RECOMMENDATIONS FOR 15% ABOVE-CODE ENERGY EFFICIENCY MEASURES FOR COMMERCIAL OFFICE BUILDINGS

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OUTLINE

INTRODUCTION

THE 79TH LEGISLATURE TO ENHANCE EFFECTIVENESS OF SENATE BILL 5

Requires the Laboratory
To develop 3 methods for achieving at least 15% potential energy savings in residential, commercial, and industrial construction.

The Process
Worked on residential and commercial measures
Held stakeholders meetings
Refined measures

BASE-CASE

As per ASHRAE 90.1-1999

Two system types:
Electric cooling Natural gas heating (Electric / Gas)
Electric cooling Electric heating (All - Electric)

Building Envelope
- 5-story office building (89,304 ft²) in Houston, TX
- Roof R-value: R-15
- Wall R-value: R-13

Fenestration
- 50% window to wall area ratio
- U-value: 1.22 Btu/hr °F ft²
- SHGC: 0.44 for North, 0.17 for other orientations

Lighting Power Density
- 1.3 W/ft²
ENERGY EFFICIENCY MEASURES

1. Decreased Glazing U-value (both)
   From 1.22 Btu/hr ft\(^2\) to 0.45 Btu/hr ft\(^2\)

2. Energy Efficient Lighting
   Lighting Power Density – From 1.3 W/ ft\(^2\) to 1 W/ ft\(^2\)

3. Window Shading
   2.5 ft Width of Overhangs on all orientations except north

4. Installation of Occupancy Sensors for Lighting
   Modifying electric lighting profiles

5. Cold Deck Reset
   Cold deck temperature decreases linearly as outdoor temperature increases

6. Supply Fan Total Pressure
   From 2.5 in. W.G. to 1.5 in. W.G.

7. Chiller COP
   From 4.9 COP to 6.1 COP

8. Boiler Efficiency (For Gas Building Only)
   From 75% to 95% (condensing boiler)

9. VSD on Chilled Water Pumps
   From constant speed to variable speed drives

10. VSD on Hot Water Pumps
    From constant speed to variable speed drives

COMBINED SET OF MEASURES

Combination 1
- Decreased Glazing U-factor
- Decreasing Lighting Power Density

Combination 2
- Occupancy Sensor Installation
- Cold Deck Reset

Combination 3
- Decreased Glazing U-factor
- Raising chiller COP
- VSD on Chilled Water Pump
- VSD on Hot Water Pump

RESULTS

Process adopted for analysis:
- Annual energy use & demand use for individual and combined measures
- Energy Cost
- First Costs

Payback
Number of Years
### RESULTS

**Envelope and Fenestration Measures for Electric / Gas Building**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Energy Use (MBtu/yr)</th>
<th>Energy Savings</th>
<th>First Cost ($)</th>
<th>Payback Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass, 1.000</td>
<td>1126</td>
<td>590</td>
<td>43</td>
<td>3899</td>
</tr>
<tr>
<td>Glazing Efficiency</td>
<td>1125</td>
<td>43</td>
<td>3899</td>
<td>3.1%</td>
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<tr>
<td>Boiler Efficiency</td>
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<td>590</td>
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<tr>
<td>Chilled Water Pressure</td>
<td>1126</td>
<td>590</td>
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<td>3899</td>
</tr>
</tbody>
</table>

**Lighting Loads**

- Glazing – 10.7%
- Lighting Loads – 6.9%
- Occupancy Sensors – 13%

*Payback Period: Lighting Loads – 0 Years*

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**Plant Equipment Measures for Electric / Gas Building**

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Energy Use (MBtu/yr)</th>
<th>Energy Savings</th>
<th>First Cost ($)</th>
<th>Payback Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Case</td>
<td>1126</td>
<td>590</td>
<td>43</td>
<td>3899</td>
</tr>
<tr>
<td>Chiller COP</td>
<td>1126</td>
<td>590</td>
<td>43</td>
<td>3899</td>
</tr>
<tr>
<td>Chilled Water</td>
<td>1126</td>
<td>590</td>
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<tr>
<td>VSD on Chilled Water Pump</td>
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**Energy Savings**

- Chiller COP – 4.8%
- VSD on Chilled Water Pump – 2.4%

*Payback Period:* Chiller COP – 3.4 – 2.1 years

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**HVAC System Measures for Electric / Gas Building**

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<tr>
<td>Supply Fan Total Pressure</td>
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</tr>
</tbody>
</table>

**Energy Savings**

- VSD on Hot Water Pump – 1.7 – 2.7 years
- Sensor – 13%
- Glazing – 10.7%
- Lighting Loads – 0 Years

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**Energy Use Savings from Individual Measures for Electric / Gas Building**

<table>
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<tr>
<th>Measure</th>
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**Energy Savings**

- VSD on Hot Water Pump – 1.7 – 2.7 years