Hotel Retrocommissioning Case Study

Presented by:
Don Frey
Architectural Energy Corporation
February 8, 2007
Typical Hotel Energy Systems

- HVAC
- Lighting (indoor and outdoor)
- Refrigeration
- Water Heating (including laundry and pools)
- Cooking and Kitchen Ventilation
- Laundry
- Vertical Transport
- Plug Loads
Typical Conservation Opportunities

• Schedule the use of lights in meeting rooms and conference spaces.
• Set up (down) thermostats in unoccupied rooms.
• Relamp guest rooms with CFLs.
• Switch to T-8 lamps and electronic ballasts.
• Maintain packaged roof top units.
Typical Conservation Opportunities

• Install variable frequency drives.
• Reset fans and chillers according to the load.
• Schedule guest room setpoints according to occupancy.
• Optimize kitchen ventilation and control according to demand.
• Demand-controlled ventilation.
Packaged Rooftop Unit Problems

- Economizers
- Refrigerant charge
- Low airflow
- Cycling fans during occupied period
- Fans run during unoccupied period
- Simultaneous heating and cooling
- No outside air intake at unit

Problem Frequency
Packaged Rooftop Units

• Major opportunities
  – Economizers
  – Refrigerant Charge
  – Air Flow
  – Duct Sealing
  – Controls
Retrofit Smart Light Switch

- Occupancy sensor to switch bathroom lighting
- Nightlight provides ability to see at night
- Saves 45 – 75 % of bathroom fixture energy use
- 2 - 3 year payback for new construction, 5 - 6 year payback for retrofits
Smart Bathroom Fixture

- LEDs and integrated occupancy sensor.
- Provides low level lighting when area is unoccupied.
- Applications include large scale hotels and assisted living facilities.
- 50% energy reduction
- Battery backup for emergencies.
- 2 – 6 year payback
Bi-Level Stairwell Fixture

- Reduces lighting levels when stairwell is vacant.
- Instantly raises lighting when someone enters the stairwell.
- Applicable to all stairwells.
- Battery backup for emergencies is an option.
- Payback 2 – 6 years new construction, 3 – 10 years retrofit
Commercial Kitchen Ventilation

• Tune-up the existing system
  – Add side curtains
  – Optimize exhaust air flow
  – Match supply and exhaust flow volumes

• Install demand ventilation control (DVC)
  – Reduce exhaust and make-up air during low cooking periods.
Commercial Kitchen Ventilation

• DVC – controls exhaust and make-up air fans
• Saving range from $1,500 to $5,000 per year.
• Payback
  – New construction, 1 – 3 years
  – Retrofit, 2-6 years
Alternative Energy

- Purchase wind-generated power.
- Install PV system.
- Purchase hybrid vehicles.
- Install fuel cells (Rebate: $2,500/kW)
Retro-commissioning at the Sheraton Chicago Hotel & Towers Cityfront Center

Investigation Report
Building Facts

- Owned by Tishman Realty and Construction Co.
- Managed by Starwood Hotels and Resorts Worldwide
- Built in 1992
- 1.2 million sq. ft.
- 37 story structure
- 1,209 guest rooms
Space Use

- Meeting rooms
- Exhibition space
- Promenade reception space
- Restaurants
- Business center
- Health club
- Retail space
- Office space
- Guest rooms
Building Systems

- Three water-cooled centrifugal chillers
- Two constant speed cooling towers
- Constant-volume chilled water and condenser water loops
- 26 AHUs serve common spaces (most CV); four MUA units serve hallways
- Electric resistance heat in terminal boxes and AHUs
- Two-pipe FCUs with electric heat serve guestrooms
- Pneumatic controls; no central BAS
Utility Rates!

- Average annual total utility bill from July ’03 to July ’05: $2,409,698 ($1.64/ft² conditioned space)
- Due to recent rate increases and new demand charges, utility costs (for same electric and gas usage) predicted to cost $3,846,841 !!

<table>
<thead>
<tr>
<th>Year</th>
<th>Electric Usage Charge ($/kWh)</th>
<th>Gas Usage Charge ($/therm)</th>
<th>Total Electric Costs</th>
<th>Total Gas Costs</th>
<th>Total Energy Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>$0.0603</td>
<td>$0.5747</td>
<td>$1,995,816</td>
<td>$281,620</td>
<td>$2,277,436</td>
</tr>
<tr>
<td>2004</td>
<td>$0.0623</td>
<td>$0.8241</td>
<td>$2,037,906</td>
<td>$391,312</td>
<td>$2,429,218</td>
</tr>
<tr>
<td>2005</td>
<td>$0.0585</td>
<td>$1.0746</td>
<td>$1,962,137</td>
<td>$560,304</td>
<td>$2,522,441</td>
</tr>
<tr>
<td>Average</td>
<td>$0.0604</td>
<td>$0.8237</td>
<td>$1,998,620</td>
<td>$411,079</td>
<td>$2,409,698</td>
</tr>
<tr>
<td>New Rates¹</td>
<td>$0.1056</td>
<td>$1.2357</td>
<td>$3,214,735</td>
<td>$632,106</td>
<td>$3,846,841</td>
</tr>
</tbody>
</table>

¹ The rates listed are blended rates that include fixed and demand costs
RCx Investigation Activities

• Site visit performed prior to submitting proposal
• Functional performance tests performed
• Data loggers installed
• Data analysis to uncover true system performance and validate assumptions
• Energy model developed for ECM analysis
Acceptable CO2 levels are 400 ppm above ambient conditions (typically 350 ppm)
Kitchen AHU Scheduling

Supply fans operating at 80% of design nameplate

Fans operate irregularly
Corrective Measures

- Correct the outside air fractions and air-side economizer operation ($498,478; 0.1yr SPB)
- Correct the supply air temperature control and heating element operation (-$12,881; - SPB)
- Lower the domestic hot water temperature set point ($62,759; 0.01yr SPB)
Controls

- Incorporate a central DDC System ($627,344; 0.7yr SPB)
  - Common space zone temperature set point reset
  - Terminal box minimum flow to 0%
  - AHU scheduling
  - Optimized economizer control (differential enthalpy)
  - Supply air temperature reset
  - Mixed air temperature reset
  - Chilled water temperature reset
  - Condenser water temperature reset
  - Cooling plant outside air temperature enable
Controls

• Incorporate “smart” thermostats in guest rooms ($114,225; 3.6yr SPB)
  – Coordinated control between an infrared occupancy sensor and a door lock sensor
  – Controls zone set point to reset, typically +/- 5°F from the occupant’s selected heating or cooling set point
  – Networked option: resets an additional 3°F to 5°F if central system indicates room is un-rented
  – Stand-alone option: resets additional 2°F if unoccupied for >14 hours
  – System could switch lighting off in guestrooms too
AHU Retrofit

• Incorporate variable frequency drives and controls on the supply and return fans with a duct static pressure reset strategy ($552,300; 3.9yr SPB)

• Incorporate demand controlled ventilation ($151,523; 0.1yr SPB)

• Install hot water heating coils in place of existing electric heating coils ($120,799; 1.3yr SPB)
  – Laundry outsourced, so capacity from laundry steam boilers used to supply coils via heat exchanger
Cooling Plant Retrofit

- Incorporate a plate and frame heat exchanger for waterside economizing ($40,593; 2.3yr SPB)
- Replace aging chillers with high-efficiency, variable speed chillers ($83,261; 11.4yr SPB)
- Convert chilled water loop to variable-flow control ($69,051; 7.4yr SPB)
- Incorporate variable frequency drives and controls on the cooling tower fans ($5,437; 10.6yr SPB)
Heating Plant Retrofit

• Replace aging domestic hot water boilers with high-efficiency condensing boilers ($35,582; 2.6yr SPB)

• Repair the laundry heat recovery system ($40,405; 0.1yr SPB)
  – Laundry outsourced
Tower Exhaust

• Incorporate heat recovery ($78,963; 0.8yr SPB)
  – Selected for rooftop MUA units only, due to prohibitive piping issues for lower MUA units

• Incorporate variable frequency drives and controls on the exhaust fans ($2,787; 12.6yr SPB)
Lighting

• Replace public space lighting with more efficient T-8 lighting ($80,435; 5.9yr SPB)
• Replace guestroom lighting with more efficient compact fluorescent lighting ($58,164; 2.2yr SPB)
• Incorporate central lighting control for the public space lighting ($22,144; 6.8yr SPB)
Bottom Line

- Total savings of selected measures: $1,333,605, or 35% of projected energy costs.
- Investigation cost: $54,000. ($.045/sf)
- Implementation costs: $4.0 million, for a 3.0 year SPB.
- Retro-commissioning will add $16 million to the value of the building!! (12 x NOI)
Thank you.

www.archenergy.com