Existing Building Retrofits
An integrated solution set for energy and occupant benefits

Today’s Speakers

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New Buildings Institute

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CSU, Dominguez Hills

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Associate Technical Director, Lighting
TRC Companies
### 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
### Project Team and Acknowledgments

#### Project Team
- Cathy Higgins, PI
- Kevin Carbonnier
- Webley Bowles
- Katie Wilson
- Michael Mutmansky
- David Douglass-Jaimes
- Abhijeet Pande
- Gwelen Paliaga
- Paul Mathew
- Cindy Regnier
- Jordan Shackelford
- Travis Walter

#### Funders
- California Energy Commission
- ROLLEASE ACMEDA
- Edison
- Enlighted
- Lumenomics
- Energy Coalition

#### Site Partners
- City of Santa Ana
- CSU Dominguez Hills

#### Manufacturer and Contractor Partners
- City of Santa Ana

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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*
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

What’s wrong with this picture?

Our current controls approach to lighting and other technologies is badly outdated in most existing buildings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

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

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

Benefits
- Whole building energy savings 20%+
- Improved occupant comfort and wellbeing
- Space use flexibility
- Business analytics for owners
The INTER Technology: Automated Window Shades

• Windows – Automated Shade/Blind Combo

The INTER Technology: Lighting

• LED retrofit
The INTER Technology: Networked Lighting Control (NLC) Systems

- Daylight dimming
- Occupancy controls
- Institutional Tuning
- Timeclock

The INTER Technology: HVAC Retro-commissioning

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

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

Site 1: Santa Ana City Hall

- Wide variety of space configurations
- Consistent window conditions
- Unusual ceiling grid and lighting configuration
Site 2: CSUDH Welch Hall

- Mix of glazing conditions and orientations
- Primarily administrative offices

Site 2: CSUDH Welch Hall

- Mix of private office and open office
- Mix of punched and strip windows
Project Spotlight: CSU Dominguez Hills Welch Hall

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
CSUDH Welch Hall Energy Trends

Luminaire Level Lighting Controls Benefits

- Customization
- HVAC controls
- Business Analytics
### Site Savings and Benefits

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### Retrofit Summary

**What was the extent of the retrofit installation?**

<table>
<thead>
<tr>
<th>Technologies</th>
<th>Santa Ana</th>
<th>CSU DH</th>
<th>Totals</th>
<th>Ratio of Shades</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced Light Fixtures</td>
<td>2,413</td>
<td>1,989</td>
<td>4,402</td>
<td>n/a</td>
</tr>
<tr>
<td>Illuminate Shades¹</td>
<td>142</td>
<td>164</td>
<td>306</td>
<td>32%</td>
</tr>
<tr>
<td>Automate Shades</td>
<td>2</td>
<td>37</td>
<td>39</td>
<td>4%</td>
</tr>
<tr>
<td>Manual Shades</td>
<td>337</td>
<td>271</td>
<td>608</td>
<td>64%</td>
</tr>
<tr>
<td><strong>Total Shades</strong></td>
<td><strong>481</strong></td>
<td><strong>472</strong></td>
<td><strong>953</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

¹ With daylight redirecting upper louvers
Results: Retrofit Savings

How much energy did the retrofit package save?

<table>
<thead>
<tr>
<th>Location</th>
<th>Site Energy</th>
<th>Lighting Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSUDH Welch Hall</td>
<td>26%</td>
<td>35%</td>
</tr>
<tr>
<td>Santa Ana City Hall</td>
<td>15%¹</td>
<td>42%</td>
</tr>
</tbody>
</table>

¹ 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.

Results: Energy Reduction During Shelter in Place (SIP)

How much did lower occupancy during SIP reduce energy use?

<table>
<thead>
<tr>
<th>Location</th>
<th>Site Energy</th>
<th>Electricity</th>
<th>Lighting</th>
<th>HVAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSUDH Welch Hall</td>
<td>39%</td>
<td>25%</td>
<td>21%</td>
<td>49%</td>
</tr>
<tr>
<td>Santa Ana City Hall</td>
<td>n/a</td>
<td>8%</td>
<td>7%</td>
<td>n/a</td>
</tr>
</tbody>
</table>
Non-Energy Benefits

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

Project Costs

- $5-8/ft^2 for full networked lighting retrofit with BAS integration
- $10-14/ft^2 for full retrofit package, including lighting, automated shades, and retro-commissioning
Lessons Learned

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)
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

Conclusions
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

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

<table>
<thead>
<tr>
<th>Sector</th>
<th>Floor Space</th>
<th>Electricity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Offices (&lt;30,000 sf)</td>
<td>5%</td>
<td>4%</td>
</tr>
<tr>
<td>Large Offices (&gt;30,000 sf)</td>
<td>17%</td>
<td>22%</td>
</tr>
<tr>
<td>Primary and Secondary School</td>
<td>8%</td>
<td>3%</td>
</tr>
<tr>
<td>Post High School Education</td>
<td>4%</td>
<td>3%</td>
</tr>
<tr>
<td>Total Market</td>
<td>34%</td>
<td>32%</td>
</tr>
<tr>
<td>Hospitals and Health Care</td>
<td>4%</td>
<td>12%</td>
</tr>
</tbody>
</table>

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

- **LED and NLC retrofits successful**
  - Market is relatively mature – substantial energy savings, mature LED technology. Proved deeper savings with shades.

- **Lack of occupant and industry training materials**
  - New video for shade users and QR codes to gain local access for occupants. New installer guidance.

- **Shades 3% light transmittance & dark interior allow views and controls customize settings.**
  - Feedback indicates improved IEQ, aesthetics and satisfaction.

- **COVID-19 pandemic and SIP**
  - Produced innovative thinking about energy impacts relevant to Covid and support for re-opening.

Feedback indicates improved IEQ, aesthetics and satisfaction.

**Resources**

[New Buildings Institute](www.newbuildings.org)
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

Discussion and Q&A