

# Existing Building Retrofits




An integrated solution set for energy and occupant benefits



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## Today's Speakers

			
<b>Kevin Carbonnier</b> <i>Project Manager</i> New Buildings Institute	<b>Cathy Higgins</b> <i>Research Director</i> New Buildings Institute	<b>Kenneth Seeton</b> <i>Central Plant Manager / Energy Manager</i> CSU, Dominguez Hills	<b>Michael Mutmanský</b> <i>Associate Technical Director, Lighting</i> TRC Companies

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## Topics

- Intro and Approach Cathy Higgins, NBI
- Technologies + Demo Sites Michael Mutmansky, TRC
- Project Spotlight: Welch Hall Kenny Seeton, CSU Dominguez Hills
- Site Savings and Benefits Kevin Carbonnier, NBI
- Lessons Learned All
- Conclusions + Resources Cathy Higgins, NBI
- Discussion / Q&A All

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## Leading in Los Angeles -

*Demonstrating scalable emerging energy efficient technologies for integrated façade, lighting, HVAC Retro-commissioning*

- **Goal:** Support California energy and carbon reduction goals.
- **Project Objectives:**
  1. Validate viability and performance of an **integrated set of technologies** for existing commercial buildings
  2. Demonstrate **20%+** whole building energy savings
  3. Develop and share guidance and resources to **facilitate widespread adoption**
- **Length:** July 2017 – June 2021



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## Project Team and Acknowledgments

### Project Team

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Cathy Higgins, PI  
Kevin Carbonnier  
Webly Bowles



Katie Wilson  
Michael Mutmanský  
David Douglass-Jaimes  
Abhijeet Pande  
Gwelen Paliaga



Paul Mathew  
Cindy Regnier  
Jordan Shackelford  
Travis Walter

### Funders



### Site Partners

- City of Santa Ana
- CSU Dominguez Hills



### Manufacturer and Contractor Partners



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## We spend 80% of our time indoors...we need windows, but we don't know how to control them



- Views provide an essential link to the outside world
- Exposure to daylight kickstarts internal circadian cycles

*From CABA project on Impacts of Automated Shading 1/19*

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## What's wrong with manual shades and blinds

2017 Study by Univ. of Oregon:

- 51% of occupants did not change their window shades position even once.
- 20% adjust the shades once or so annually
- 24% seasonal users
- **Only 6% actively adjusting shades daily**



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## What's wrong with this picture?



Our current controls approach to lighting and other technologies is badly outdated in most existing buildings

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## Project Approach

Develop Package

FLEXLAB Testing

Field  
Demonstration

Market Resources

- Systems approach
- Beyond widgets
- Low disruption
- Eliminate wiring costs

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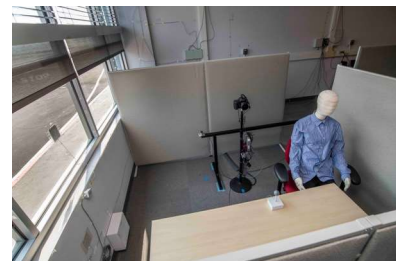
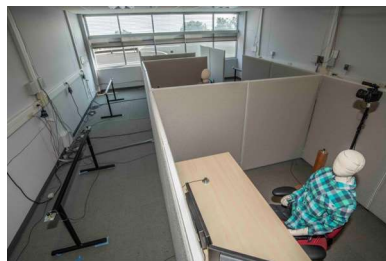
## Project Approach

Develop Package

FLEXLAB Testing

Field  
Demonstration

Market Resources



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# Project Approach

- Develop Package
- FLEXLAB Testing
- Field Demonstration**
- Market Resources



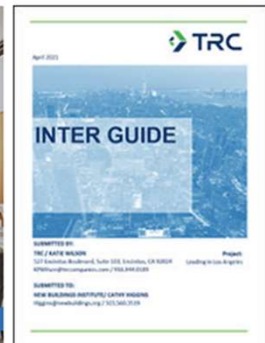
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# Project Approach

- Develop Package
- FLEXLAB Testing
- Field Demonstration
- Market Resources**



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## Retrofit Package Technologies

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## The INTER Technology

- Combines an innovative set of precommercial technologies targeted across window shades, lighting, and HVAC
  - End uses = ~70% building's energy
- Technologies can be combined and customized to suit a variety of building types and spaces

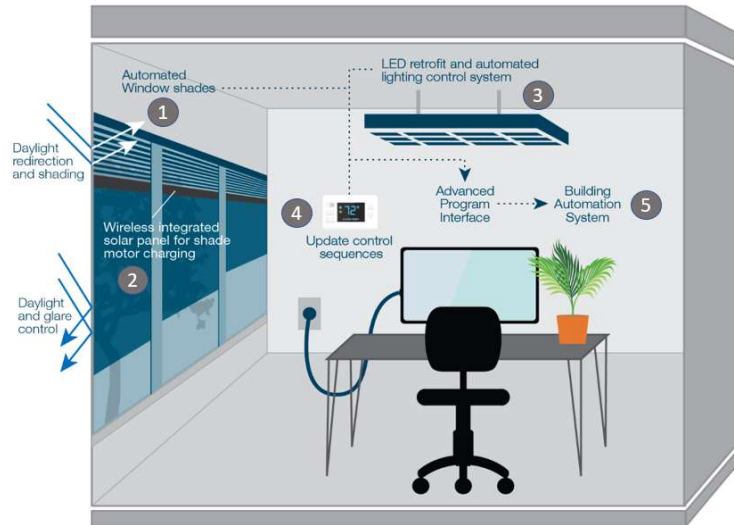
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## The INTER Technology

1. Automated shades/blinds with dedicated daylight redirecting
2. Solar panel for automation
3. LED upgrade with Networked Lighting Controls
4. Light HVAC Retro-Commissioning
5. M&V through the Building Automation System



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## The INTER Technology

### Benefits

- Whole building energy savings 20%+
- Improved occupant comfort and wellbeing
- Space use flexibility
- Business analytics for owners



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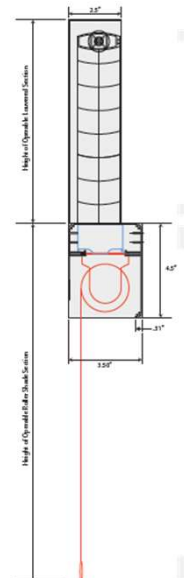
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## The INTER Technology: Automated Window Shades

- Windows –Automated Shade/Blind Combo



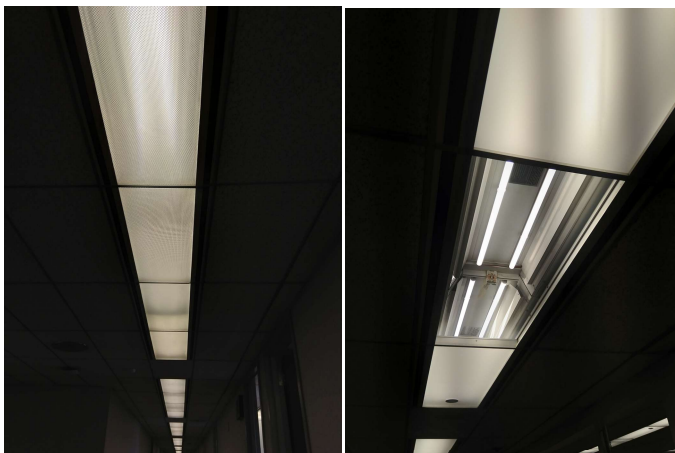
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## The INTER Technology: Lighting

- LED retrofit



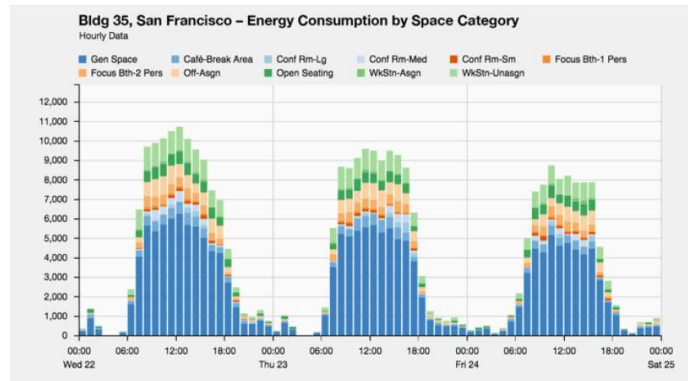
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## The INTER Technology: Networked Lighting Control (NLC) Systems

- Daylight dimming
- Occupancy controls
- Institutional Tuning
- Timeclock



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## The INTER Technology: HVAC Retro-commissioning

- Light-touch Retro-commissioning
  - Scheduling/sequencing
  - Tuning setpoints/setbacks
  - Software-only
  - Guideline 36 measures where possible



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## Demonstration Sites

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## Demonstration Sites

Building	Owner	Year Built	Building Size	Retrofitted Area	Existing Lighting
<b>Santa Ana City Hall</b>	City of Santa Ana	1970	127,000 sq. ft.	88,000 sq. ft. (~70%)	2-lamp T8 troffers with Daintree lighting controls
<b>Welch Hall</b>	California State University Dominguez Hills	2001	183,000 sq. ft.	131,000 sq. ft. (~70%)	3-lamp T8 troffers with Enlighted lighting controls

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## Site 1: Santa Ana City Hall

- Relatively high window-to-wall ratio and narrow floorplates
- Primarily south- and north-facing windows
- Significant energy savings opportunities



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## Site 1: Santa Ana City Hall

- Wide variety of space configurations
- Consistent window conditions
- Unusual ceiling grid and lighting configuration



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## Site 2: CSUDH Welch Hall

- Mix of glazing conditions and orientations
- Primarily administrative offices



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## Site 2: CSUDH Welch Hall

- Mix of private office and open office
- Mix of punched and strip windows



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## Project Spotlight: CSU Dominguez Hills Welch Hall

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## Technology Installation

### Lighting

- Full LED Retrofit on Floors 1-4
- Updated Enlighted sensors and expanded to whole building

### Windows

- Full Shade/Blinds on Floors 2-4 (limited on Floor 1)

### HVAC

- Tuning AHU start/stops
- Demand-based supply air temp. reset
- Demand-based static pressure resets
- Reduce zone airflow minimums
- Widening dead-bands



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# CSUDH Welch Hall Energy Trends



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# Luminaire Level Lighting Controls Benefits

- Customization
- HVAC controls
- Business Analytics



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## Site Savings and Benefits

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## Retrofit Summary

What was the extent of the retrofit installation?

Technologies	Santa Ana	CSU DH	Totals	Ratio of Shades
Advanced Light Fixtures	2,413	1,989	4,402	n/a
Illuminate Shades <sup>1</sup>	142	164	306	32%
Automate Shades	2	37	39	4%
Manual Shades	337	271	608	64%
<b>Total Shades</b>	<b>481</b>	<b>472</b>	<b>953</b>	<b>100%</b>

<sup>1</sup> With daylight redirecting upper louvers

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## Results: Retrofit Savings

How much energy did the retrofit package save?

Location	Site Energy	Lighting Energy
CSUDH Welch Hall	26%	35%
Santa Ana City Hall	15% <sup>1</sup>	42%

<sup>1</sup> Steam energy data was not available so whole building energy savings may be larger

Welch Hall savings is an overestimate because it includes additional HVAC controls measures that were initiated by the facility manager outside of the scope of the INTER system retrofit. Conversely, the SACH savings are an underestimate because they did not include district steam savings due to a data anomaly in the post-retrofit steam data.

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## Results: Energy Reduction During Shelter in Place (SIP)

How much did lower occupancy during SIP reduce energy use?

Location	Site Energy	Electricity	Lighting	HVAC
CSUDH Welch Hall	39%	25%	21%	49%
Santa Ana City Hall	n/a	8%	7%	n/a

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## Non-Energy Benefits

- Occupant comfort and wellbeing
- Custom lighting
- Reduced maintenance
- Flexible operations
- Data analytics



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## Project Costs

- **\$5-8/ft<sup>2</sup>** for full networked lighting retrofit with BAS integration
- **\$10-14/ft<sup>2</sup>** for full retrofit package, including lighting, automated shades, and retro-commissioning

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## Lessons Learned

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## What would we do differently?

- Bring in IT early
- Pilot new technology in subset of building first
- Maintain a manual override for automated shades
- De-motorize louver portion of shade to manual operation
- Manage occupant expectations (LED brightness, operations)



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## What's still needed in the market?

- Workforce development
- Systems integrators
- More shade automation providers
- Improved shade hardware:
  - PV panels and batteries
  - Power over Ethernet enabled network gateways
- Education of design community around benefits of shades and specification requirements



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## Conclusions

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## Technology System Benefits

### Energy Benefits

- Significant energy savings of 20%+ whole building savings available from integrated retrofits in existing buildings

### Non-Energy Benefits:

- Tangible improvements in occupant comfort and wellbeing, including views to the outside, custom lighting levels, and heat gain mitigation at perimeter zones
- Owners and Operators gain value

#### Benefits of Automated Lighting and Shading Systems

##### Owners

- Modernized building
- Reduced operating costs
- Higher tenant satisfaction

##### Occupants

- Personalized control
- Thermal comfort
- Elimination of glare
- Maintained views

##### Operators

- Centralized data and control
- Reduced maintenance of lamp change outs
- Reduced comfort complaints

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## Target Markets ~ 1/3 of CA Floor Space and Commercial Electricity Use

Sector	Floor Space	Electricity
Small Offices (<30,000 sf)	5%	4%
Large Offices (>30,000 sf)	17%	22%
Primary and Secondary School	8%	3%
Post High School Education	4%	3%
Total Market	34%	32%
Hospitals and Health Care	4%	12%

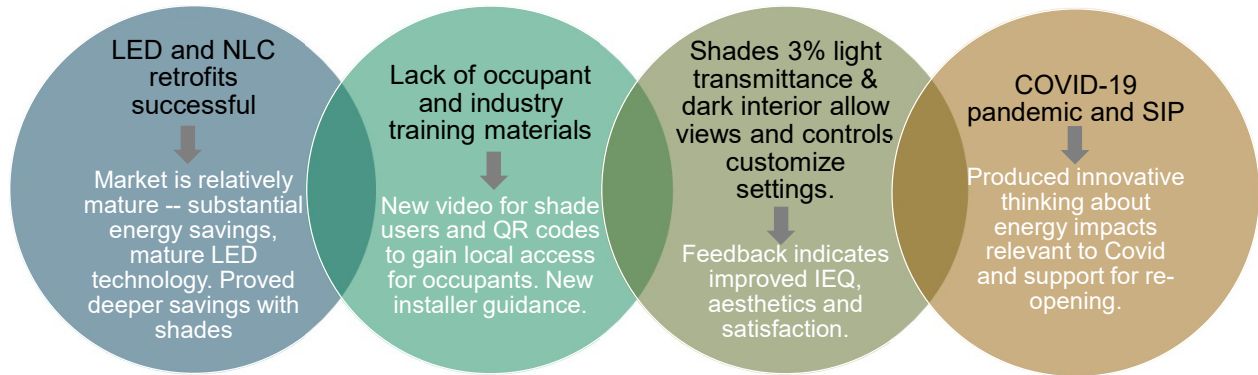
Source: CEC 2016, Attachment 12 PIER GFO 16-304

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## Demonstration Outcome Examples



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## Resources

- [Project Webpage](#)

[www.newbuildings.org/nbi-key-markets/leading-in-la](http://www.newbuildings.org/nbi-key-markets/leading-in-la)

- 3 Case Studies
- Market-facing owner's guide
- Installer guide
- Re-opening office buildings, recommendations and checklist



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## Discussion and Q&A

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