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?

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.

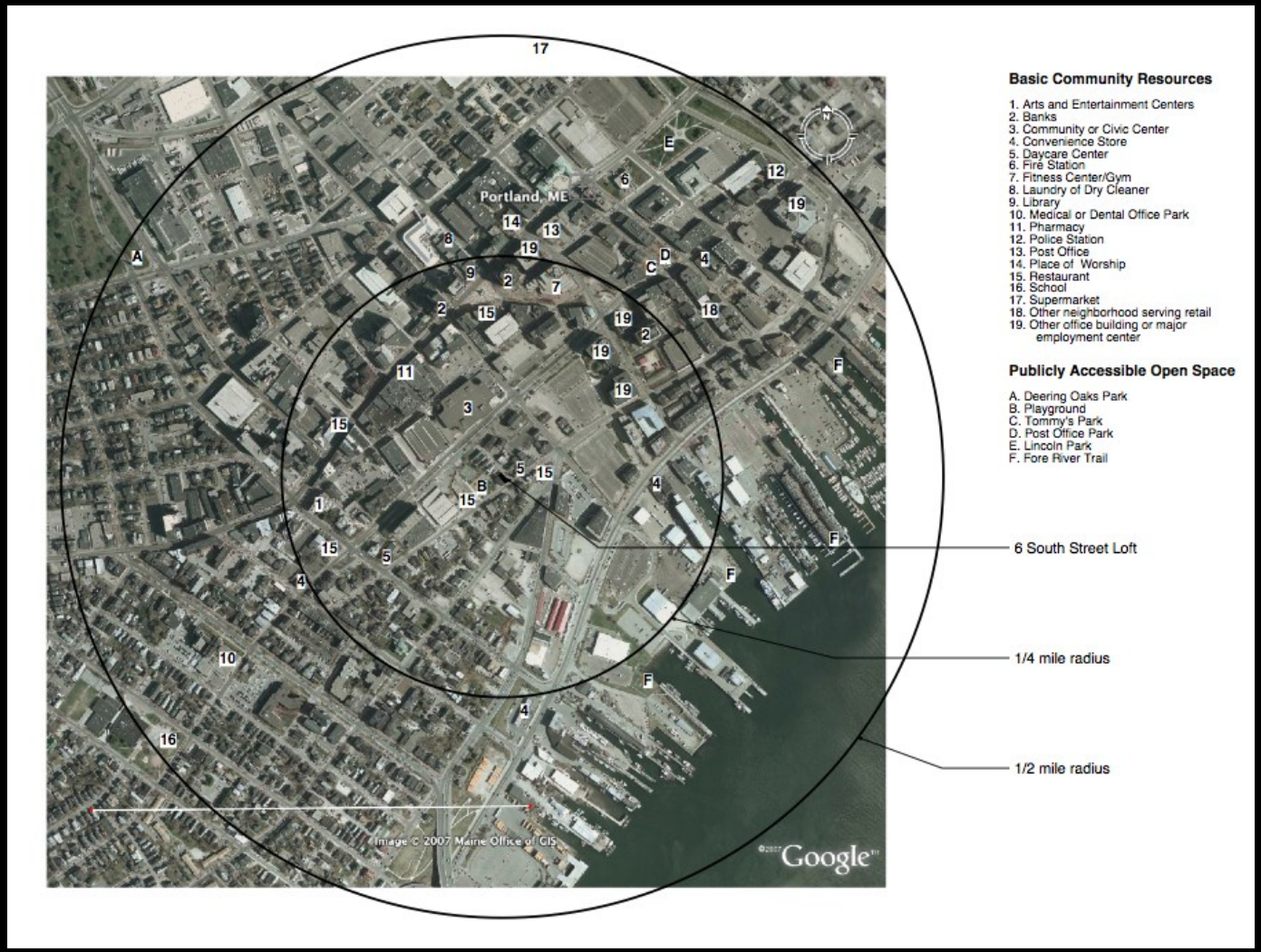
In the renovation, the lower level became a 1,500 SF office which can accommodate a staff of up to six; the upper level is a 1,400 SF two-bedroom loft where my wife, Janet Friskey, and I lived.

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



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

Portland Loft

Case Study Questions:

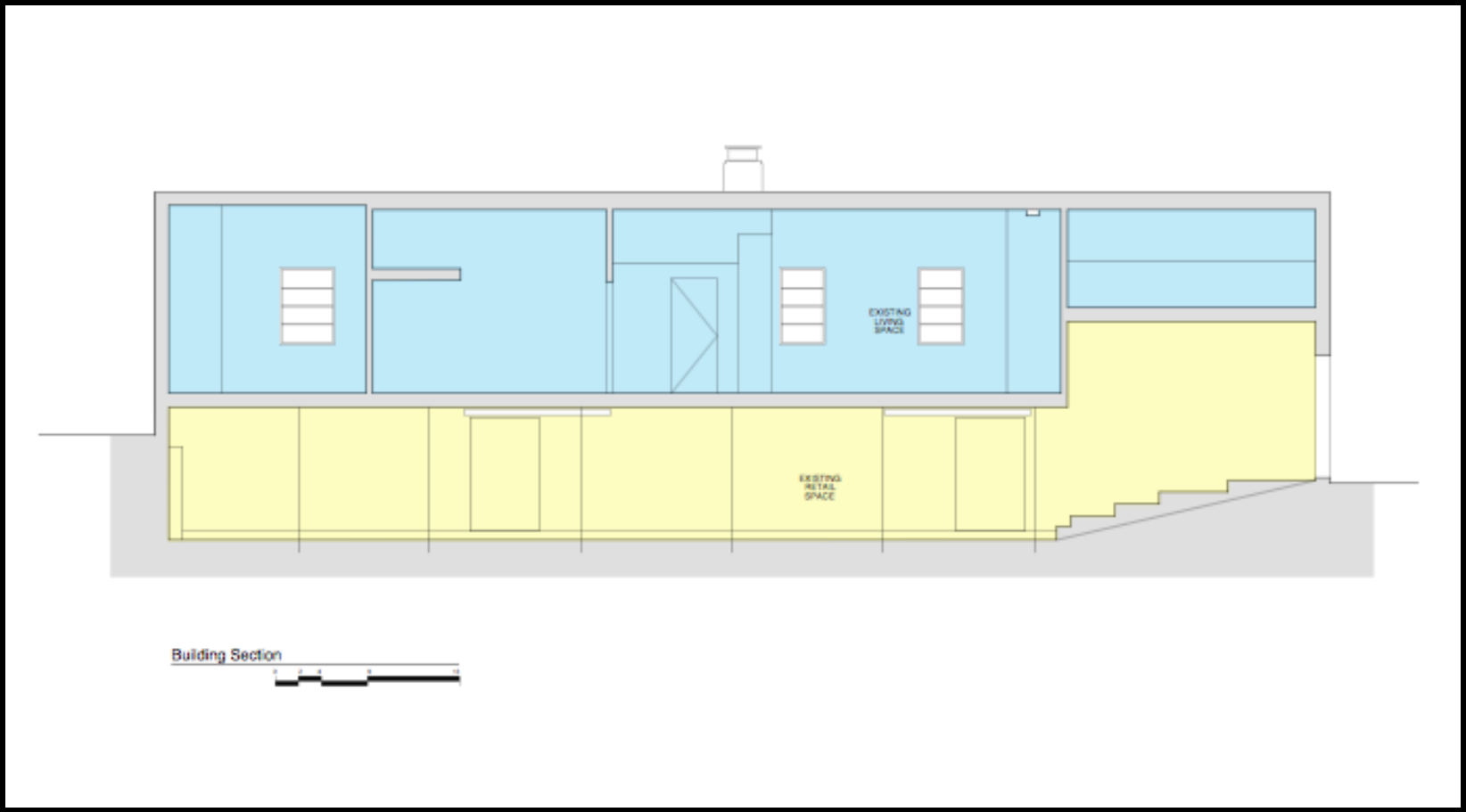
Why do this project?
What was done?
How was it done?
What was learned?

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 thriple glazed fiberglass windows were installed throughout.

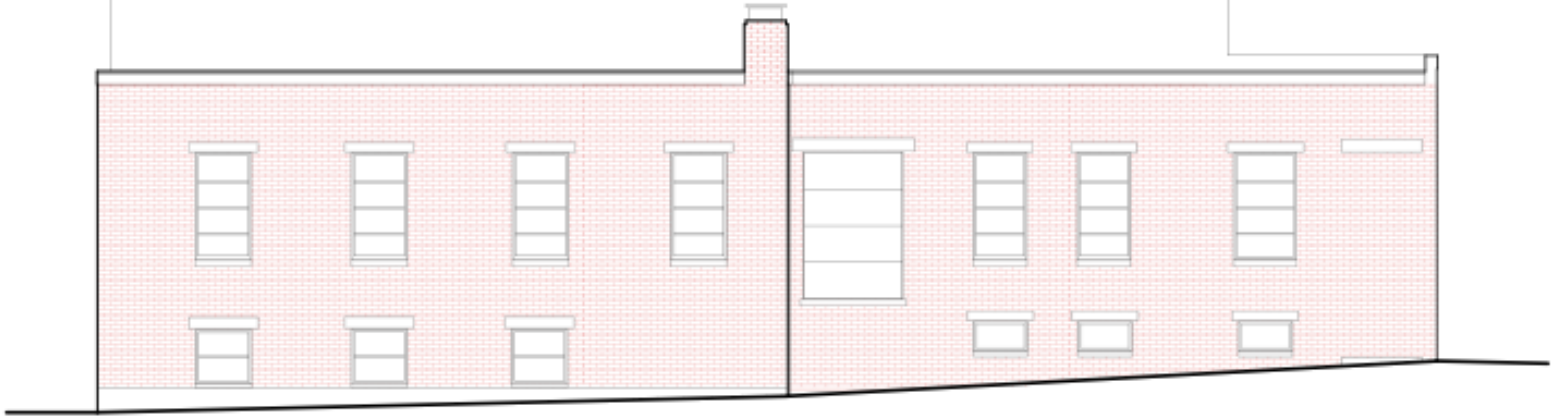
Original Floor Plan

Portland Loft



Original building section

Portland Loft

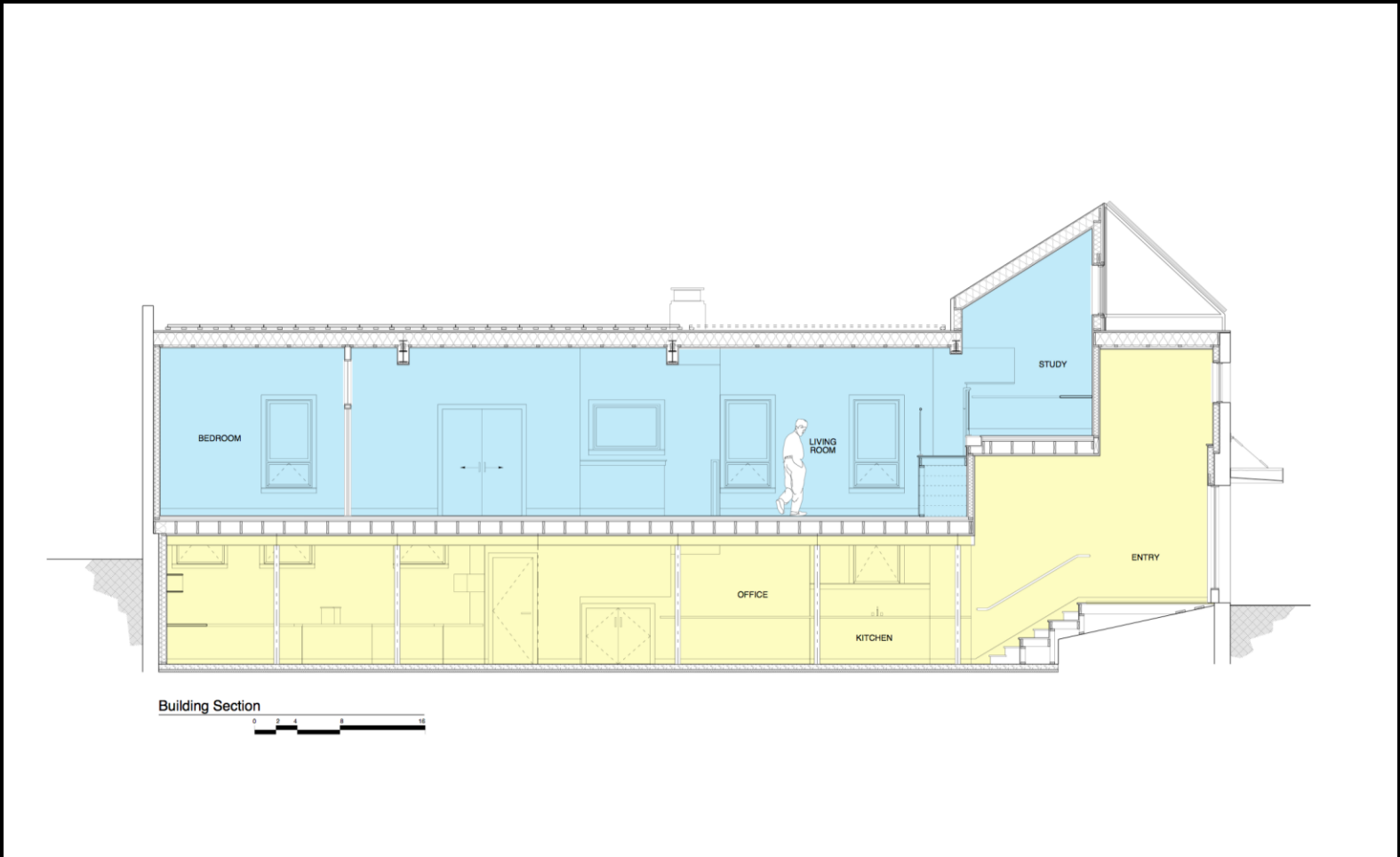


Original Building Elevation

Portland Loft

Completed Floor Plan

Portland Loft



Completed Building Section

Portland Loft

Completed Building Elevation

Portland Loft

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

Completed loft looking toward mezzanine with clerestory

Portland Loft

Mezzanine study with high windows for light and ventilation

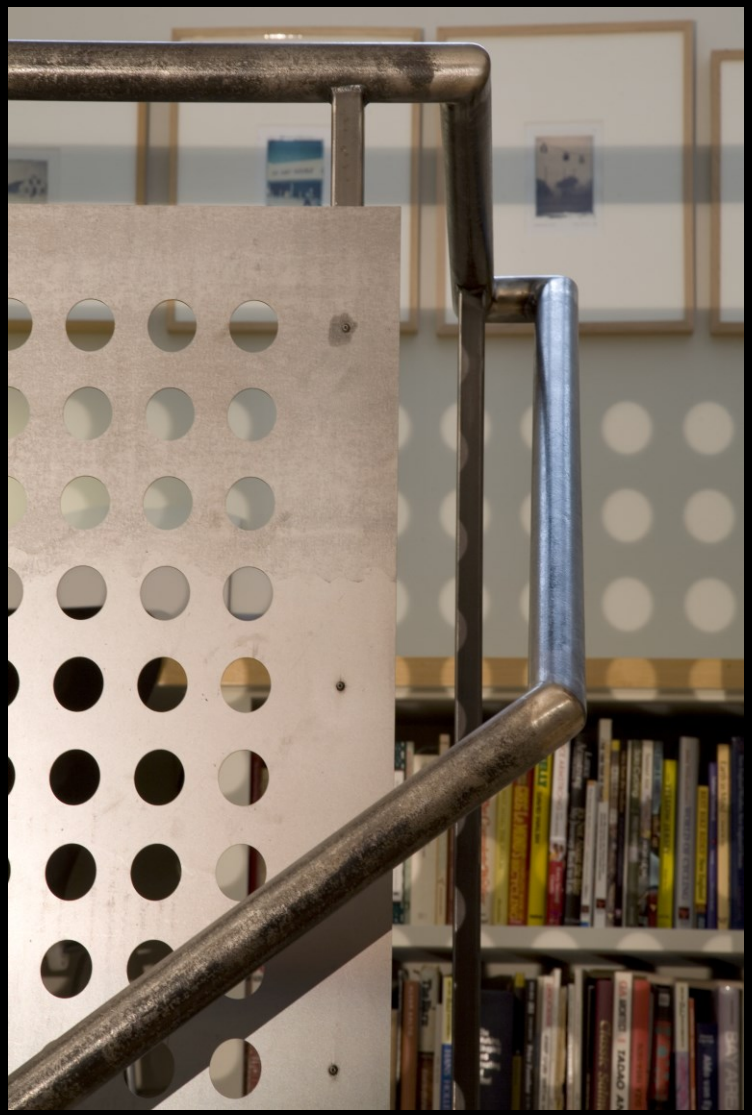
Folding stair to roof deck

Portland Loft

Installation of vegetated roof

Roof deck

Portland Loft



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.

Portland Loft

Office and Loft Exterior

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Loft Interior

Kitchen and Entry

Portland Loft

Loft Interior

Living Area and Kitchen

Portland Loft

Loft Interior

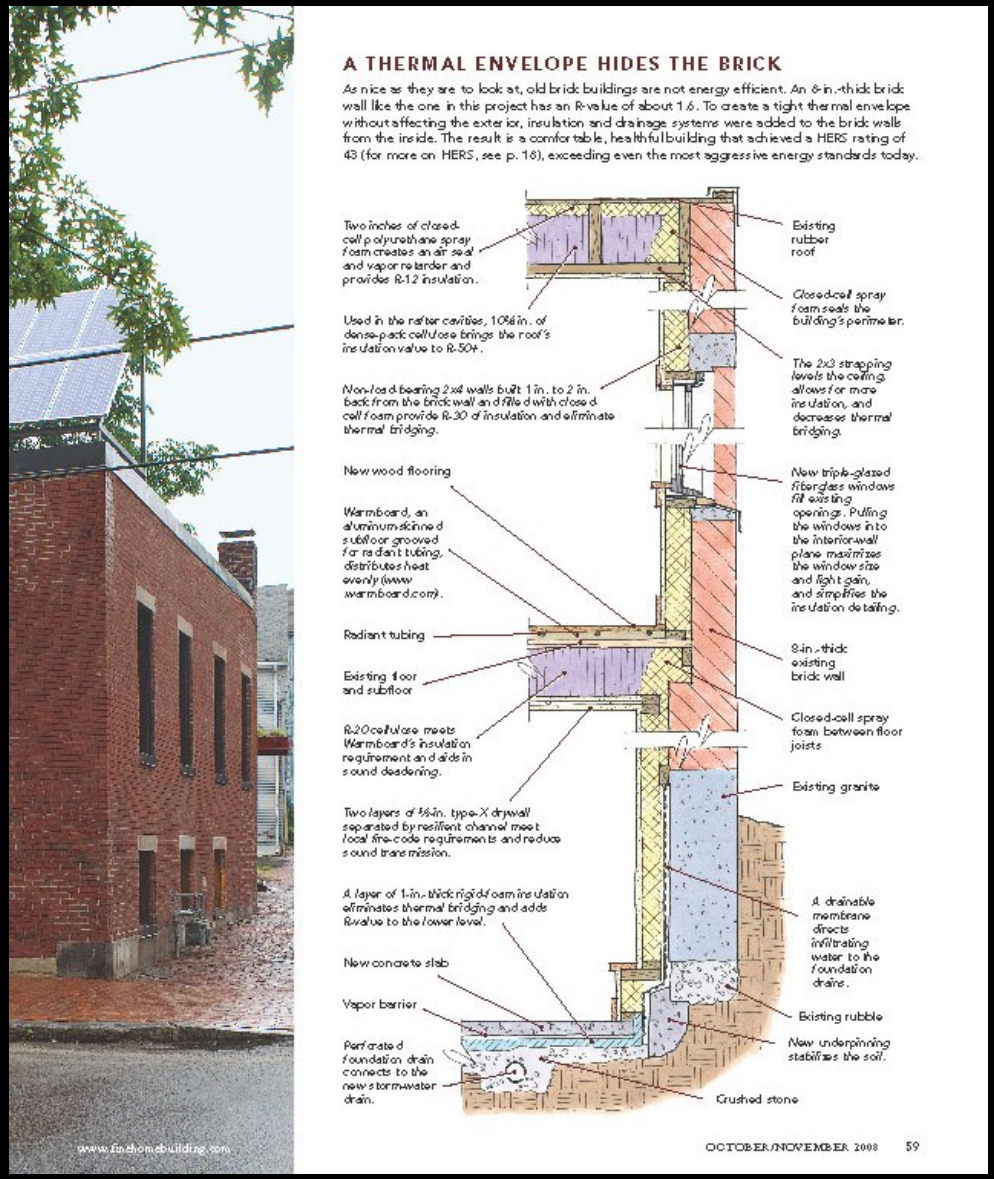
Bedroom, Hall, and Bath

Portland Loft

Case Study Questions:

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

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.



www.finehomebuilding.com

A THERMAL ENVELOPE HIDES THE BRICK

As nice as they are to look at, old brick buildings are not energy efficient. An 8-in.-thick brick wall like the one in this project has an R-value of about 1.6. To create a tight thermal envelope without affecting the exterior, insulation and drainage systems were added to the brick walls from the inside. The result is a comfortable, healthful building that achieved a HERS rating of 43 (for more on HERS, see p. 18), exceeding even the most aggressive energy standards today.

Two inches of closed-cell polyurethane spray foam creates an air seal and vapor retarder and provides R-12 insulation.

Used in the rafter cavities, 10¼ in. of dense-pack cellulose brings the roof's insulation value to R-50+.

Non-load-bearing 2x4 walls built 1 in. to 2 in. back from the brick wall and filled with closed-cell foam provide R-30 of insulation and eliminate thermal bridging.

New wood flooring

Warmboard, an aluminum-skinned subfloor grooved for radiant tubing, distributes heat evenly (www.warmboard.com).

Radiant tubing

Existing floor and subfloor

R-20 cellulose meets Warmboard's insulation requirement and aids in sound deadening.

Two layers of 5/8-in. type-X drywall separated by resilient channel meet local fire-code requirements and reduce sound transmission.

A layer of 1-in.-thick rigid-foam insulation eliminates thermal bridging and adds R-value to the lower level.

New concrete slab

Vapor barrier

Perforated foundation drain connects to the new storm-water drain.

Existing rubber roof

Closed-cell spray foam seals the building's perimeter.

The 2x3 strapping levels the ceiling, allows for more insulation, and decreases thermal bridging.

New triple-glazed fiberglass windows fill existing openings. Pulling the windows in to the interior-wall plane maximizes the window size and light gain, and simplifies the insulation detailing.

8-in.-thick existing brick wall

Closed-cell spray foam between floor joists

Existing granite

A drainable membrane directs infiltrating water to the foundation drains.

Existing rubble

New underpinning stabilizes the soil.

Crushed stone

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Demolition and brick re-pointing

Demolition (loft above, office below)

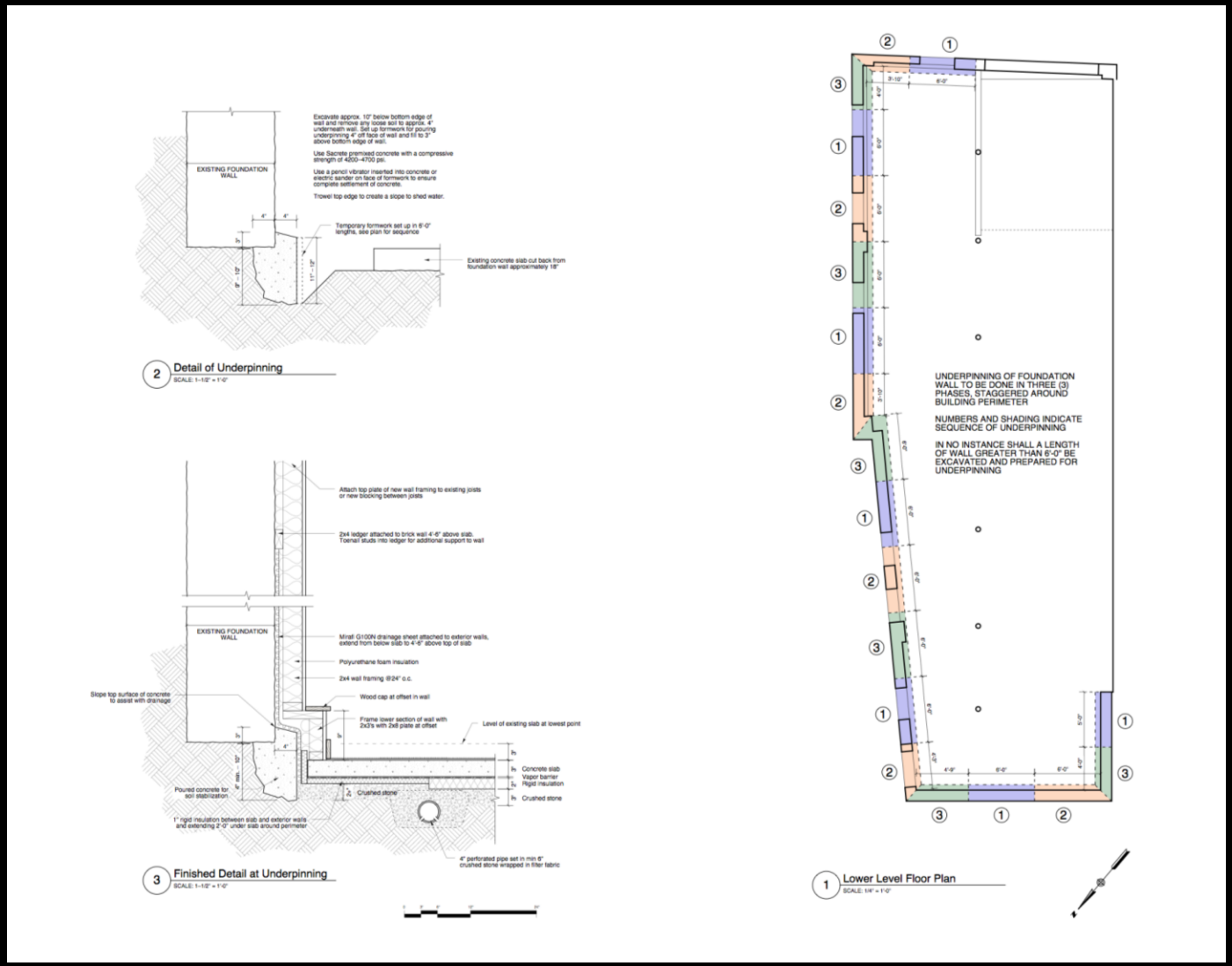
Demolition - Loft, looking north

Demolition - Removing brick to create loft entry

Portland Loft

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)

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Framing at windows

Framing at master bedroom

Framing - Loft, looking north

Gap between framing and exterior masonry wall to eliminate thermal bridging

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Reinforced roof structure

Detail of roof reinforcing

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.

New roof monitor

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Repointing - Existing window not removed, yet

Repointing

Brick prior to repointing

Portland Loft

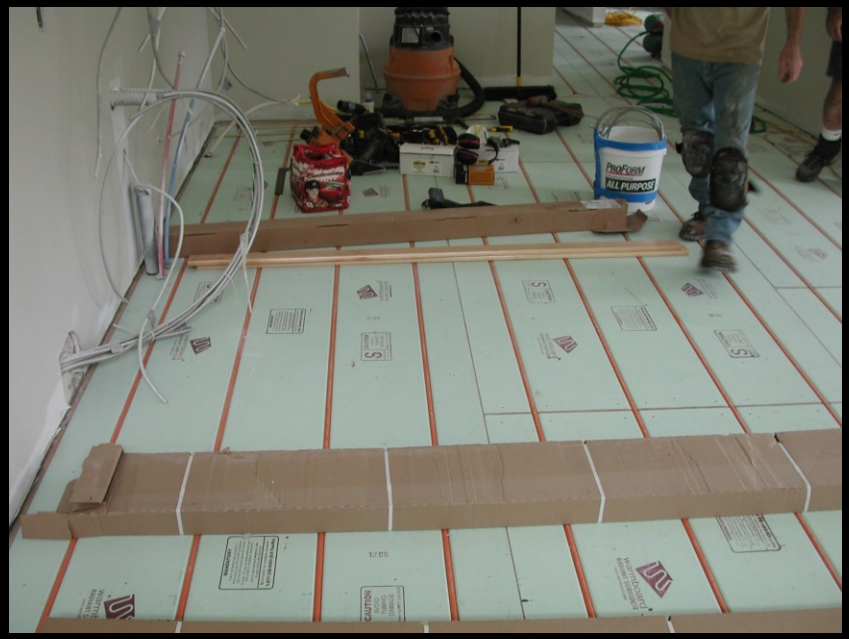
Insulation - Foam in walls; foam+cellulose in roof

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.

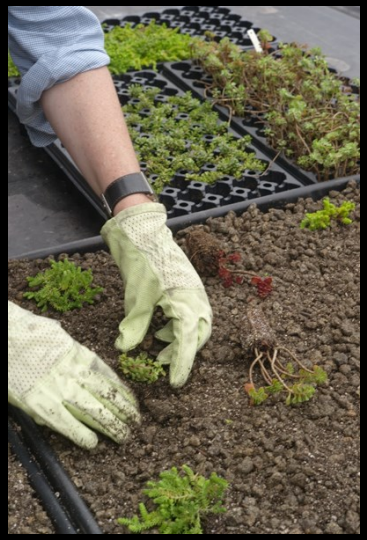
Installation of drywall and trim. Note the new entrance door at the level of the sidewalk. This was cut out of what had been a loading dock in this location.

Moving materials to roof

Laying out trays

Adding soil

Planting



Planting

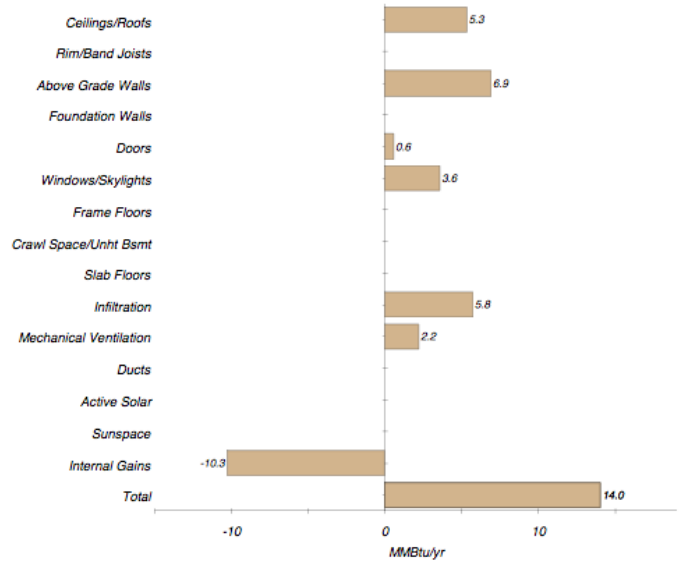
Roughly 1/3 of the roof is covered with vegetation in trays. This reduces runoff from the hard surface of the roof and may reduce cooling loads in the summer.

Portland Loft

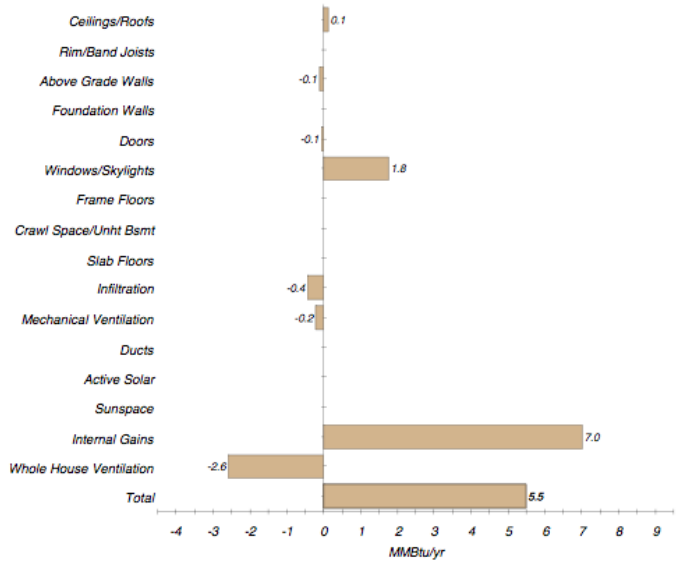
COMPONENT LOAD SUMMARY

Date:	November 02, 2007	Rating No.:	
Building Name:	AS BUILT	Rating Org.:	HORIZON RESIDENTIAL ENERGY SER
Owner's Name:	RICHARD RENNER	Phone No.:	207-221-3221
Property:	6 SOUTH ST	Rater's Name:	DAVID MILLIKEN
Address:	PORTLAND, ME 04101	Rater's No.:	HRES-04
Builder's Name:	DAN KOLBERT		
Weather Site:	Portland, ME	Rating Type:	Confirmed Rating
File Name:	Renner Loft As Is.blg	Rating Date:	10/30/2007

Heating Season



Cooling Season



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Portland Loft

AIR LEAKAGE REPORT

Date:	November 02, 2007	Rating No.:	
Building Name:	AS BUILT	Rating Org.:	HORIZON RESIDENTIAL ENERGY SER
Owner's Name:	RICHARD RENNER	Phone No.:	207-221-3221
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Builder's Name:	DAN KOLBERT		
Weather Site:	Portland, ME	Rating Type:	Confirmed Rating
File Name:	Renner Loft As Is.blg	Rating Date:	10/30/2007

Whole House Infiltration

	Blower door test	
	Heating	*Cooling*
Natural ACH:	0.12	0.09
ACH @ 50 Pascals:	2.39	2.39
CFM @ 25 Pascals:	366	366
CFM @ 50 Pascals:	575	575
Eff. Leakage Area:	31.6	31.6
Specific Leakage Area:	0.00016	0.00016
ELA/100 sf shell:	1.15	1.15

Total Duct Leakage to Outside

CFM @ 25 Pascals:	N/A
CFM25 / CFMfan:	N/A
CFM25 / CFA:	N/A
CFM per Std 152:	N/A
CFM per Std 152 / CFA:	N/A
CFM @ 50 Pascals:	N/A
Eff. Leakage Area:	N/A
Thermal Efficiency:	0.00

Ventilation

Mechanical:	Balanced
Sensible Recovery Eff. (%):	71.0
Total Recovery Eff. (%):	62.0
Rate (cfm):	37
Hours/Day:	24.0
Fan Watts:	65.0
Cooling Ventilation:	Natural Ventilation

ASHRAE 62.2 - 2003 Ventilation Requirements

For this home to comply with ASHRAE 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 73 cfm mechanical ventilation system would need to operate 12 hours per day, as long as the system operates to provide required average ventilaton once each hour.

FUEL SUMMARY

Date:	November 02, 2007	Rating No.:	
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AS BUILT

Annual Energy Cost ($/yr)		
Natural gas	$	532
Electric	$	418
Annual End-Use Cost ($/yr)		
Heating	$	246
Cooling	$	68
Water Heating	$	213
Lights & Appliances	$	667
Photovoltaics	$	-226
Service Charges	$	60
Total	$	1028
Annual End-Use Consumption		
Heating (Therms)		148
Cooling (kWh)		473
Water Heating (Therms)		127
Lights & Appliances (Therms)		44
Lights & Appliances (kWh)		4092
Photovoltaics (kWh)		-1559

Utility Rates:

Electricity:	Elec .145 kwh
Gas:	NG $1.65/Therm

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2005 EPACT ENERGY EFFICIENT HOME TAX CREDIT

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Weather Site:	Portland, ME	Rating Type:	Confirmed Rating
File Name:	Renner Loft As Is.blg	Rating Date:	10/30/2007

Normalized, Modified End-Use Loads (MMBtu/year)

	2004 IECC 50% Target	*As Designed*
Heating:	14.1	6.9
Cooling:	3.7	5.4
Total:	17.7	12.3

Envelope Loads (MMBtu/year)

	2004 IECC 90% Target	*As Designed*
Heating:	25.3	11.5
Cooling:	6.6	6.2
Total:	31.9	17.7

This home MEETS the requirements for the residential energy efficiency tax credits under Section 1332, 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 cooling energy consumption of a reference dwelling in the same climate zone, and the building envelope components improvements alone account for at least 10% of those savings. The projected heating and cooling energy savings above have been calculated in the manner prescribed in Section 2.02 of Notice 2006-27 of the Internal Revenue Service. Field inspections of the dwelling unit performed by the undersigned eligible certifier 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 undersigned certifier.

Building Shell Features

Ceiling Flat:	R-54	Slab:	None
Vaulted Ceiling:	NA	Duct:	NA
Above Grade Walls:	R-34	Window:	U-Value = 0.150, SHGC = 0.280
Foundation Walls:	NA	Integrated:	Natural gas, Htg eff 0.95 CAafue. DHW eff 0.80 CAef.
Exposed Floor:	NA	Cooling:	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.

Name: _____ Signature: _____

Company: _____ Date: _____

Address: _____

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ENERGY STAR

ENERGY STAR HOME REPORT

Date:	November 02, 2007	Rating No.:	
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Weather Site:	Portland, ME	Rating Type:	Confirmed Rating
File Name:	Renner Loft As Is.blg	Rating Date:	10/30/2007

Normalized, Modified End-Use Loads (MMBtu/year)

	ENERGY STAR	*As Designed*
Heating:	22.5	6.6
Cooling:	5.9	5.7
Water heating:	8.5	4.8
Lighting & Appliances:	16.2	19.8
Total:	53.1	36.9
HERS Index:	**80**	**43**

ENERGY STAR Mandatory Requirements

[X]	Thermal Bypass Inspection Checklist *	[X]	ENERGY STAR Products *
[X]	Ductwork Requirements	[X]	ENERGY STAR Scoring Exceptions

** Thermal Bypass Checklist and ENERGY STAR Products are not checked in REM/Rate at this time.*

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

Pollution Prevented

Type of Emissions	*Reduction (lb/year)*
Carbon Dioxide (CO2)	4821.3
Sulfur Dioxide (SO2)	1.5
Nitrogen Oxides (NOx)	6.1

Energy Cost Savings ($/year)

Heating:	$509
Cooling:	$24
Water Heating:	$99
Lights & Appliances:	$17
Total:	$647

The energy savings and pollution prevented are calculated by comparing the Rated Home to the Reference Home as defined in the "Mortgage Industry National Home Energy Rating Systems Standards" as promulgated by the Residential Energy Services Network (RESNET). In accordance with these guidelines, building inputs affecting setpoints, infiltration rates, window shading and the existence of mechanical systems may have been changed prior to calculating loads.

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Case Study Questions:

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

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.

6 South Street Loft

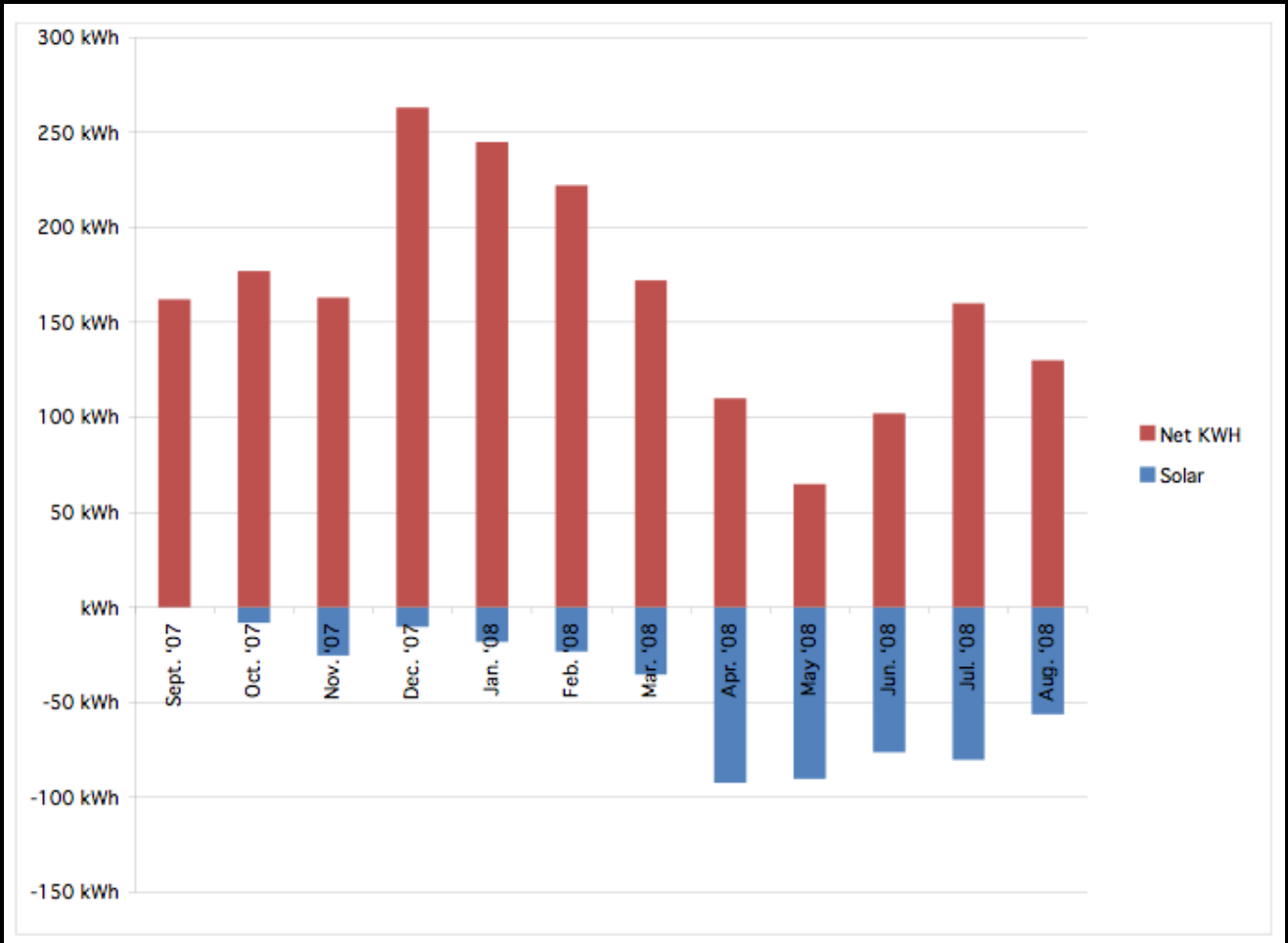
Energy Use: September, 2007 through August, 2008
Richard Renner|Architects
September 10, 2008; revised February 23, 2009

Invoice Date	Company	No.	6 South Street Loft Total KWH	Solar KWH	Electricity Net KWH	$	btu	Ccf	Natural Gas $	btu
9/25/07	Central ME Power		162	0	162	$ 25.76	552,744			
9/27/07	Northern Utilities	207244					0	6	$ 9.92	618,600
10/24/07	Central ME Power		185	8	177	$ 15.82	603,924			
11/26/07	Central ME Power		188	25	163	$ 25.91	556,156			
12/24/07	Central ME Power		273	10	263	$ 41.06	897,356			
12/28/07	Northern Utilities	206913					0	58	$ 101.26	5,979,800
1/24/08	Central ME Power		263	18	245	$ 38.34	835,940			
2/25/08	Central ME Power		245	23	222	$ 34.85	757,464			
3/10/08	Northern Utilities	217998					0	77	$ 141.60	7,938,700
3/24/08	Central ME Power		207	35	172	$ 28.37	586,864			
3/28/08	Northern Utilities	209393					0		$ 110.50	0
4/23/08	Central ME Power		202	92	110	$ 19.09	375,320			
4/29/08	Northern Utilities	208021					0	57		5,876,700
5/22/08	Central ME Power		155	90	65	$ 33.36	221,780			
5/29/08	Northern Utilities	202593					0		$ (2.13)	0
6/25/08	Central ME Power		178	76	102	$ 51.60	348,024			
6/28/08	Northern Utilities	213775					0	12	$ 25.47	1,237,200
7/23/08	Central ME Power		240	80	160	$ 27.08	545,920			
7/30/08	Northern Utilities	214140					0	0	$ (4.40)	0
8/22/08	Central ME Power		186	56	130	$ 22.52	443,560			
		Totals	2,484	513	1,971	$ 363.76	6,725,052	210	$ 382.22	21,651,000
		btu	8,475,408	1,750,356	6,725,052			21,651,000		

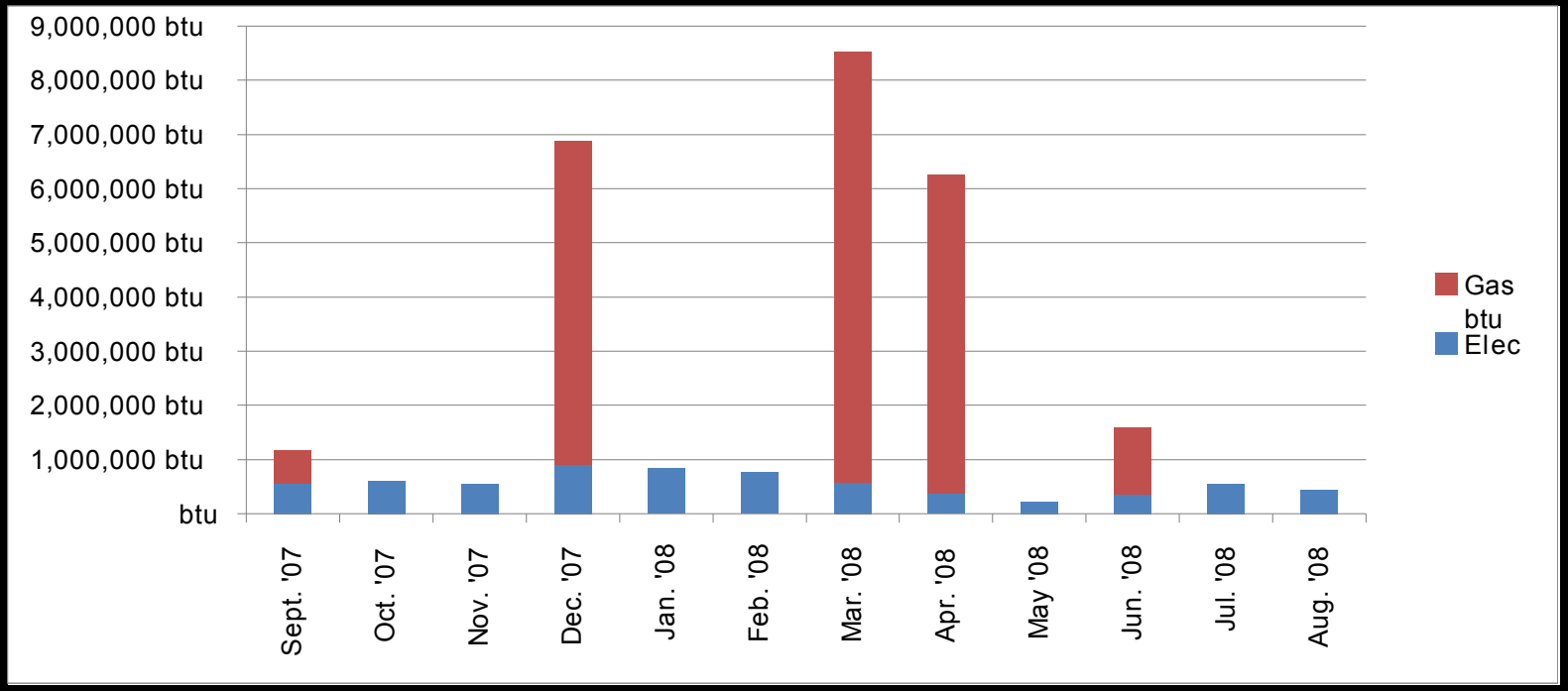
6 South Street Loft btu/SF (Aug. '07-Sept. '08) 20,269 2.096 Btu/SF/HDD/Yr

Spreadsheet developed to track actual energy consumption using information from utility bills

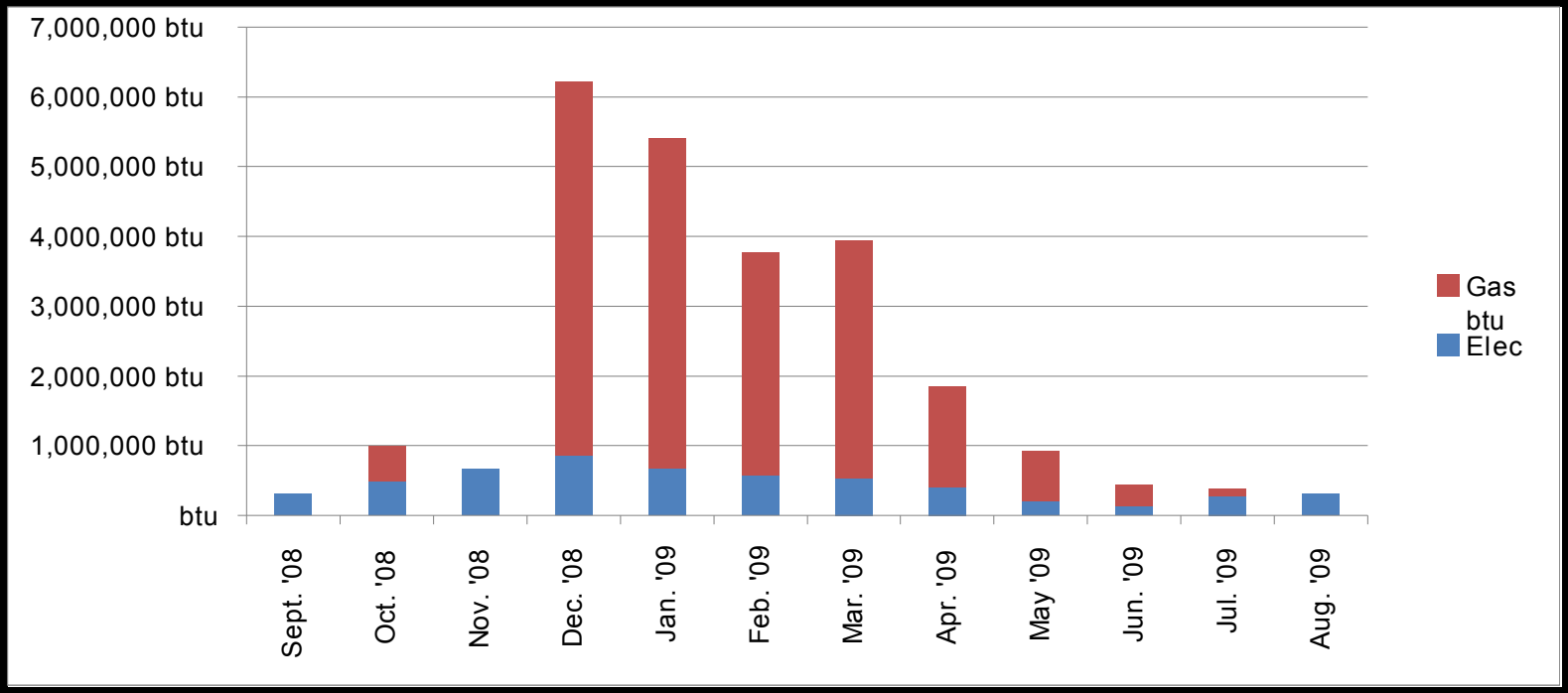
Portland Loft



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.

User Interface - Performance Threshold Calculator for Thousand Home Challenge

yellow	shaded cells require user input
blue	shaded cells are calculated outputs

Home Description, Basic Inputs

Home's 5-digit zip code	04101
Finished floor area (ft2)	1,400
Number of occupants	2
Number of households in building	1
Attached home, % common	45%

Weather Station Info

Station linked to zipcode is	ME_PORTLAND_INTL_JETPORT
Preferred weather station is	use zip code

Energy Unit Conversion Chart

Select Energy Source	Enter annual use	MMBtu	kWh
Nat Gas - ccf	210.0	21.4200	6277.8429
Electricity - kWh	1971.0	6.7251	1971.0000
Nat Gas - ccf	0.0	0.0000	0.0000
Other	0.0	0.0000	0.0000
TOTALS		**28.1**	**8,249**

Option A: 75% Reduction (requires one year pre-retrofit energy bills)

Current gas/fossil/wood use(MMBtu/year)	21.4	
Current electric use (kWh/year)	1,971	
Current total energy use kWh/year	**8,241**	Gas/fossil/wood MMBtu converted to kWh
Threshold gas/fossil/wood use (MMBtu/yr)	5.4	
Threshold electric use (kWh/yr)	493	
Maximum total energy use (kWh/yr)	**2,060**	Gas/fossil/wood MMBtu converted to kWh; Excludes solar

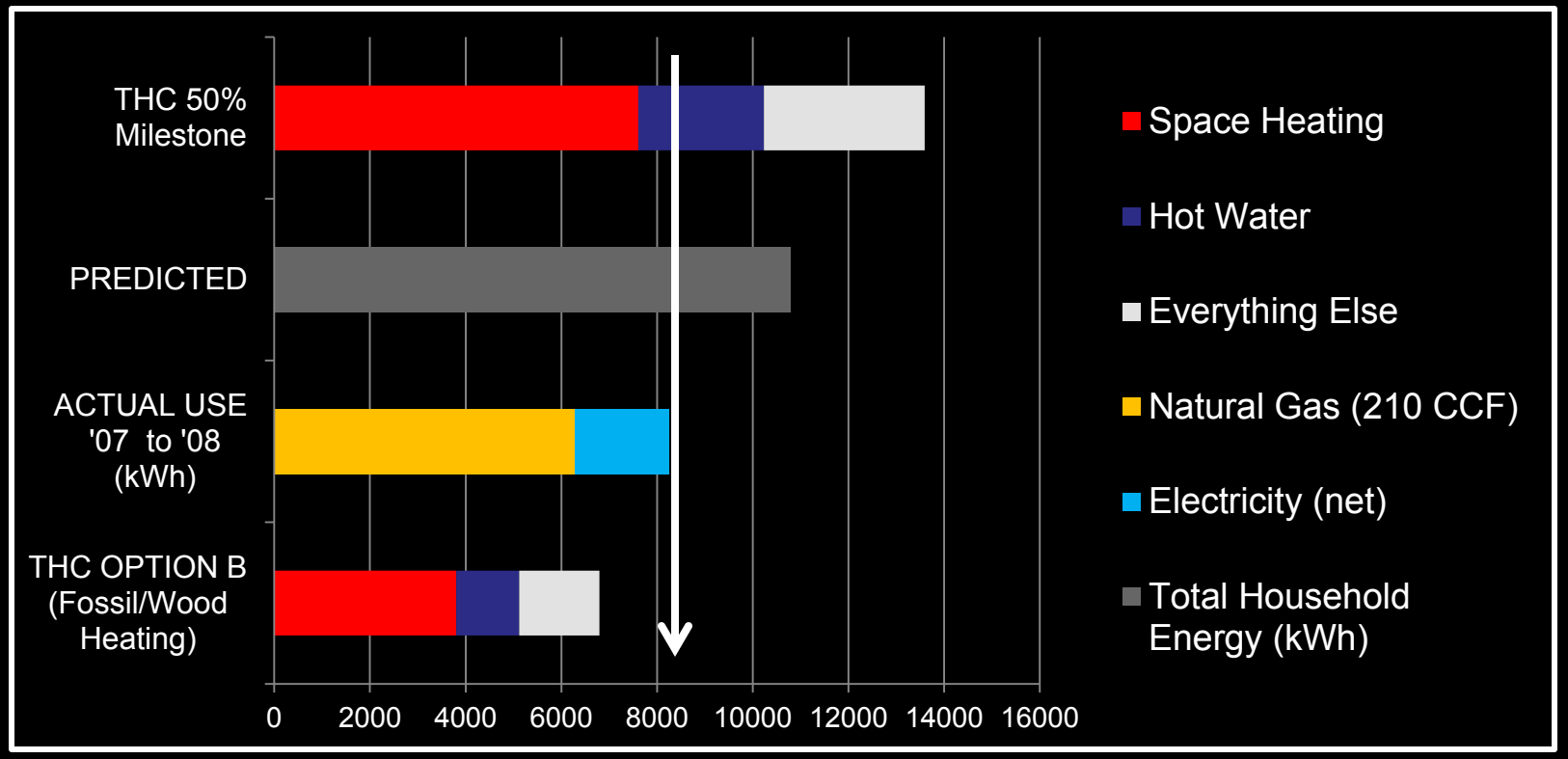
Option B: Calculated Performance Threshold (see Threshold Calculator worksheet)

	If electric heat	If gas/fossil/wood heat	
Gas/fossil/wood (MMBtu/year)	0	17.5	
Electric (kWh/year)	4,896	1,680	
Maximum total kWh/year (net)	**4,896**	**6,797**	Gas/fossil/wood MMBtu converted to kWh; Excludes solar
Approximate $/yr at $10/MMBtu and 10¢/kWh	$490	$343	

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

6 South Street Loft

Energy Use: 2007 to 2008
Richard RennerlArchitects
February 6, 2010

Source	Model Amount	Unit	Btu	2007-2008 Amount	Unit	Btu	Remarks
Electricity	4,565	KwH	15,662,515	2,484	KwH	8,475,408	
Natural Gas	309	Therm	30,900,000	210	Ccf	21,651,000	
Solar PV	(1,559)	KwH	(5,348,929)	(513)	KwH	(1,750,356)	
		TOTAL	41,213,586			28,376,052	
		MMBtu	41.21			28.38	
	2007-2008	Btu/SF	20,269	2.096	Btu/SF/HDD/Yr		

Summary of energy use during the first year of occupancy

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

Fine Homebuilding: “Brick Rehab Meets LEED’s Highest Standards” - www.warmboard.com/wp-content/uploads/2008/09/wb_fhb_10-1108_all.pdf

Fine Homebuilding: “This Roof Grows Greener” - www.finehomebuilding.com/how-to/video/green-roof-in-portland-maine.aspx

Residential Architect: “Town Architect: Richard Renner Circumscribes His Carbon Reach” - www.residentialarchitect.com/heat-recovery-systems/town-architect.aspx

Maine Home + Design: “Taking His Own Advice” - www.mainehomedesign.com/features/621-taking-his-own-advice.html

Down East: “Green by Design” - www.downeast.com/magazine/2009/march/green-design

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