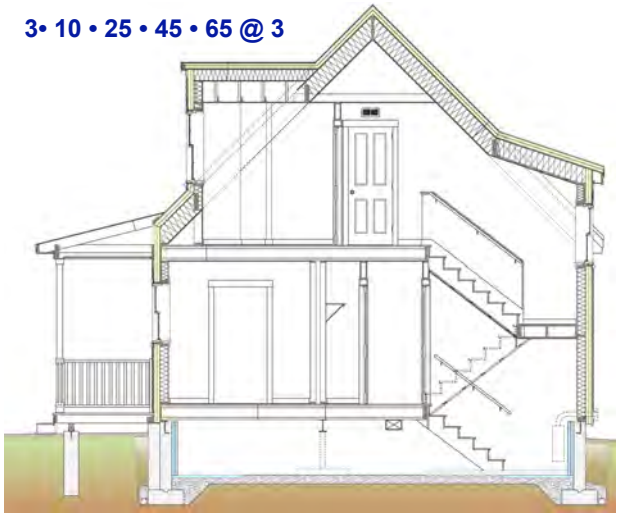
Building America for Cold Climates:

5 • 10 • 20 • 40 • 60 @ 2

Betsy Pettit, FAIA
Building Science Corporation
www.buildingscience.com

NESEA Building Energy Conference
Boston, MA March 12, 2009

3• 10 • 25 • 45 • 65 @ 3



Westford House — Westford, MA

Habitat for Humanity of Greater Lowell

Westford House

Westford House Dedication Ceremony October 5th, 2008

Westford House — Westford, MA

Habitat for Humanity of Greater Lowell

- Project Overview
  - Builder: Habitat for Humanity of Greater Lowell
  - Location: Westford, MA
  - Climate: Cold (5A)
  - Type: Single Family, Affordable
  - Stories: 1 ½
  - Bedrooms: 3
  - Baths: 2 Full
  - Floor Area: 1340 sq. ft.
  - Basement Area: 816 sq. ft.

Westford House — Westford, MA

Habitat for Humanity of Greater Lowell

- Project Overview
  - Estimated Energy Reduction: 50 %
  - Estimated Energy Savings: $1,259 / year
  - Cost: $200,000
  - Construction Start: March 2008
  - Construction Finish: October 2008
  - Construction Schedule: 8 Months

Westford House — Westford, MA

Habitat for Humanity of Greater Lowell

- Prescriptive-based Code Approval
  - Meets 7th Edition Massachusetts One-and Two-Family Dwelling Code (based on 2003 ICC International Residential Code)
    - Vapor Diffusion Retarders
    - Single Headers
  - Exceeds IECC Section 404 Compliance by over 50%

How the Costs Breakdown

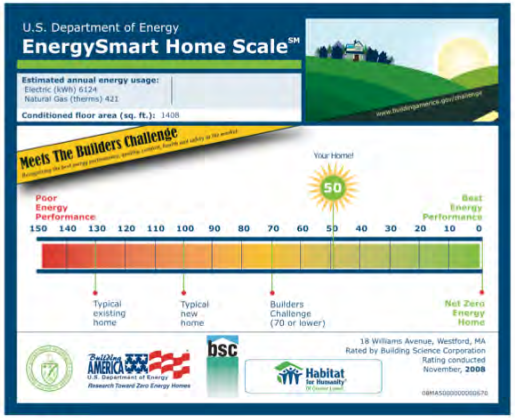
• Foundations installed including concrete	$ 3,500
• Slab installed including concrete	$ 1,000
• Lumberyard pricing of entire package including foam sheathing	$70,000
• Framer's cost to enclose building including windows and foam	$12,500
• Electrical, Plumbing, Mechanical equipment and installation	$30,000
• Interior finishes, cabinets, appliances, GWB and installation	$30,000
• Septic systems and site work	$13,000
• General labor and overhead	$40,000
TOTAL PRE SITE GENERATED ENERGY	$200,000
Lowell HFH donated labor	-$40,000
Lowell HFH donated materials	-$25,000
Total Cost to HFH	$125,000
•3.5 kW PV system after tax credits	$24,000
TOTAL WITH SITE GENERATE ENERGY	$224,000
Energy Balance left: +- 400 therms of gas at $1.50/therm	$600 per year

Lowell Habitat for Humanity Westford, MA
2,156 sq. ft. @ $92/sq. ft. HERS 49

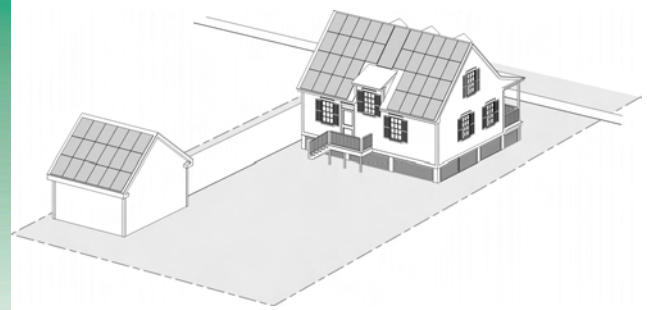
Gas (400 therms) = $50/month @ $1.50 /therm
Electric (4200 kWh) = $50/month @ $.15/kWh
= $3.30 per day

With 3.5 kWp PV (350+- kWh/month)
Electric = $0

Westford House — Westford, MA



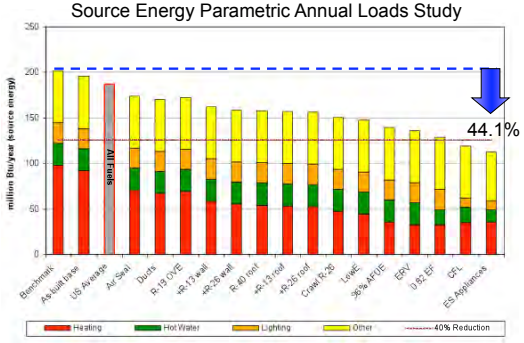
PV & SHW Installation



Westford House — Westford, MA

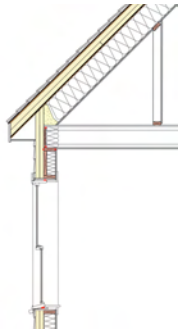
- Source Energy Savings

Source Energy Parametric Annual Loads Study



Westford House — Westford, MA

- Enclosure Design
  - R-66 Roof Insulation (unfaced fiberglass batt insulation with (2) 2" layers foil-faced polyisocyanurate insulating sheathing on roof sheathing)
  - R-45 Walls (2x6 framing at 24" o.c. with unfaced fiberglass batt insulation and (2) 2" layers foil-faced polyisocyanurate insulating sheathing)
  - Windows (Low-E double pane argon filled, U = 0.33 & SHGC = 0.28)



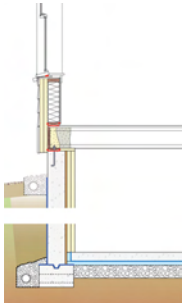
Wall Section

Westford House

Westford, MA

Habitat for Humanity of Greater Lowell

- Enclosure Design
  - R-26 Basement Walls
    (2) 2" layers foil-faced polyisocyanurate insulating sheathing)
  - R-13 Rim Joist Area
    (2" high density spray foam at first floor rim joist area)
  - R-10 Basement Slab
    (2" XPS below slab)



Wall Section

Westford House

Westford, MA

Habitat for Humanity of Greater Lowell

- Mechanical Design
  - 96% AFUE Gas Furnace
  - 0.82 EF Instantaneous Water Heater
  - Fantech Energy Recovery Ventilator (ERV)

Fantech ERV

Furnace and Return Ductwork

Westford House

Westford, MA

Habitat for Humanity of Greater Lowell

Installing Siding on Wall Mock-Up

Window Installation Demonstration

Window Flashing Demonstration

Westford House

Westford, MA

Habitat for Humanity of Greater Lowell

Westford House — Westford, MA

- Construction Support Photos

Foundation Wall Insulation

Habitat for Humanity of Greater Lowell

Westford House — Westford, MA

ERV Intake and Exhaust

Side Door

Habitat for Humanity of Greater Lowell

Westford House — Westford, MA

- Neutral Cost Analysis

Assumed Financing Rate:	7%
Assumed Financing Term (years):	30

Run ID	Parametric Run	Cumulative Cost	Savings	Annual Finance Cost	Simple cash flow
16	15 + ES Appliances	$9,825	$1,121	$792	$329
	Add third party inspections @ $700	$10,525	$1,121	$848	$273

Assumptions: 30 year mortgage, 7% interest rate, $1.40/therm, $0.18/kWh

- **$329 annual net positive cash flow ($1121 annual savings - $792 added mortgage cost)**
- **$273 annual net positive cash flow assuming testing/inspections ~$700 ($1121 annual savings - $848 added mortgage cost)**

Habitat for Humanity of Greater Lowell

Westford House — Westford, MA

Community Gathered before Westford House Dedication Ceremony

Habitat for Humanity of Greater Lowell