Portland, Maine Loft
Thousand Home Challenge/Case Study

Before

After
Case Study Questions:

- Why do this project?
- What was done?
- How was it done?
- What was learned?

Portland Loft
Why do this project?

In late 2006, I purchased a small (3,000 SF) commercial building to house my architectural office and a residence for my wife and me. My goal was to practice the environmental responsibility that I had been preaching since the early 1990’s, when I started to focus on green design. The chance to live next to my office and in an evolving mixed-use neighborhood was also appealing. And having just designed a new LEED-Home Platinum residence 18 miles outside Portland, I was anxious to do a more responsible renovation in the city. The loft portion of the project received a LEED-Home Platinum certification.

In the renovation, the lower level became a 1,500 SF office which can accommodate a staff of up to six; the upper level is a 1,400 SF two-bedroom loft where my wife, Janet Friskey, and I lived.
Project Team

Design and Project Management
Richard Renner, Richard Renner Architects
Friskey Design - Design collaboration and interiors

Consultants
Becker Structural Engineering
Petersen Engineers
Marc Rosenbaum, Energysmiths
Terry Brennan, Camroden Associates
J&M Lighting Design

Construction
Kolbert Building and Renovation - General Contractor
Wright-Ryan Construction - Millwork
Jon Chalfant - Steel railings and ladder

Portland Loft
Location near the center of Portland: Minimal commute and close to community resources

Portland Loft
Case Study Questions:

Why do this project?

What was done?

How was it done?

What was learned?
What was done?

Both levels of the building were completely gutted down to the inside face of the exterior masonry walls. The roof was reinforced for snow and vegetated roof loads, and a new slab was poured at the lower level. A portion of the roof was raised to create a clerestory, which provides added daylight and ventilation for the loft as well as access to the roof deck. Exterior walls were insulated with closed-cell foam (R-34+); the roof was insulated with closed-cell foam and cellulose (R-55+); and the floor of the loft was insulated with cellulose. New triple glazed fiberglass windows were installed throughout.
Original Floor Plan

Portland Loft
Original building section
Original Building Elevation

Portland Loft
Completed Floor Plan

Portland Loft
Completed Building Section

Portland Loft
Completed Building Elevation

Portland Loft

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Site Plan - Completed

Portland Loft
Offices on lower level - Before and after

Portland Loft
Loft interiors before demolition

Portland Loft
Demolition - South end of the loft

Portland Loft
Completed loft looking south

Portland Loft
Completed loft looking toward kitchen and bedrooms

Portland Loft
Completed loft looking north

Portland Loft

Richard Renner | Architects
Completed loft looking toward mezzanine with clerestory

Portland Loft
Mezzanine study with high windows for light and ventilation

Folding stair to roof deck

Portland Loft
Installation of vegetated roof

Portland Loft

Roof deck
Custom steel rail

Hardware from removed steel window frames

Portland Loft
Boiler - Heating and demand hot water

Mechanical systems for the loft and the office are completely separate. The loft has radiant floor heating, a heat recovery ventilator, and a two-zone mini-split air conditioner. The 1 KW grid-tied solar collector serves the loft. There is a two-zone mini-split air conditioner to cool the unit in very hot weather; it is seldom needed.
Office and Loft Exterior

- Solar PV collector
- New roof monitor with windows for daylighting
- Steel canopy with plants
- Reuse of existing building
- Closed cell foam wall insulation R-30+
- Cellulose and closed cell roof insulation R-50+
- Triple-glazed insulated fiberglass windows
- Vegetated roof
- Steel canopy with plants

Portland Loft
Portland Loft

Loft Interior

- Formaldehyde-free plywood
- Bamboo plywood (Plyboo)
- Fluorescent lighting
- Recycled content tile
- Paperstone counters
- FSC certified framing lumber
- High-efficiency appliances
- FSC certified wood trim
Richa2l Renner Architects

Portland Loft

Loft Interior

Cellulose and closed cell roof insulation R-50+
Low or no VOC paint
Triple-glazed insulated fiberglass windows
Recycled doors
FSC certified birch flooring
Formaldehyde-free plywood
Bamboo plywood (Plyboo)
Recycled content tile

Living Area and Kitchen
Portland Loft

**Loft Interior**

- Recycled doors
- FSC certified birch flooring
- Heat recovery ventilation
- Fluorescent lighting
- Wheatcore doors
- High-efficiency plumbing fixtures
- Bamboo plywood (Plyboo)
- Paperstone counters

**Bedroom, Hall, and Bath**
Case Study Questions:

Why do this project?
What was done?
How was it done?
What was learned?

Portland Loft
Wall section showing continuity of insulation from the roof to the office floor slab. Note insulation in the floor between the loft above and the office below. Mechanical systems for loft and office are completely separate. Loft has radiant floor heating, a heat recovery ventilator, and a two-zone mini-split air conditioner.

Portland Loft
Demolition and brick re-pointing

Demolition (loft above, office below)

Demolition - Loft, looking north

Demolition - Removing brick to create loft entry
Demolition - Existing single-glazed, steel frame windows had to be removed, but they had steel flanges embedded in the surrounding brick. The windows were cut out of the walls, making it possible to install new triple-glazed fiberglass windows. Some of the removed steel window frames were cut into short lengths and used as door handles and drawer pulls in the new kitchen.
The existing foundation walls had to be underpinned because they did not have footings. At first, the existing slab was cut back to create space for the underpinning operation. Later, it became clear that the entire slab had to be removed, which made it possible to install a drainage system, insulation, and a vapor barrier.
Foundation underpinning details and sequence (sections of underpinning had to alternate so that the wall above did not collapse)
Foundation waterproofing
Framing at windows
Framing at master bedroom
Framing - Loft, looking north
Gap between framing and exterior masonry wall to eliminate thermal bridging

Portland Loft
The existing roof structure had to be reinforced to meet code for snow loads and to carry the additional weight of the vegetated roof. Steel was added to the main cross beams, and existing joists were reinforced in three of the four bays. The roof monitor was added at the fourth bay. The windows in the monitor bring sunlight into the loft and assist with natural ventilation.
Repointing - Existing window not removed, yet

Repointing

Brick prior to repointing

Portland Loft
Insulation - Foam in walls; foam+cellulose in roof

Foam insulation at party wall

Foam insulation at exterior wall

Foam insulation at roof monitor

Portland Loft
Warmboard radiant heat sub-flooring

Warmboard detail

Portland Loft
Installation of drywall and trim. Note that new windows are installed in the plane of the insulation, not in the plane of the brick wall. This was done to (a) maximize the continuity of the thermal barrier and (b) to maximize the size of the glass opening.

Installation of drywall and trim. Note the new entrance door at the level of the sidewalk. This was cut out of what had been a loading dock in this location.
Roughly 1/3 of the roof is covered with vegetation in trays. This reduces runoff from the hard surface of the roof and may reduce cooling loads in the summer.
<table>
<thead>
<tr>
<th>Component Type</th>
<th>Rating</th>
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<tbody>
<tr>
<td>Ceilings/Roofs</td>
<td>6.1</td>
</tr>
<tr>
<td>Rim/Band Joints</td>
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</tr>
<tr>
<td>Above Grade Walls</td>
<td>6.6</td>
</tr>
<tr>
<td>Foundation Walls</td>
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</tr>
<tr>
<td>Doors</td>
<td>2.0</td>
</tr>
<tr>
<td>Windows/Skylights</td>
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<tr>
<td>Framed Floors</td>
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<tr>
<td>Crawl Space/Unfinished Basement</td>
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<tr>
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<tr>
<td>Infiltration</td>
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</tr>
<tr>
<td>Mechanical Ventilation</td>
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<tr>
<td>Ducts</td>
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**Cooling Season**

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<td>Doors</td>
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<td>Windows/Skylights</td>
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<td>Framed Floors</td>
<td>1.8</td>
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<td>Crawl Space/Unfinished Basement</td>
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<td>Slab Floors</td>
<td>-0.4</td>
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<td>Sunspace</td>
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<td>Internal Gains</td>
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**Total**

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AIR LEAKAGE REPORT

Date: November 02, 2007
Rating No.: 44

Building Name: AS BUILT
Owner's Name: RICHARD RENNER
Property: 6 SOUTH ST
Address: PORTLAND, ME 04101
Builder's Name: DAN KOLBERT
Weather Site: Portland, ME
File Name: Renner Loft As Is.bgl

Rating Org.: HORIZON RESIDENTIAL ENERGY SER
Rater's Name: DAVID MILLKEN
Rater's No.: HRES-04
Rating Type: Confirmed Rating
Rating Date: 10/02/2007

Whole House Infiltration
Blower door test

<table>
<thead>
<tr>
<th>Natural ACH</th>
<th>Heating</th>
<th>Cooling</th>
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</thead>
<tbody>
<tr>
<td>0.12</td>
<td>0.09</td>
<td></td>
</tr>
<tr>
<td>ACH @ 50 Pascals</td>
<td>2.39</td>
<td>2.39</td>
</tr>
<tr>
<td>CFM @ 25 Pascals</td>
<td>326</td>
<td>326</td>
</tr>
<tr>
<td>CFM @ 50 Pascals</td>
<td>575</td>
<td>575</td>
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<tr>
<td>Eff. Leakage Area: 31.6</td>
<td>31.6</td>
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<tr>
<td>Specific Leakage Area: 0.00016</td>
<td>0.00016</td>
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</tr>
<tr>
<td>ELAT/100 s: 1.15</td>
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</tr>
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</table>

Duct Leakage to Outside

| CFM @ 25 Pascals | N/A |
| CFM@ 25 Pascals | N/A |
| CFM@ 50 Pascals | N/A |
| Eff. Leakage Area: N/A |
| Thermal Efficiency: 0.60 |

**Ventilation**

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<th>Mechanical</th>
<th>Balanced</th>
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<tr>
<td>Sensible Recovery Eff. (%)</td>
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<td>Total Recovery Eff. (%)</td>
<td>62.0</td>
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<tr>
<td>Rate (cfm)</td>
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<tr>
<td>Hours/Day</td>
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<tr>
<td>Fan Watts</td>
<td>65.0</td>
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<tr>
<td>Cooling Ventilation: Natural Ventilation</td>
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**ADHRAE 62.2 - 2003 Ventilation Requirements**
For this home to comply with ADHRAE Standard 62.2 - 2003 Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings, a minimum of 37 cfm of mechanical ventilation must be provided continuously, 24 hours per day. Alternatively, an intermittently operating mechanical ventilation system may be used if the ventilation rate is adjusted accordingly. For example, a 75 cfm mechanical ventilation system would need to operate 12 hours per day, as long as the system operates to provide required average ventilation once each hour.

**FUEL SUMMARY**

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File Name: Renner Loft As Is.bgl

Rating Org.: HORIZON RESIDENTIAL ENERGY SER
Rater's Name: DAVID MILLKEN
Rater's No.: HRES-04
Rating Type: Confirmed Rating
Rating Date: 10/02/2007

**AS BUILT**

Annual Energy Cost ($/yr)
- Natural Gas: $532
- Electric: $418

Annual End-Use Cost ($/yr)
- Heating: $246
- Cooling: $66
- Water Heating: $213
- Lights & Appliances: $667
- Photovoltaics: $220
- Service Charge: $80
- Total: $1028

Annual End-Use Consumption
- Heating (Therm s): 148
- Cooling (kWh): 473
- Water Heating (Therm s): 127
- Lights & Appliances (Therm s): 44
- Photovoltaics (kWh): -1559

Utility Rates:
- Electric: $0.145/kWh
- Gas: $0.105/Therm

This information does not constitute any warranty of energy cost or savings. © 1995-2007 Architectural Energy Corporation, Boulder, Colorado.
**2005 EPACT ENERGY EFFICIENT HOME TAX CREDIT**

<table>
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<tr>
<td>Building Name:</td>
<td>AS BUILT</td>
<td>Rating Org.: HORIZON RESIDENTIAL ENERGY SER</td>
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<tr>
<td>Owner's Name:</td>
<td>RICHARD RENNER</td>
<td>Phone No.: 207-221-3232</td>
</tr>
<tr>
<td>Property:</td>
<td>6 SOUTH ST</td>
<td>Rater's Name: DAVID MILLIKEN</td>
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<td>Portland, ME</td>
<td>Rating Date: 10/03/2007</td>
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### Normalized, Modified End-Use Loads (MMThy/year)

**2004 EECO**

<table>
<thead>
<tr>
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<th>20% Target</th>
<th>As Designed</th>
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<tbody>
<tr>
<td>Heating</td>
<td>14.1</td>
<td>6.9</td>
</tr>
<tr>
<td>Cooling</td>
<td>3.7</td>
<td>5.4</td>
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<thead>
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<tr>
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<td>25.3</td>
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<td>Cooling</td>
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**Total:**

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<tr>
<td>Heating</td>
<td>31.9</td>
<td>17.7</td>
</tr>
</tbody>
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This home MEETS the requirements for the residential energy efficiency tax credits under Section 1322, Credit for Construction of New Energy Efficient Homes, of the Energy Policy Act of 2005. As demonstrated above, this dwelling unit has a projected level of annual heating and cooling energy consumption that is at least 50% below the annual level of heating and cooling energy consumption of a reference dwelling in the same climate zone, and the building envelope components improvements account for at least 50% of the energy savings. The projected heating and cooling energy savings above have been calculated in the following manner:

1. Heating savings: The heating energy consumption is calculated by the Energy Star Pro software and is based on the heating load of the building and the efficiency of the heating system.
2. Cooling savings: The cooling energy consumption is calculated by the Energy Star Pro software and is based on the cooling load of the building and the efficiency of the cooling system.

The undergound eligible certificate during and after the completion of construction have confirmed that all features of the home affecting such heating and cooling energy consumption comply with the design specifications provided to the underground code.

---

**Building Shell Features**

- **Ceiling Flat:** R-54
- **Occupancy:** NA
- **Aperture Grade:** R-34
- **Foundation Walls:** NA
- **Exposed Floor:** NA

**Slab:** None

- **U-Value:** 0.150
- **UHIC:** 0.280

**Window:** Natural gas, Hig eff 0.85 CAnue. DHW eff 0.80 CAnet.

**Air conditioner:** Electric, 13.0 SEER.

---

Under penalties of perjury, I declare that I have examined this certification, including accompanying documents, and to the best of my knowledge and belief, the facts presented in support of this certification are true, correct, and complete.

<table>
<thead>
<tr>
<th>Name:</th>
<th>Signature:</th>
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</thead>
<tbody>
<tr>
<td></td>
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Company:

Address:

---

REMRate - Residential Energy Analysis and Rating Software v12.41


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**ENERGY STAR HOME REPORT**

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<tr>
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<th>November 02, 2007</th>
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### Normalized, Modified End-Use Loads (MMThy/year)

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<table>
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<td>36.3</td>
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<tr>
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<td>30</td>
<td>43</td>
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**HERS Index:**

- **Energy Star:** 53.1
- **As Designed:** 36.3

**ENERGY STAR Mandatory Requirements**

- **Thermal Bypass Inspection Checklist:**
- **Ductwork Requirements:**

This home MEETS or EXCEEDS the energy efficiency requirements for designation as an EPA ENERGY STAR® Qualified Home.

<table>
<thead>
<tr>
<th>Pollution Prevented</th>
<th>Reduction (btu/year)</th>
<th>Energy Cost Savings (G/year)</th>
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<tbody>
<tr>
<td>Type of Emission</td>
<td>Reduction</td>
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<tr>
<td>- Carbon Dioxide (CO2)</td>
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<td>$0.09</td>
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**Total:**

- **Energy Cost Savings:** $17.04

The energy savings and pollution prevented are calculated by the Energy Star Pro software and are based on the design of the building and the energy efficiency of the systems installed. The HERS Index is calculated based on the energy consumption of the building and is used to determine the energy efficiency of the home.

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REMRate - Residential Energy Analysis and Rating Software v12.41


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Portland Loft

Richard Renner | Architects
Case Study Questions:

Why do this project?
What was done?
How was it done?
What was learned?

Portland Loft
The project has a HERS rating of 43. The following is a summary of predicted versus actual performance:

- Total Energy Use (MMBtu/year) - Predicted, 36.9; Actual, 28.4
- Solar PV Contribution (kWh) - Predicted, 1,559; Actual, 513
- Cost of Natural Gas - Predicted, $532; Actual, $382
- Cost of Electricity - Predicted, $418; Actual, $364

It is important to remember that some of this performance is due to immediate adjacency to a heated office below and heated residential space along most of one side. This means that the project cannot be compared to a stand-alone house, but, on the other hand, it demonstrates the inherent advantage of greater density. This advantage in individual building performance is reinforced by the likely lower transportation energy use.
Spreadsheet developed to track actual energy consumption using information from utility bills

### 6 South Street Loft

**Energy Use: September, 2007 through August, 2008**

Richard Renner | Architects

**September 10, 2008; revised February 23, 2009**

<table>
<thead>
<tr>
<th>Invoice Date</th>
<th>Company</th>
<th>No.</th>
<th>Total KWH</th>
<th>Solar KWH</th>
<th>Electric Net KWH</th>
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<th>Ccf</th>
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Totals: 2,484 btu, 8,475,408 Ccf, 1,971 $, 363.76 $, 6,725,052 btu, 210 $, 382.22 $, 21,651,000 btu

6 South Street Loft btu/SF (Aug. '07-Sept. '08): 20,269, 2.096 Btu/SF/HDD/Yr

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*Portland Loft*
Portland Loft
Bar chart showing total energy use during the first year of occupancy and the relative shares of natural gas and electricity. The intermittent pattern of gas use is a billing anomaly, not the actual pattern of use.
This chart or total energy use during the second year of occupancy better represents the actual pattern of gas use.
The project does not quite meet the Option B criteria. One factor is that two people are living in a space that could easily accommodate three occupants; there is a second full bedroom. Since actual overall energy use is quite low, it is hard to think of anything dramatic that could have been done differently. A few marginal but, perhaps important improvements, like better exterior doors and pressure testing to tighten the envelope come to mind. Given the building’s immediate surroundings and orientation, additional solar was not a good option.

Possible operating improvements are listed in a following slide.
Comparing Predicted & Actual Post Use Against THC OPTION B Threshold & 50% Milestone

This project does not quite meet the OPTION B 1000 Home Challenge threshold: 6,796 kWh/yr. (site energy).

OPTION B Inputs: ZIP code: 04101; 2 occupants; 1,400 FFA; 45% common wall

Portland Loft
Summary of energy use during the first year of occupancy

<table>
<thead>
<tr>
<th>Source</th>
<th>Amount</th>
<th>Model Unit</th>
<th>Btu</th>
<th>2007-2008</th>
<th>Amount</th>
<th>Unit</th>
<th>Btu</th>
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<td>Electricity</td>
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<td>KwH</td>
<td>15,662,515</td>
<td>2,484</td>
<td>KwH</td>
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<td>Therm</td>
<td>30,900,000</td>
<td>210</td>
<td>Ccf</td>
<td>21,651,000</td>
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<tr>
<td>Solar PV</td>
<td>(1,559)</td>
<td>KwH</td>
<td>(5,348,929)</td>
<td>(513)</td>
<td>KwH</td>
<td>(1,750,356)</td>
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<td><strong>TOTAL</strong></td>
<td><strong>41,213,586</strong></td>
<td><strong>41.21</strong></td>
<td><strong>28,376,052</strong></td>
<td><strong>28.38</strong></td>
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</table>

2007-2008 Btu/SF: 20,269
2007-2008 Btu/SF/HDD/Yr: 2.096

Portland Loft
Lessons Learned

- There is no conflict between high levels of building performance and good design.
- The high windows in the clerestory are only ten feet above the windows on the main level, but this is enough of a difference to create air flow for natural ventilation. These high windows deliver sufficient daylighting on all but the darkest days. A shade, which was planned but omitted for budget reasons, would have reduced solar gain in the summer.
- The bathroom has no windows, but Solartube skylights provide plenty of daylight.
- An unexpected benefit of triple glazing is that the loft is quiet in spite of its urban location.
- The loft’s open plan and long interior views make it feel larger than its actual size.
- Locating the heat recovery ventilator above the bathroom ceiling makes maintenance more difficult. However, there was no other place to put it.
- Recessing the windows to maximize size and thermal efficiency required complicated head, jamb, and sill flashing. Snow frozen on the deep sill occasionally restricts the operation of the awning windows.
- At today’s prices, the 1KW grid-tied solar system is not cost effective.
Possible energy performance improvements

- Aggressively address passive loads. AFTER SEVEN YEARS: Not sure the magnitude is that high. On other more recent projects, we have installed an eMonitor to track the power consumption of each circuit, and this allows us to see where there are possible improvements, both in equipment and patterns of use. An eMonitor installed in the loft would tell us where to focus our attention.
- Closely coordinate heat recovery ventilation with open windows in warmer months. When the windows are open, turn the system completely off. AFTER SEVEN YEARS: We also looked at running the ventilation system at less than 100% during the heating season.
- Turn down the heat in the winter. Daily setback will not work well, because the system is radiant, but overall set points could be lower. Bedroom zone is currently set at 62 degrees; the rest of the loft is set at 65 degrees. Both could be reduced somewhat. AFTER SEVEN YEARS: Not done, because heating costs were already low.
Possible energy performance improvements - continued

- Put coffee in a thermos instead of using the coffee maker’s heating element to keep the coffee warm. AFTER SEVEN YEARS: Not done, in part because in the several years before the loft was rented, occupancy was intermittent.
- The outside light at the front door is left on all night, because there is a graffiti problem in the neighborhood. Installing a motion sensor would reduce energy use.
- Install an exterior sunshade at the south-facing clerestory windows to reduce heat gain in the summer. AFTER SEVEN YEARS: This was implemented, but more because the lighted door attracted graffiti.
- Use the roof deck for drying clothes when possible. AFTER SEVEN YEARS: The deck was installed, but just before renting the loft. Also, access to the deck is difficult with a basket of wet clothes. However, there is little doubt that this would save energy.
Links


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Portland Loft