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High Performance Commercial Buildings (Webinar 1)

Daylight Redirecting Film
Jay Stein – E Source

Secondary Glazing Systems & Interior Storm Windows
Rob Curry – NEEA
Rob Penney – WSU Energy Program

Intelligent Outlets
Rob Peña – UW Integrated Design Lab
Rob Penney – WSU Energy Program
Daylight Redirecting Film

Jay Stein
Executive Vice President
E Source

ComTAG Webinar 1, April 16, 2014
What’s the Matter with Daylighting?

Courtesy: National Renewable Energy Laboratory
Old Solution: Light Shelves
Why Are They So Seldom Seen?

Source: Ann Arbor District Library
New Solution: 3M Daylight-Redirecting Film

Source: Sacramento Municipal Utility District
How It Works

© E Source; adapted from 3M
# By the Numbers

<table>
<thead>
<tr>
<th>Metric</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost ($ per square foot)</td>
<td>30</td>
<td>35</td>
</tr>
<tr>
<td>Energy savings (%)</td>
<td>20</td>
<td>22</td>
</tr>
<tr>
<td>Simple payback period (years)</td>
<td>6</td>
<td>21</td>
</tr>
</tbody>
</table>

© E Source; data from Lawrence Berkeley National Laboratory and 3M

Metrics based on the following conditions:
A. Based on simulation results reported by Lawrence Berkeley National Laboratory with further adjustments.
B. Simulations based on 40-foot deep sidelighted offices in Chicago, Houston, and Sacramento.
C. Baseline conditions include daylight dimming lighting controls, vision glazing covered by venetian blinds at a 45 degree cut off angle, and clerestory glazing covered by closed venetian blinds.
D. Electric energy costs assumed to be $0.10 per kWh.
Cheaper and Deeper

Source: Sacramento Municipal Utility District
Five More Questions

• How significant and reliable are the energy savings?
• How great are the non-energy benefits?
• How ready are the providers to scale up?
• How easy is it for the end-user to install?
• Considering all costs and benefits, how good of a buy is this technology?
Questions?
Secondary Glazing Systems
(for installation in commercial buildings)

Rob Curry
Senior Project Manager
Northwest Energy Efficiency Alliance
(NEEA)

ComTAG Webinar 1, April 16, 2014
What - Product Definition:

High performance Insulated Glazing Units (IGU) for commercial building **single-pane retrofits** that are installed on the **interior side without replacing the existing glass**, window frames, or altering the exterior appearance of the building.

Example (courtesy Serious Windows)
Why & Who – Benefits/Market

**Rough cost:** (per manufacturers)
- Rough order of magnitude estimate: **$40.00 SF installed** - approximately half the cost (and double the ROI) of replacement.

**Primary benefits:** (per manufacturers published data)
- **Annual total building energy savings up to 20%** - primarily due to minimizing exterior solar heat gain loads and exterior air infiltration
- increased occupant comfort thermally, visually, and acoustically in existing commercial buildings with single pane windows for Installation time is 2-3 times faster than replacement.

**Target market:**
Existing buildings **greater than 50,000 SF** with low performance single pane windows in thermally unbroken metal frames constructed **before 1990’s** – “Mid-century modernism”.

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E3T  
Energy  
Efficiency  
Emerging Technologies
Who - Existing Market

• Roughly 80 billion square feet of existing commercial space in the US including approximately 2 billion square feet of single pane glazing.

• 72 percent of floor stock in the U.S., 46 billion square feet, belongs to buildings over twenty years old.

• In NW region (private sector only) roughly 470,000,000 square feet, including 3400 existing buildings.
When - Existing Conditions

Window manufacturer guidelines

- Existing window (incl. caulking and gasketing) waterproofing must be confirmed for potential air and moisture infiltration with an air and water infiltration field test

- Distance from existing glazing line and interior edge of mullion must accommodate SGS requirement

- Specific location conditions must be confirmed for heating, cooling, humidity, seismic, and wind loads

- Window widths and heights may exceed SGS maximums and require new additional mullions

- Existing window structural support system adequacy must be confirmed

- Potential applicable code related requirements must be confirmed
How - Attributes

Per manufacturers published data

- Low and high **solar heat gain** glass packages create **custom-tuned solar control** according to a building’s unique location and orientation

- Greatly improves inside glass surface temperatures, making it **more comfortable to work and sit near windows** and allowing temperature set-point changes that reduce HVAC energy costs

- Minimizes tenant disruption – 20 minute installation per window

- Installation is not weather dependent

- Can increase Center-of-Glass thermal performance of ¼” clear single glazing from R-value 1.0 to R-value 7.1 (U-factor from 1.0 to 0.14)

- Maintains natural daylight while reducing glare

- Reduces noise transmission

- 96 to 99.6% UV blockage reduces fading and damage to interior furnishings
How – Current USA manufacturers

Primary manufacturers:

1) **JE Berkowitz:** (Pedricktown, NJ.)
   "Renovate" (only patented system)

2) **Serious Windows:** (Sunnyvale, CA.)
   "iWindow"

Secondary manufacturer:

1) **Thermolite Windows:** (South Bend, IN)
   "RetroWAL"
## Manufacturer published performance data

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Number of Years on Market</th>
<th>Sizes (Min and Max)</th>
<th>Published Center of Glass U-factor (Winter) (Including 1/4&quot; Clear Single Pane Existing Glass) (Btu/h<em>sf</em>degF)</th>
<th>Published Solar Heat Gain Coefficient - SHGC (Summer) (0 - 1)</th>
<th>Published VisibleTransmittance - VT (0-1)</th>
<th>Published Condensation Resistance Factor - CRF (1 - 100)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serious Windows</td>
<td>3 years</td>
<td>12&quot;w x 14&quot;h Min 84&quot;w x 84&quot;h Max 36 sf Max Area</td>
<td>0.15 HighSHG 0.15 LowSHG 0.17 LowSHG - South (LBNL v 6.3)</td>
<td>0.35 HighSHG 0.27 LowSHG 0.28 LowSHG - South (LBNL v 6.3)</td>
<td>0.58 HighSHG 0.51 LowSHG 0.52 LowSHG - South (LBNL v 6.3)</td>
<td>Not Published</td>
</tr>
<tr>
<td>JE Berkowitz</td>
<td>4 years</td>
<td>15 sf Min Area 45 sf Max Area</td>
<td>1.02 Single Glazed Existing 0.18 Platinum 0.15 Platinum Plus II 0.15 Platinum Plus II XL (LBNL v 5.2A)</td>
<td>0.84 Single Glazed Existing 0.42 Platinum 0.35 Platinum Plus II 0.27 Platinum Plus II XL (LBNL v 5.2A)</td>
<td>0.89 Single Glazed Existing 0.63 Platinum 0.57 Platinum Plus II 0.50 Platinum Plus II XL (LBNL v 5.2A)</td>
<td>CRF Frame RbB = 41 CRF Frame Single Glazed = 44 CRF Glass RbB = 71 CRF Glass Single Glazed = 28 AAMA 1503-09</td>
</tr>
<tr>
<td>Thermolite Window Systems</td>
<td>1 year (thermal)</td>
<td>Not Published</td>
<td>1.02 Single Glazed Existing 0.37 Silver 0.21 Gold 0.12 Platinum (LBNL v 6.3)</td>
<td>0.82 Single Glazed Existing 0.66 Silver 0.55 Gold 0.42 Platinum (LBNL v 6.3)</td>
<td>0.89 Single Glazed Existing 0.74 Silver 0.62 Gold 0.57 Platinum (LBNL v 6.3)</td>
<td>CRF Frame 2000 = 71 CRF Frame Single Glazed = 20 CRF Glass 2000 = 63 CRF Glass Single Glazed = 24 AAMA 1503-98</td>
</tr>
</tbody>
</table>
## Manufacturer published performance data

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Published Air Infiltration Rate (CFM / sf)</th>
<th>Published Sound Transmission Class - STC @ Air Gap (dB)</th>
<th>Prior Laboratory Testing Conducted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serious Windows</td>
<td>Not Published</td>
<td>___ Single Glazed Existing</td>
<td>Not Published</td>
</tr>
</tbody>
</table>
|                            | Single glazed Air Infil @ 1.57 psf = 0.02 cfm/sf                                                         | 38 @ 1/2" Air Gap                                      | Winter U-Factor RbB = 0.43  
|                            | Single glazed Air Infil @ 6.27 psf = 0.04 cfm/sf                                                         | 42 @ 1" Air Gap                                       | Winter U-Factor Single Glazed = 1.23  
|                            | Single glazed + RbB Air Infil @ 1.57 psf = 0.04 cfm/sf                                                   | 45 @ 2" Air Gap                                       | CRF Frame RbB = 41  
|                            | Single glazed + RbB Air Infil @ 6.27 psf = 0.09 cfm/sf                                                   |                                                       | CRF Frame Single Glazed = 44  
|                            | Single glazed Air Exfil @ 1.57 psf = <0.01 cfm/sf                                                       |                                                       | CRF Glass RbB = 71  
|                            | Single glazed Air Exfil @ 6.27 psf = <0.01 cfm/sf                                                       |                                                       | CRF Glass Single Glazed = 28  
|                            | Single glazed + RbB Air Exfil @ 1.57 psf = 0.01 cfm/sf                                                   |                                                       | AAMA 1503-09  
|                            | Single glazed + RbB Air Exfil @ 6.27 psf = 0.03 cfm/sf                                                   | AAMA 1503-09                                          | Water Penetration - No Water Leakage at 15.04 psf  
|                            |                                                                                                           |                                                       | ASTM E 331  
| JE Berkowitz               | 0.28 Single Glazed Existing (15 mph)  
|                            | 0.50 Single Glazed Existing (25 mph)  
|                            | 0.01 (15 mph)                                                                                           | 2000 = 0.53                                           | Winter U-Factor 2000 = 0.53  
|                            | 0.04 (25 mph)                                                                                           | 26 Single Glazed Existing                             | Winter U-Factor Single Glazed = 1.21  
|                            |                                                                                                           | 49 Single Glazed + Thermolite                         | CRF Frame 2000 = 71  
|                            |                                                                                                           |                                                       | CRF Frame Single Glazed = 20  
|                            |                                                                                                           |                                                       | CRF Glass 2000 = 63  
|                            |                                                                                                           |                                                       | CRF Glass Single Glazed = 24  
|                            |                                                                                                           |                                                       | AAMA 1503-98  
| Thermolite Window Systems  | 0.28 Single Glazed Existing (15 mph)                                                                       | 30 Single Glazed Existing                             | Winter U-Factor 2000 = 0.53  
|                            | 0.50 Single Glazed Existing (25 mph)                                                                       | 37 Platinum                                          | Winter U-Factor Single Glazed = 1.21  
|                            | 0.01 (15 mph)                                                                                           | 37 Platinum Plus II                                  | CRF Frame 2000 = 71  
|                            | 0.04 (25 mph)                                                                                           | 37 Platinum Plus II XL                               | CRF Frame Single Glazed = 20  
|                            |                                                                                                           | AAMA 1503-98                                          | CRF Glass 2000 = 63  
|                            |                                                                                                           |                                                       | CRF Glass Single Glazed = 24  
|                            |                                                                                                           |                                                       | AAMA 1503-98  

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**E3T** Energy Efficiency Emerging Technologies

**NEEA** Northwest Energy Efficiency Alliance

**RECS** Regional Energy Compliance Services

**Bonneville Power Administration**

**Washington State University Extension Energy Program**
Interior Storm Windows

Rob Penney
Senior Energy Engineer
WSU Energy Program

ComTAG Webinar 1, April 16, 2014
Energy Savings

• Cuts window heat losses and gains by 30-60%
• Portland State University found overall home heating costs were cut by 11-22%
• PNNL found overall home energy savings of 22%
• Energy savings are reliable as long as the storm windows are in place
• Estimated 35 million square feet of single-pane windows in NW commercial buildings
Non-energy Benefits

• Reduction in:
  • Cold drafts and moisture in outside air
  • Radiative losses to cold window surfaces
  • Condensation from warm, moist indoor air
  • Windowsill deterioration due to moisture
  • Outside noise, by 10 db—up to 50%
  • UV light that fades fabrics

• Can be removed for window operation
• No noticeable change in building appearance
Ready for Wide-spread Use in the NW?

These storm windows are manufactured by at least half a dozen manufacturers, one in Portland, so ramping up supply shouldn’t be a big problem.
Ease of Adoption

• This technology is easy to adopt
  • Contractor carefully measures windows, which can be out-of-square or rounded
  • Attached with bulb gasket, clip, or magnetic strips
  • Much faster than for window replacement
• They can be removed for window operation
• Acrylic is light weight but needs to be handled and stored carefully
Is This a Good Buy for the Owner?

Yes — in good applications:

- Windows not too large
- Maintenance staff willing and able to handle and store them carefully when removed during temperate weather for window operation

About $18-20 per square foot—much cheaper than window replacement
Questions?
Intelligent Outlets

Rob Peña
Associate Professor
University of Washington Integrated Design Lab

ComTAG Webinar 1, April 16, 2014
the BULLITT CENTER:

*Intelligent Outlets*
ENERGY

ONE HUNDRED PERCENT OF THE PROJECT’S ENERGY NEEDS MUST BE SUPPLIED BY ON-SITE RENEWABLE ENERGY ON A NET ANNUAL BASIS
Energy Efficiency

MERGING TECHNOLOGIES

ARCHITECTURE & ENGINEERING

HEATING/Cooling
- high performance glass
- high performance walls & low infiltration
- 65% effective heat recovery
- ground source heat pumps
- demand controlled ventilation
- ventilative cooling
- radiant slab cooling
- operable windows
- operable blinds

OCCUPANT

TENANT
- "irresistible" stair to discourage elevator use
- heating setpoint w/radiant
- cooling setpoint w/radiant
- daytime office cleaning
- 80% laptop, 20% desktop
- phantom loads
- low flow water fixtures

BASELINE BUILDING
- typical office
- energy star score: 50

LIGHTING
- maximize daylighting
- daylight dimming
- lighting power

PV ROOF & FACADE
- 230,000 kWh/year
- supports 52,000 gsft
- (with 10% safety)

BUILDING ENERGY USE INTENSITY(EUI): ENERGY CONSUMPTION PER FLOOR AREA

THE PATH TO NET ZERO ENERGY
Plug Loads

92 EUI

TYPICAL BUILDING

BULLITT CENTER

42%

TYPICAL BUILDING

BULLITT CENTER

(82% REDUCTION)
# Work Station Efficiencies

<table>
<thead>
<tr>
<th>Typical</th>
<th>Monitors</th>
<th>Computer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2 – 20” CFL-LCD @ 75 Watts each</td>
<td>1 - Desktop @ 100 Watts</td>
</tr>
<tr>
<td>Good (2009)</td>
<td>2 – 22” LED-LCD @ 40 Watts each</td>
<td>1 - Desktop @ 80 Watts</td>
</tr>
<tr>
<td>Better (2010)</td>
<td>2 – 22” LED-LCD @ 14 Watts each</td>
<td>1 - Laptop @ 62 Watts</td>
</tr>
</tbody>
</table>
Intelligent Plugstrip vs Intelligent Outlets – First Cost

**thinkeco**
- Outlet + ethernet gateway: $155
- Additional outlets: $50

**Enmetric**
- Plugstrip + ethernet bridge: $260
- Additional plugstrips: $130
- Data service: $10/year per plugstrip
Measurement & Control

PowerPort + Wireless Bridge + Data Service
Measurement & Control

1. Measure and Control
   - On/Off control
   - Measure by individual, by device, or by group
   - Data log wattage, voltage, amperage, frequency and power factor

2. Rules Based Automation
   - Schedule on/off
   - Apply simple rules for demand control, current limiting, activation, etc.

3. Administrative Tools
   - Detailed demand and plug load reports
   - Track efficiency targets
In the image, we see a page from the UW Integrated Design Lab – Real-time visualization. The page displays a graph titled "Instantaneous Demand" showing the wattage usage for different devices over time. The graph includes data from 1:16:00 PM to 1:16:50 PM, with a total demand of 575.6 W.

The table below the graph lists the device ID, display in graph, device name, demand in watts, percentage of total, device type, assigned to, and control status. The devices listed are:
- Chris Desk - Misc: 0.0 W, assigned to enmetric@idl.com
- Chris Desk - Task Lights: 0.0 W, assigned to enmetric@idl.com
- Chris Desk - Monitors: 103.0 W, assigned to enmetric@idl.com
- Chris Desk - Computers: 54.6 W, assigned to enmetric@idl.com
Create New Time-Based Rule

I. When should this rule execute?

- Daily at 8:00 AM

II. Which Devices Are Controlled By This Rule?

Selected Devices:

Drag and drop devices from the table on the right

<table>
<thead>
<tr>
<th>Device ID</th>
<th>Device Name</th>
<th>Type</th>
<th>Assigned To</th>
</tr>
</thead>
<tbody>
<tr>
<td>000425FC.1</td>
<td>Rob Desk - Computer</td>
<td>Unknown</td>
<td><a href="mailto:enmetric@idl.com">enmetric@idl.com</a></td>
</tr>
<tr>
<td>000425FC.2</td>
<td>Rob Desk - Monitor</td>
<td>Monitor</td>
<td><a href="mailto:enmetric@idl.com">enmetric@idl.com</a></td>
</tr>
<tr>
<td>000425FC.3</td>
<td>Rob Desk - Task Light</td>
<td>Lamp</td>
<td><a href="mailto:enmetric@idl.com">enmetric@idl.com</a></td>
</tr>
<tr>
<td>000425FC.4</td>
<td>Rob Desk - Misc.</td>
<td>Other</td>
<td><a href="mailto:enmetric@idl.com">enmetric@idl.com</a></td>
</tr>
<tr>
<td>00042527.1</td>
<td>Seattle U Main Desk</td>
<td>Desktop Computer</td>
<td><a href="mailto:enmetric@idl.com">enmetric@idl.com</a></td>
</tr>
<tr>
<td>00042527.2</td>
<td>Seattle U Main Desk</td>
<td>Unknown</td>
<td><a href="mailto:enmetric@idl.com">enmetric@idl.com</a></td>
</tr>
<tr>
<td>00042527.3</td>
<td>Seattle U Main Desk</td>
<td>Lamp</td>
<td><a href="mailto:enmetric@idl.com">enmetric@idl.com</a></td>
</tr>
<tr>
<td>00042527.4</td>
<td>Seattle U Main Desk</td>
<td>Other</td>
<td><a href="mailto:enmetric@idl.com">enmetric@idl.com</a></td>
</tr>
</tbody>
</table>
UW Integrated Design Lab – Energy Efficiency Targets for Plug Loads

Predicted Annual Energy Use = 236,389 kWhr/yr

Building Area = 50,095 SF

Energy Budget = 4.27 kWhr / SF yr

Plug Loads = 42% of total energy budget

Plug Load Budget = 1.98 kWhr / SF yr
Plug Load Budget: 1.98 kWhr / SF yr
Lab Area: 2435 SF yr
Annual Budget = 4821 kWhr / yr

Monthly Budget = 402 kWhr / month

MARCH PLUG LOAD = 135 kWhr
Bullitt Center Energy
First 8 Months of Operation
2013

EUI = 15.7 kBTU/sf yr

157,938 kWhr
ACTUAL Energy Consumption

Bullitt Center Energy
First 8 Months of Operation
2013

EUI = 8.4 kBTU/sf yr

82,570 kWhr
More Intelligent Outlets

Rob Penney
Senior Energy Engineer
WSU Energy Program

ComTAG Webinar 1, April 16, 2014
Features and Uses

• Automatically turns off equipment left on after work hours and “vampire” loads
• Wirelessly connects to a central local computer for control and reporting of energy use
• Accessible through smart phones
• Identifies wasteful energy uses
• Identifies best methods of device operation (i.e. various power saving options)
Energy Savings

• Energy savings vary widely depending upon what’s plugged into the outlet

• BC Hydro found 14% savings during the summer and 44% during the winter due to space heaters

• NYSERDA found a payback of 7.4 years for ten offices, each with 25 intelligent outlets

• Savings reliability should be good; they seem to perform as advertised once set up
Ready for Wide-spread Use in the NW?

With multiple manufacturers and growing positive press for these devices, we have reason to believe that scaling up won’t be an issue.
Ease of Adoption

This technology is easy to adopt:

– Turn off and unplug equipment, plug this device into outlet, and plug in equipment
– Activate each outlet through a local computer, noting when each should be turned off
– View reports and make better decisions about buying and operating plug load equipment

For a large number of outlets, some troubleshooting may be needed
Is This a Good Buy for the Owner

Yes – in good applications (not every outlet):

– Occupied 45 hours per week
– Significant plug loads (computers, space heater, task lights, printers, copiers)
– At least some loads typically left on all night
– Plugs loads aren’t adversely affected by being turned off, unlike digital clocks, cable boxes, etc.
– Building operators are interested in a high performance building
Questions?
Contacts

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WSU Energy Program  
penneyr@energy.wsu.edu  
360-956-2053
Next Webinar

Thursday, April 24 at 10:00 AM Pacific Time

High Performance Commercial Buildings – Webinar 2

- High Performance Elevators
- Natural Ventilation for Nighttime Cooling
- Mechanical Ventilation for Nighttime Cooling

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