involved with their working groups for systems integration.

CEE SM
Consortium for Energy Efficiency

ALLIANCE TO SAVE ENERGY
Creating an Energy-Efficient World

Next Steps & Future Plans

Next Steps & Future Plans:

- **Complete system selection & conduct market segmentation**. Develop value proposition & outline of protocols to extent needed to select systems
- **Coordinate with utility stakeholders** to introduce the project objectives & ensure project design and outcomes are framed to meet the needs of all parties, & enable future successful systems EE deployment for DSM programs
- **Develop the draft system packages** in preparation for FLEXLAB testing and validation & review with utility programs & regulators
- **Obtain firm utility program commitments** to develop systems incentive programs & work with regulators to obtain approval.
- **Develop draft packages**.
- **Conduct FLEXLAB testing of the protocols**.
- Early discussions on system selection have highlighted a need by utilities to be able to better identify peak HVAC system sizing for retrofit conditions that does not require full custom level simulation approaches. Future work may look at other empirical methods to enable this work, such as through the use of Smart Meter data.

REFERENCE SLIDES

Project Budget

Project Budget:

- NEW PROJECT starting FY15 ($700k); FY16 & 17, $1M/yr

Variances:

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

Cost to Date:

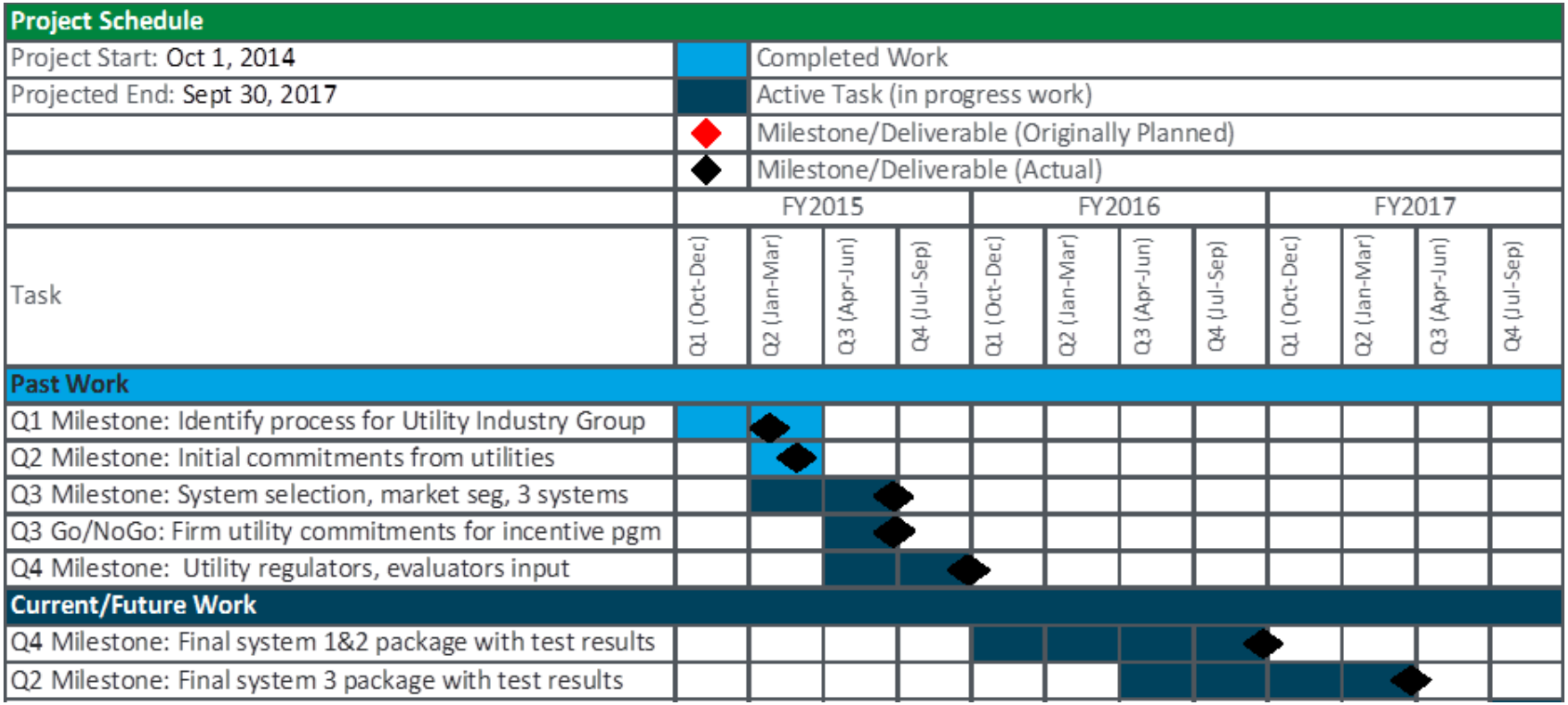
- $120K to end of Feb (will be updated prior to submission)

Additional Funding: N/A

Budget History					
FY2014 (past)		FY2015 (current)		FY2016 – FY2017 (planned)	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
N/A	N/A	$700K	TBD	$2M	TBD

Project Plan & Schedule

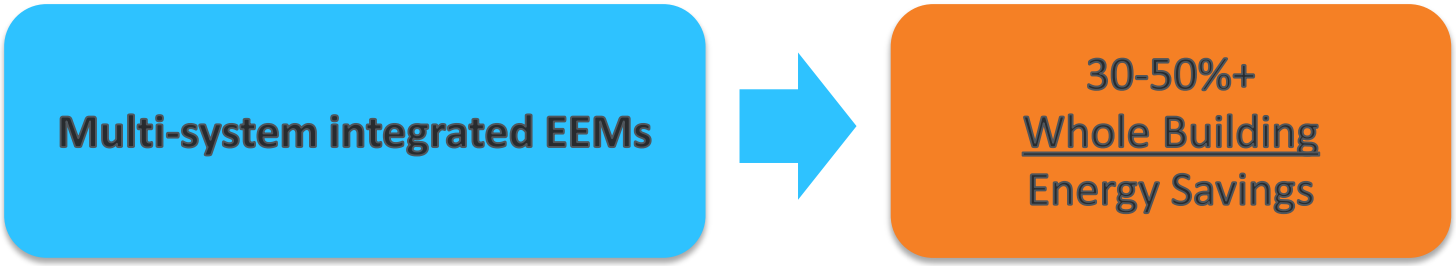
- Project started Oct. 1, 2014, completion projected Sept. 30, 2017
- FY15 focused on gaining utility partner commitments, system selection, engagement with regulators & evaluators, system specifications, savings & performance metrics, savings validation test plan development, implementation plan framework
- Go/no-go points consist of firm utility commitments to implement a systems EE incentive program; buy-in from regulators on systems packages & satisfactory system test results
- Current work includes system selection with utilities, engagement with regulators & evaluators, alignment with regulatory cycles



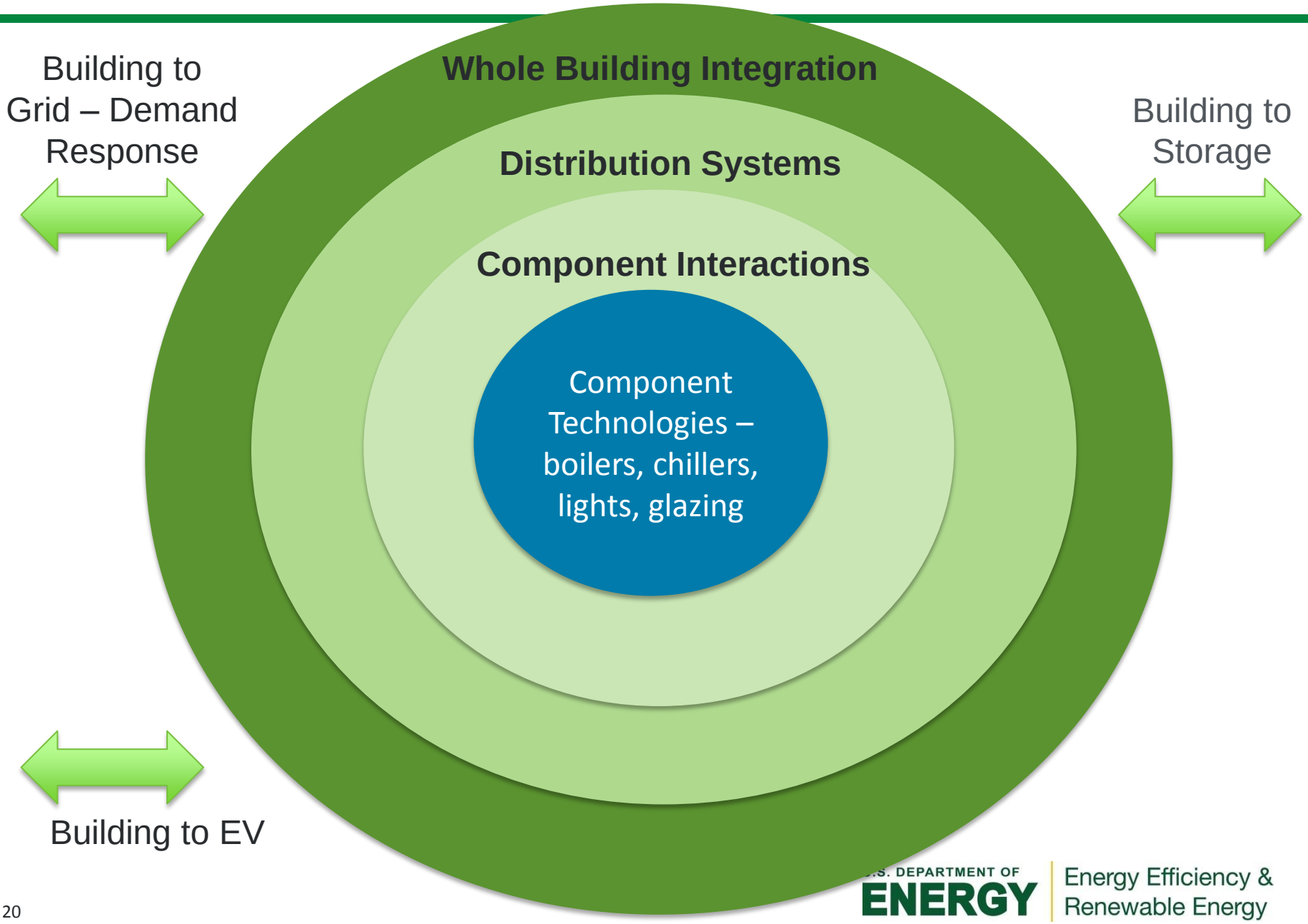
Integrated Building Systems Approach

DOE Goal: **50% Energy Savings Cost Effectively by 2030**

- Component replacements alone will not enable energy savings at level needed to meet aggressive state & federal energy savings goals
- Cost-effective deep energy saving strategies must be done holistically.
- For example, whole building strategies that select envelope strategies that enable reduced size HVAC systems, or potentially eliminate a system such as cooling, provide orders of magnitude opportunities for cost effective, efficient solutions to be selected.

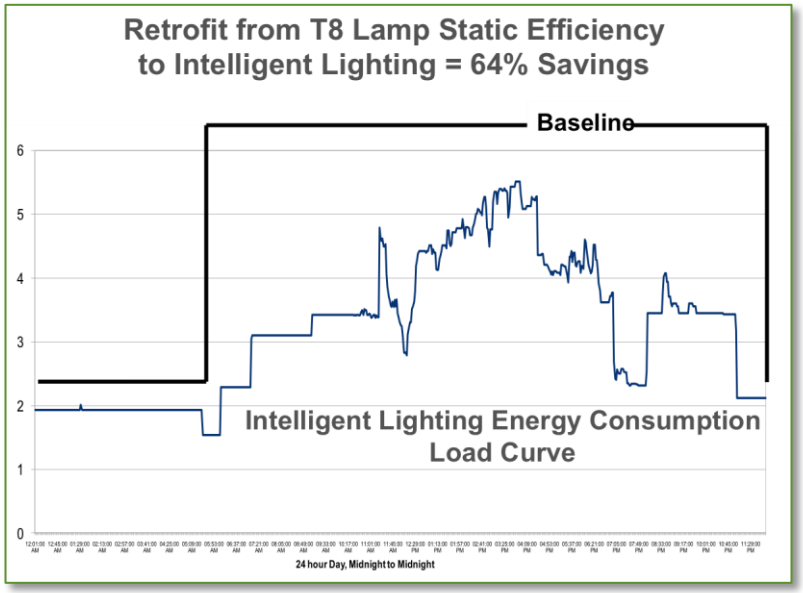


Building Systems Ecosystem



Benefits for Utilities

- Gain access to a wider set of deep, energy saving technologies
- Realize greater savings yields
- Work towards providing additional value to their customer base - create intelligent infrastructure which enables future energy savings opportunities
- Gain access to a controlled, true comparison testing environment to enable definitive energy savings
- Greater degree of defensibility of claimed energy savings
- For lighting related measures, disaggregate lighting controls systems impacts from fixture upgrades



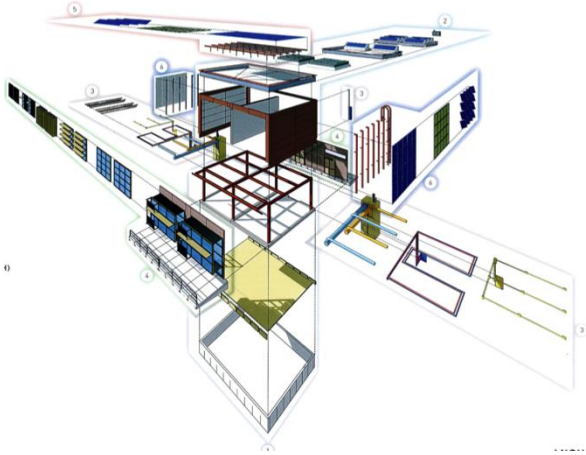
FLEXLAB

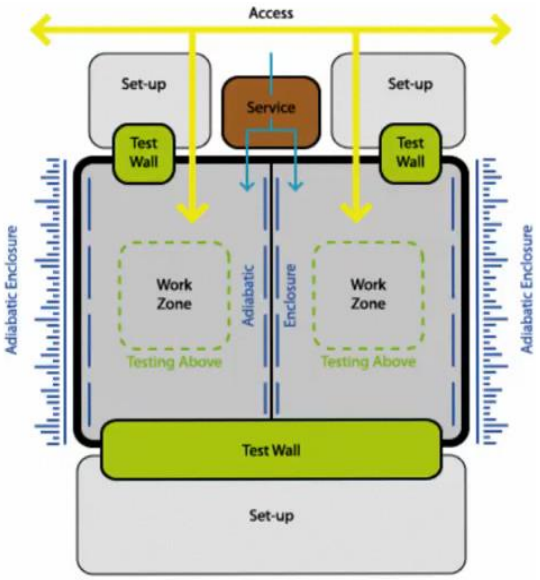
The Facility for Low Energy eXperiments in Buildings –
A test facility for systems integration

FLEXLAB – Controlled, High Accuracy Testing

Configurable buildings testbeds:

- 4 Integrated systems testbeds with interchangeable components (HVAC, lighting, windows, shading, envelope, control systems)
- Occupied Plug Loads & Lighting Testbed; Virtual Design & Visualization Testbed
- Highly granular power measurement
- Full suite of high accuracy sensors, submeters
- 2 cells/testbed enables true comparison studies
- Accelerated testing – climates, sun angles
- Initial fit-outs include test walls & lighting representing code minimum conditions & 1980s era for ET & retrofit comparisons
- Partners include gov't agencies, manufacturers, design community & utilities





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