I. MOTIVATION

1) Prove or disprove the economic viability of whole-building energy efficiency retrofits.

Prior to 2008, the Empire State Building’s performance was average compared to most U.S. office buildings.

**Annual utility costs:**
- $11 million ($4/sq. ft.)

**Annual CO2 emissions:**
- 25,000 metric tons (22 lbs/sq. ft.)

**Annual energy use:**
- 88 kBtu/sq. ft.

**Peak electric demand:**
- 9.5 MW (3.8 W/sq. ft. inc. HVAC)
WINDOWS
Remanufacture 6,500 existing dual glazed windows
Add suspended film between panes, fill with argon gas
R-2 to R-8

RADIANT BARRIERS
Install more than 6,000 radiant barriers behind existing radiators at perimeter of building

CHILLER PLANT RETROFIT
Retrofit + controls, variable speed drives and primary loop bypass

VAV AIR HANDLING UNITS
Replace existing constant volume units with Variable Air Volume units using 2 floor mounted instead of 4 ceiling mounted
III. KEY FINDINGS
1) Eight interactive levers ranging from base building measures to tenant engagement deliver these results.

Energy and CO2 savings in the optimal package result from 8 key projects.

![Annual Energy Savings by Measure](image)

8.3 metric Tons/year

III. KEY FINDINGS
1) Eight interactive levers ranging from base building measures to tenant engagement deliver these results.

Though it is more informative to look at financials for the package of measures, capital costs and energy savings were determined for each individual measure.

<table>
<thead>
<tr>
<th>Project Description</th>
<th>Projected Capital Cost</th>
<th>2008 Capital Budget</th>
<th>Incremental Cost</th>
<th>Estimated Annual Energy Savings*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Windows</td>
<td>$4.5m</td>
<td>$455k</td>
<td>$4m</td>
<td>$410k</td>
</tr>
<tr>
<td>Radiative Barrier</td>
<td>$2.7m</td>
<td>$0</td>
<td>$2.7m</td>
<td>$190k</td>
</tr>
<tr>
<td>DDC Controls</td>
<td>$7.6m</td>
<td>$2m</td>
<td>$5.6m</td>
<td>$741k</td>
</tr>
<tr>
<td>Demand Control Vent</td>
<td>Inc. above</td>
<td>$0</td>
<td>Inc. above</td>
<td>$117k</td>
</tr>
<tr>
<td>Chiller Plant Retrofit</td>
<td>$5.1m</td>
<td>$22.4m</td>
<td>-$17.3m</td>
<td>$675k</td>
</tr>
<tr>
<td>VAV AHUs</td>
<td>$47.2m</td>
<td>$44.8m</td>
<td>$2.4m</td>
<td>$702k</td>
</tr>
<tr>
<td>Tenant Day/Lighting/Plugs</td>
<td>$24.5m</td>
<td>$16.1m</td>
<td>$8.4m</td>
<td>$941k</td>
</tr>
<tr>
<td>Tenant Energy Mgmt.</td>
<td>$365k</td>
<td>$0</td>
<td>$365k</td>
<td>$396k</td>
</tr>
<tr>
<td>Power Generation (optional)</td>
<td>$15m</td>
<td>$7.8m</td>
<td>$7m</td>
<td>$320k</td>
</tr>
<tr>
<td><strong>TOTAL (ex. Power Gen)</strong></td>
<td><strong>$106.9m</strong></td>
<td><strong>$93.7m</strong></td>
<td><strong>$13.2m</strong></td>
<td><strong>$4.4m</strong></td>
</tr>
</tbody>
</table>

*Note that energy savings are also incremental to the original capital budget.
Consider Carbon Payback

Embodied carbon “investment”

Reduced operational carbon “savings” or “return”

Energy efficiency measures can have short or long “payback” high or low ROI

Panelists

Larry Strain,
Siegel & Strain Architects

Bruce King,
Ecological Building Network

Nick Dirr,
Association for Energy Affordability