Advancing Passive House Policy
NAPHN 2016 policy session 2 presentations

“The building sector offers the largest low-cost potential in world regions to lower emissions.”

- Dr. Diana Urge-Vorsatz, Vice Chair, Intergovernmental Panel on Climate Change (IPCC)
The Empire State Building
Repositioning an Icon as a Model for Energy Efficient Investment

Motivation

“The goal with ESB has been to define intelligent choices which will either save money, spend the same money more efficiently, or spend additional sums for which there is reasonable payback through savings. Addressing these investments correctly creates a competitive advantage for owners through lower costs and better work environment for tenants. Succeeding in these efforts has made a replicable model for others to follow, and a chance to inform policy with good practice.”

- Anthony E. Malkin
Chairman and CEO, Empire State Realty Trust

The Empire State Building
Demonstrate the business case for cost effective energy efficient retrofits through verifiable operating costs reductions and payback analysis

- 102 stories and 2.85 million square feet
- 4.5 million visitors per year
- $11 million in annual energy costs
- Peak electric demand of 9.5 MW down from 11.6 (3.8 W/sf including HVAC)
- 88 kBtu per sf per yr for the office building
- CO₂ emissions of 25,000 tons per year (22 lbs/sqft)
Motivation

The retrofit of the Empire State Building was motivated by the building ownership’s desire to:

1) Reposition the world’s most famous office building into a pre-war trophy asset
2) Prove or disprove energy efficiency retrofits’ economic viability
3) Use our work to publicize and differentiate our building and attract tenants
4) Produce a replicable model for energy efficiency retrofits of existing buildings, which will make up 85% of buildings in place in New York City in 2030
5) “If the only place we succeed is ESB, the effort is a failure.”

Industry drivers for energy efficient retrofits

Converging forces
Recognition of need to develop more sustainable and efficient business practices
Acceptance of energy supply constraints and national security issues posed by energy dependence
Ongoing federal, state and local legislative action
Corporate trend toward GRI reporting, self regulation and reduction in GHG emissions
Customer, employee and shareholder pressures

Business opportunity
Growing pressure to alter appraisals, values for lending and purchasing based on sustainability
Reduced operating costs through efficiency
Increased marketability, competitiveness
Improved work environments, productivity, recruitment and retention
Positive NPV and ROI
Fund improvements through energy savings
Maintain value

Create a replicable model

Demonstrate how to cost-effectively retrofit a large multi-tenant office building to inspire others to embark on integrated energy efficiency retrofits.
Demonstrate business case through verifiable operating costs reductions and payback analysis

With a $550 million capital improvement program underway, ownership decided to re-evaluate certain projects with cost-effective energy efficiency and sustainability opportunities in mind.

Balance financial return & carbon reduction
ESB can achieve a high level of energy reduction cost-effectively

The business case – integrated approach
More than half the savings exist within tenant spaces
Tenant Spaces

Enhanced work environments are created

- Thermal comfort resulting from high performing windows, radiative barriers, HVAC, controls
- Indoor air quality resulting from DCV
- Lighting conditions that coordinate ambient and task lighting.
- High Performance Tenant Design and Construction Guidelines
- Tenant Prebuilt Program
- Positive ROI

Savings in Tenant Spaces

Investments based on incremental cost and projected savings

<table>
<thead>
<tr>
<th>Class A Office Budget</th>
<th>Total Project Cost</th>
<th>Total Cost (B&amp;M)</th>
<th>Construction Cost (B&amp;M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$4,413,404</td>
<td>$1,180.88</td>
<td>$1,214.55</td>
<td></td>
</tr>
<tr>
<td>Actual Costs</td>
<td>$4,624,262</td>
<td>$1,895.2</td>
<td>$1,329.95</td>
</tr>
<tr>
<td>LEED Premium &amp; Energy Efficiency*</td>
<td>$210,858</td>
<td>$8,64</td>
<td>$11,50</td>
</tr>
</tbody>
</table>

* Total LEED Premium – 4.7%

- Energy Saving (NPV for 15 Yrs) $593,496
- NYSERDA Grant (Approx.) $22,002
- Net Positive** $405,440

** Total Savings – 9.2%

Data provided by Skanska based on performance of their 32nd floor office at the ESB

Measured and Verified Energy Savings

Utility Consumption Comparison

<table>
<thead>
<tr>
<th>2019 Annual kWh</th>
<th>2018 Annual kWh</th>
<th>2019 Annual Projected kWh</th>
<th>2018 Annual Projected kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>$3,121.71</td>
<td>$3,101.8</td>
<td>$3,151.11</td>
<td>$3,125.99</td>
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<tr>
<td>$5,468.54</td>
<td>$5,480.94</td>
<td>$5,622.22</td>
<td>$5,625.99</td>
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<tr>
<td>$0.27</td>
<td>$0.26</td>
<td>$0.31</td>
<td>$0.30</td>
</tr>
<tr>
<td>$0.32</td>
<td>$0.31</td>
<td>$0.33</td>
<td>$0.31</td>
</tr>
</tbody>
</table>

Data provided by Skanska based on performance of their 32nd floor office at the ESB

57% Energy Savings
Implementing recommended measures
Eight interactive levers chosen iteratively from more than 60 options ranging from base building measures to tenant engagement deliver these results

Measures
**WINDOWS:** Remanufacture existing insulated glass units (IGU) within the Empire State Building’s approximately 6,500 double-hung windows to include suspended coated film and gas fill.

Measures
**RADIATIVE BARRIER:** Install more than six-thousand insulated reflective barriers behind radiator units located on the perimeter of the building.
Measures

**TENANT DAYLIGHTING / LIGHTING / PLUGS:** This measure involves reducing lighting power density in tenant spaces, installing dimmable ballasts and photosensors for perimeter spaces, and providing occupants with a plug load occupancy sensor for their personal workstation.

**CHILLER PLANT RETROFIT:** The chiller plant retrofit project includes the retrofit of four industrial electric chillers in addition to upgrades to controls, variable speed drives, and primary loop bypasses.

**VAV AIR HANDLING UNITS:** Replace existing constant volume units with variable air volume units using a new air handling layout (two floor-mounted units per floor instead of four ceiling-hung units).
Measures

**DDC CONTROLS:** The measure involves upgrading the existing control systems at the Empire State Building becoming one of the largest wireless networks ever installed. Real-time facilities performance index monitoring used for continuous commissioning of HVAC systems.

**DEMAND CONTROL VENTILATION:** This project involves the installation of CO2 sensors for control of outside air introduction to chiller water and DX Air Handling Units.

**TENANT ENERGY MANAGEMENT:** This project will provide tenants with access to online energy consumption and benchmarking information as well as sustainability tips and updates.
Empire State Building - Tenant Energy Portal

Educate and Engage on Energy Efficiency and Sustainability

Sustainability Efforts

Windows Retrofit & Radiator Insulation resulted in savings, represented by 100 lightbulbs of 100 Watts running for 1500 hours.

Weather Action Plan

WHAT YOU CAN DO
- Shut the draperies/blinds during the hottest time of the day.
- Set the thermostat to 74 degrees.
- When buying new appliances, choose ENERGY STAR-certified models.
Measurement & Verification

2013 Performance: Energy Performance Contract

<table>
<thead>
<tr>
<th>No.</th>
<th>ECM</th>
<th>Contract Guaranteed Savings</th>
<th>PY Target Guaranteed Savings (Using 2013 Baseline Adjustments)</th>
<th>PY ECM Performance Savings (Using 2013 Measurements)</th>
<th>PY Actual Operation Savings (Using 2013 Actual Operations Data)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Windows Retrofit</td>
<td>$338,508</td>
<td>$304,101</td>
<td>$262,205</td>
<td>$262,205</td>
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<tr>
<td>2</td>
<td>Radiator Insulation and Steam Trap</td>
<td>$491,191</td>
<td>$521,519</td>
<td>$586,166</td>
<td>$586,166</td>
</tr>
<tr>
<td>3</td>
<td>BMS Retrofit</td>
<td>$774,388</td>
<td>$786,660</td>
<td>$1,066,907</td>
<td>$1,066,907</td>
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<tr>
<td>4</td>
<td>Chiller Plant Retrofit</td>
<td>$611,641</td>
<td>$730,649</td>
<td>$940,072</td>
<td>$940,072</td>
</tr>
<tr>
<td>5</td>
<td>Tenant Energy Management</td>
<td>$25,000</td>
<td>$26,533</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>$2,240,728</td>
<td>$2,369,462</td>
<td>$2,855,350</td>
<td>$2,831,173</td>
</tr>
</tbody>
</table>
Measurement & Verification

Reduction in ESB’s 2007 Total Utility Costs During Performance Period

Results that matter

Median NYC Office Building EUI = 213
ESB EUI = 73
Practical Next steps

What you can do to take action

1) Triage your building portfolio based on renovation cycle
2) Create a sustainability master plan including retrofit projects, design standards, lease structure changes, tenant energy management programs, and marketing initiatives
3) Commit to an integrated, whole-building retrofit approach: Conduct whole-building audits rather than single measure projects
4) Require performance guarantees with ongoing measurement and verification of savings to reduce risk and maintain performance
5) Engage tenants, employees, and building occupants in energy savings efforts through training, tools, technology
6) Create concrete successes at the building and pre-built level to build momentum and enthusiasm

ESB Model for Energy Retrofits

- Replicating this process in over 100 buildings nationally
- Below is a summary of the results we project in buildings where we have replicated this process:

<table>
<thead>
<tr>
<th>Bldg</th>
<th>Capital cost</th>
<th>Energy reduction</th>
<th>Annual savings</th>
<th>Payback period</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>$4,000,024</td>
<td>50%</td>
<td>$2,501,756</td>
<td>1.6 years</td>
</tr>
<tr>
<td>B</td>
<td>$1,761,680</td>
<td>22%</td>
<td>$371,408</td>
<td>5.5 years</td>
</tr>
<tr>
<td>C</td>
<td>$1,453,484</td>
<td>25%</td>
<td>$363,135</td>
<td>3.5 years</td>
</tr>
<tr>
<td>D</td>
<td>$1,005,046</td>
<td>45%</td>
<td>$366,749</td>
<td>2.9 years</td>
</tr>
<tr>
<td>E</td>
<td>$1,806,088</td>
<td>28%</td>
<td>$376,898</td>
<td>6.1 years</td>
</tr>
<tr>
<td>F</td>
<td>$780,000</td>
<td>26%</td>
<td>$202,500</td>
<td>2.9 years</td>
</tr>
</tbody>
</table>

The Empire State Building: A groundbreaking energy and sustainability program

- Reduce energy use by 38 percent
- Annual savings of $4.4M
- 3.1 year payback
- Reduce carbon emissions 105,000 metric tons
- Energy Star 90
- LEED EBOM Gold
- Energy Performance Contract
- Quantifiable transparent results
- Serve as a model for owners of existing buildings

Practical Next steps
For more information…

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917.882.5646

esbsustainability.com
The Building Energy Exchange connects the Manhattan real estate communities to energy and lighting efficiency solutions through exhibitions, education, technology demonstrations, and research. We identify opportunities, navigate barriers to adoption, broker relationships, and showcase best practices at our resource center in the Surrogate’s Courthouse in Manhattan.