PASSIVE HOUSE:
THE WORLD’S MOST ENERGY EFFICIENT PERFORMANCE STANDARD
WHAT IT IS

THE HIGHEST ENERGY STANDARD
MA GOALS: Commitment to 80% reduction by 2050
WE CAN INFLUENCE THE FUTURE

The choices we make today will determine how high sea level rises this century, how fast it occurs, and how much time we have to protect our communities.

Global Average Sea Level Rise

High-end range: +48-78 inches

Most likely range: +12-48 inches above current sea level

Low-end range: +8-12 inches

Global Temperature Projections for various RCP Scenarios

Source: Architecture 2030; Adapted from IPCC Fifth Assessment Report, 2013

Representative Concentration Pathways (RCPs), temperature projections for SR2ES scenarios and the RCPs.
WHY ARE BUILDINGS SO IMPORTANT?

U.S. Energy Consumption by Sector

PASSIVE HOUSE:
THE WORLD’S MOST ENERGY EFFICIENT PERFORMANCE STANDARD

Goal: lower consumption
   Radically reduce energy demand

Requirements: measurable criteria
   Meet a specifically low energy budget
THE STANDARD

How does this Compare?

Energy Footprint

- Code
- Passive House
  - 90% less heating energy
  - 66% less total energy
WHAT IT IS NOT

HOLISTIC SUSTAINABLE DESIGN:

LEED, Living Building Challenge

- Site: 18%
- Materials: 13%
- Water: 12%
- Location: 8%
- Energy: 32%
- IEQ: 17%
WHAT IT IS

FOUNDATION FOR NET ZERO:

#1 Minimize Load with Passive House

#2 Produce with Renewable Energy

CONSUMPTION

GENERATION
EXAMPLES

International Commercial
EXAMPLES

International School/University
EXAMPLES

International Retrofit

Figure ES3. Base Case Energy Use

EXAMPLES  US Multifamily
EXAMPLES

US Commercial/Educational

ROCKY MOUNTAIN INSTITUTE

CORNELL TECH RES. HALL – NY

CENTER FOR DESIGN RESEARCH – UNIV OF KANSAS
THE STANDARD  Radical Simplicity

Credit: Albert Righter Tittmann Architects
THE STANDARD  Measurable Criteria

**Annual Space Heating/Cooling Demand** = Miles Per Gallon for the Building

Heating and Cooling makes up nearly 50% energy Demand

**Airtightness** = Durability

**Primary Energy Demand** = Carbon Footprint
## The Standard Measurable Criteria

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Condition</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Space Heating Energy Demand</td>
<td></td>
<td>4.75 kBTU/ftsq/yr</td>
</tr>
<tr>
<td>Annual Space Cooling Energy Demand</td>
<td></td>
<td>4.75 kBTU/ftsq/yr</td>
</tr>
<tr>
<td>Peak Heat Load</td>
<td></td>
<td>4.4 BTU/ftsq/hr</td>
</tr>
<tr>
<td>Peak Cooling Load</td>
<td></td>
<td>4.2 BTU/ftsq/hr</td>
</tr>
<tr>
<td>Airtightness</td>
<td></td>
<td>.6 ACH</td>
</tr>
<tr>
<td>Primary Energy Demand Commercial</td>
<td></td>
<td>38 kBTU/ftsq/yr</td>
</tr>
<tr>
<td>Primary Energy Demand Residential</td>
<td></td>
<td>38 kBTU/ftsq/yr</td>
</tr>
<tr>
<td>Primary Energy Demand Residential</td>
<td></td>
<td>38 kBTU/ftsq/yr</td>
</tr>
<tr>
<td>Primary Energy Demand Residential</td>
<td></td>
<td>6200 kWh/person</td>
</tr>
</tbody>
</table>

**Note:** Climate specific: Boston
## The Standard

### How does this Compare?

<table>
<thead>
<tr>
<th>Description</th>
<th>Office</th>
<th>K-12</th>
<th>Res</th>
<th>5.3 kBTU/ftsq/yr</th>
<th>2.9 kBTU/ftsq/yr</th>
<th>8.1 total</th>
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<tbody>
<tr>
<td>Annual Space Heating Energy Demand</td>
<td>33 kBTU/ftsq/yr</td>
<td>29 kBTU/ftsq/yr</td>
<td>24 kBTU/ftsq/yr</td>
<td><strong>3-4 TIMES</strong></td>
<td></td>
<td></td>
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<tr>
<td>Annual Space Cooling Energy Demand</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*climate specific: Boston
## Airtightness

### Air Leakage Compliance Methods

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>2006 IECC Visual inspection only</th>
<th>2009 IECC Visual inspection or blower door</th>
<th>2012 IECC Blower door only</th>
<th>2105 IECC Blower door only</th>
<th>Energy Star V2.5 and V3.0 Blower door only</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Follow checklist</td>
<td>Follow checklist or 7 ACH</td>
<td>5 ACH</td>
<td>5 ACH</td>
<td>6 ACH</td>
</tr>
<tr>
<td>2</td>
<td>Follow checklist</td>
<td>Follow checklist or 7 ACH</td>
<td>5 ACH</td>
<td>5 ACH</td>
<td>6 ACH</td>
</tr>
<tr>
<td>3</td>
<td>Follow checklist</td>
<td>Follow checklist or 7 ACH</td>
<td>3 ACH</td>
<td>3 ACH</td>
<td>5 ACH</td>
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<tr>
<td>4</td>
<td>Follow checklist</td>
<td>Follow checklist or 7 ACH</td>
<td>3 ACH</td>
<td>3 ACH</td>
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<td>5</td>
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<td>Follow checklist or 7 ACH</td>
<td>3 ACH</td>
<td>3 ACH</td>
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<td>6</td>
<td>Follow checklist</td>
<td>Follow checklist or 7 ACH</td>
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<td>3 ACH</td>
<td>4 ACH</td>
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<td>7</td>
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<td>Follow checklist or 7 ACH</td>
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<td>4 ACH</td>
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<tr>
<td>8</td>
<td>Follow checklist</td>
<td>Follow checklist or 7 ACH</td>
<td>3 ACH</td>
<td>3 ACH</td>
<td>3 ACH</td>
</tr>
</tbody>
</table>

Note: 5 ACH or less—provide mechanical ventilation.

**5 TIMES**

- .6 ACH
- .05 cfm/GSF @ 50 pa
- .08 cfm/GSF @ 75 pa
Primary Energy Demand Commercial: 38 kBTU/ftsq/yr
Primary Energy Demand Residential: 6200 kWh/person

Office: 148 kBTU/ftsq/yr
K-12: 141 kBTU/ftsq/yr
Res: 68 kBTU/ftsq/yr

**2-3 TIMES**
BENEFITS

• Reduced Carbon Footprint: Radically low energy
• Comfortable: No drafts or temperature swings
• Healthy: High Quality, Continuously filtered Air
• Resilient: Extreme Thermal Stability
• Affordable to Operate: Low Utility Bills for life
<table>
<thead>
<tr>
<th>Category</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal Control</td>
<td>Minimize thermal bridging</td>
</tr>
<tr>
<td></td>
<td>Optimize solar heat gain</td>
</tr>
<tr>
<td>Air Tightness</td>
<td>Eliminate Infiltration</td>
</tr>
<tr>
<td></td>
<td>Test</td>
</tr>
<tr>
<td>Mechanical Systems</td>
<td>Balanced Ventilation</td>
</tr>
<tr>
<td>Lighting/Appliances/Plug</td>
<td>Plan for Renewables</td>
</tr>
<tr>
<td>Loads</td>
<td></td>
</tr>
</tbody>
</table>
HOW DO YOU GET THERE?  Drive Down Loads

- Thermal Control
- Air Tightness

SUPERINSULATED + AIR TIGHT =
Brooklyn Hts Passive House
Taken on a Freezing night, Winter 2012
BUILDING INHERENT VALUE

Re-Prioritize Costs

- More $ - Envelope
- Less $ - Mechanical Systems/ductwork
- Always Saving - Low Operational Costs for the life of the Building
BUILDING INHERENT VALUE

Re-Prioritize Process

Integrated Design: Parts work together to maximize the whole
Builder as Partner: Attention to the CRAFT of building
Testing/Verification: To ensure execution/performance meets the intent
Commissioning/Reporting: Hold buildings accountable
Think Long Term: What is the life cycle of a building?
Policy and Financing: Incentives to help bridge the resource gap
Build for People: Healthy, Comfortable, Resilient
QUESTIONS?

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