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High Performance Commercial Buildings (Webinar 2)

High Performance Elevators
Sameer Kwatra – ACEEE

Natural Ventilation for Nighttime Cooling
Shanti Pless – National Renewable Energy Laboratory
Bill Livingood – National Renewable Energy Laboratory

Mechanical Ventilation for Nighttime Cooling
Shanti Pless – National Renewable Energy Laboratory
Bill Livingood – National Renewable Energy Laboratory
High Performance Elevators

Sameer Kwatra
Senior Analyst
American Council for an Energy-Efficient Economy (ACEEE)

ComTAG Webinar, April 24, 2014
Elevator Efficiency - System

- No machine room (MRL)
- Gearless, permanent magnet (PM) motor
- Variable voltage variable frequency (VVVF) controllers
- Regenerative drives
- Lighting and ventilation

Source: Mitsubishi Electric
Elevator Efficiency - Controls

- Micro-processor controls
- Occupancy sensors
- Destination dispatch control

Source: Schindler
Ease of Adoption

• Upgrade from hydraulic to roped MRL - existing platform and car can be used, with upgrades to the controls and drive
• Installation process can take less than two weeks
• Competitive market with multiple established manufacturers
• Proven technologies

Source: Otis
Energy Savings Potential

- Estimated number of elevators: 900,000 in the U.S., 36,000 in the Northwest
- Technical potential in the Northwest: ~25,000 units
- Typical energy consumption 15,000 – 20,000 kWh/year
- Typical annual savings estimate 40% -60% from baseline or roughly in the range of 10,000 kWh/year/unit
- Regional savings potential: ~300 million kWh/year
Cost Versus Savings

- Wide range of incremental cost of modernization per unit: $50,000 to $100,000+
- Annual energy savings per unit $500 to $2000
- Significant reduction in O&M expenses
- Payback period can range from 7.5 years to much longer

### Summary of Actual Elevator Upgrade Project

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated incremental cost</td>
<td>$50,000</td>
</tr>
<tr>
<td>Xcel Energy rebates earned</td>
<td>$1,300</td>
</tr>
<tr>
<td>After-rebate cost</td>
<td>$48,700</td>
</tr>
<tr>
<td>Annual energy savings</td>
<td>$2,000</td>
</tr>
<tr>
<td>Annual O&amp;M savings</td>
<td>$4,500</td>
</tr>
<tr>
<td>Payback</td>
<td>7.5 years</td>
</tr>
</tbody>
</table>

Source: Xcel Energy
Non-energy Benefits

• More *room* for design innovations
• Smoother, quieter, more comfortable ride
• Fewer stops, quicker trips
• Fewer elevators required
• Decreased maintenance requirements
• Heightened security and access control
• Aesthetics
• Market image

Source: Otis
Questions?

Sameer Kwatra
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Mechanical Nighttime Economizer - System

• Utilize a building’s air-side economizer to automatically ventilate a building with cooler outside air at night

• Attempt to reduce or delay daytime peak air conditioning load

• Takes advantage of precooling a building's thermal mass

GOAL: Fan energy used in nighttime cooling is less than fan and compressor cooling during the day
Nighttime Cooling - Controls

• Enable economizer during unoccupied hours
• Lower space set point at night
  • Typically 67F
  • But lower is better if morning overcooling is acceptable
• Morning warm-up?

James Braun, 10/1/01. Evaluating the Performance of Building Thermal Mass Control Strategies, HVAC&R Research
Ease of Adoption

The energy savings will be more with buildings:

- Having greater thermal mass, such with slab floors and exposed building structure (columns and beams)
- In climates with large diurnal temperatures swings in the summer, such as east of the Cascade Mountains (>25F)
- With few or no nighttime occupants or occupants who are amenable with cooler temperatures
- A larger rooftop unit serving a greater area of building space
- Questionable value without high delta T
  - Can be too cold in the morning when occupants arrive
Energy Savings Potential

- Estimated annual energy savings:
  - 5%-15%
  - 10%-30% of the cooling demand
  - Energy OR peak demand savings possible
- As compared to a baseline HVAC system with nighttime summer setup with fans off
  - Existing DDC economizer capability in AHU/rooftop
- Applicable to most all Northwest commercial buildings
Cost Versus Savings

• For new or existing DDC controlled AHUs with air-side economizers in favorable climates and building types:
  • Control point change labor ~$500
  • Control board upgrade $2,500
  • 1 - 2 year payback
  • If adding ductwork and 100% OA economizer capability, higher paybacks
Non-energy Benefits

• Remove off-hours indoor VOCs for enhanced IAQ at the beginning of the day
• IAQ Performance path for 24-7 ventilation can reduce overall OA requirements
  • Smaller equipment, less daytime ventilation energy use
Natural Ventilation for Nighttime Cooling

Shanti Pless
Senior Engineer / Section Supervisor
Bill Livingood
Senior Engineer / Group Manager

National Renewable Energy Laboratory (NREL)
ComTAG Webinar, April 24, 2014
Nighttime Cooling - System

• Natural ventilation - wind and stack effect
• Nighttime precooling
• Climate - diurnal variation of temperature

• Architectural Features:
  • Unobstructed floor plan
  • Aspect ratio and channeling
  • Surface properties and thermal mass
  • Operable windows
  • Features to enhance stack effect

Zion Visitor Center
Natural Ventilation – Zion Visitor Center

Diagram showing natural ventilation techniques:
- Hot Air Evaporative Cooling Pads
- Overhangs
- Daylighting
- Operable Windows
- PV Panels
- Radiant Ceiling Panels
- Trombe Wall Heating
- Cool Tower
- Natural Downdraft
- Cool Air
Natural Ventilation – Zion Visitor Center
Nighttime Cooling - Controls

- Micro-processor controls
- Actuators, dampers and operable windows
- Exterior temperature, humidity and wind speed sensors
- Acceptable interior temperature range (occupied/unoccupied)?

NREL - RSF
NATURAL VENTILATION
Ease of Adoption

• Reliance on architectural features - new construction
• Acceptable interior temperature range
• Workplace productivity improvements
• Sensitivities to pollutants, allergies and noise
• Climate - diurnal variation of temperature

Credit: Dennis Schroeder / NREL
Energy Savings Potential

• Estimated annual energy savings (Lower limit – mechanical nighttime cooling values):
  • 5%-15%
  • 10%-30% of the cooling demand
  • Energy OR peak demand savings possible
• As compared to a baseline of natural ventilation
• Applicable to most all Northwest commercial buildings
Cost Versus Savings

Key Considerations for Discussion

• Natural ventilation architectural features must already exist:
  • Unobstructed floor plan
  • Aspect ratio and channeling
  • Surface properties and thermal mass
  • Operable windows (manual low loc. / automated high loc.)
  • Features to enhance stack effect

• Realize natural ventilation benefits while avoiding some drawbacks

• DDC / BAS connected with operable windows?

• DDC / BAS software reconfiguration could be cheap (<$ 1000)

• Additional feature of the natural ventilation measure, rather than a standalone measure?
Non-energy Benefits

• Reduce off-hour indoor VOCs for enhanced IAQ at the beginning of the day
  • Workplace productivity improvements
  • Employee recruitment and retention improvements
• Depending on IAQ strategy and buildings specifics (ASHRAE 62.1), continuous ventilation could actually reduce overall energy consumption
• Potential peak cooling demand reduction

• Realize natural ventilation benefits while avoiding some drawbacks

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Next Webinars

- Wednesday, May 21, 2014 at 12:00 PM Pacific Time
- Wednesday, June 4, 2014 at 12:00 PM Pacific Time

High Performance Residential Buildings

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