FORM FOLLOWS ENERGY

J.B. Clancy, AIA
CERTIFIED PASSIVE HOUSE CONSULTANT
ALBERT, RIGHTER & TITTMANN ARCHITECTS

2011 UMass Wood Structures Symposium
Amherst, Massachusetts
September 8-9, 2011

History of Energy Consumption by Source in USA 1630 to Present

House 1630

George Stiles House 1630, Plymouth, MA

House 1732

Hartwell Tavern, Concord, MA 1732

House 1880

Drew House 1882, Sandwich MA

House 1950

Farnsworth House, Mies van der Rohe 1951, Plano, IL
Passive House Energy Standard

A Green Building Standard built on an Energy Budget For the 21st Century Energy Context

Passive House Energy Standard

Heating Demand (Site): 4.75 kBTU/SF/YR
Cooling Demand (Site): 4.75 kBTU/SF/YR
Total Energy Demand (Source): 38 kBTU/SF/YR
Air Tightness: .6 ACH @ 50pa

As modeled in the PHPP (Passive House Planning Package)

Standards Comparison

U.S. Energy Consumption by Sector

Source: ©2010 2010 inc. / Architecture 2030. All Rights Reserved.
Data Source: EIA Energy Information Administration (2009)
THE PASSIVE HOUSE STRATEGY

Passive House Concept
Controlling Heat Loss… INSULATION

R58 WALLS: R90 CEILING: R60 SLAB
High Performance WINDOWS U value 0.16

Passive House Concept
Controlling Heat Loss… ELIMINATE THERMAL BRIDGES

Passive House Concept
Controlling Heat Loss… REDUCE AIR INFILTRATION

.6 ACH @ 50 PA

Passive House Concept
Capturing Heat Gains… SOLAR ENERGY
Passive House Concept
Controlling Gains Seasonally… WINDOWS & ORIENTATION

U VALUE .10: TRIPLE GLAZED: > .5 SHGC ON SOUTH WINDOWS

Passive House Concept
Controlling Gains Seasonally… SOLAR THERMAL

Passive House Concept
Providing Fresh Air… HEAT RECOVERY VENTILATION

MINIMUM .35 ACH

Passive House Concept
INTEGRATED
“Let the architecture do the work”

Passive House Strategies
TO GET FROM CODE TO PASSIVE HOUSE

THE FIRST CERTIFIED PASSIVE HOUSE IN VERMONT
CONSTRUCTED 2010
Habitat for Humanity Passive House

Code vs. Passive House
THERM MODELS OF FOUNDATION DETAILS

CODE INSULATION—2” XPS Under Slab & on Wall

PASSIVE HOUSE INSULATION—12” XPS Under Slab & 10” on Wall
### Global Warming Potential of Insulation Materials

<table>
<thead>
<tr>
<th>Insulation Material</th>
<th>Emission Rate</th>
<th>Global Warming Potential</th>
<th>Payback of XPS Insulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cellulose (batts)</td>
<td>0.7</td>
<td>0.34</td>
<td>Payback of XPS Insulation</td>
</tr>
<tr>
<td>Rock wool</td>
<td>1.0</td>
<td>0.14</td>
<td>Payback of XPS Insulation</td>
</tr>
<tr>
<td>Foamed polyurethane</td>
<td>2.0</td>
<td>0.26</td>
<td>Payback of XPS Insulation</td>
</tr>
<tr>
<td>Spray foam</td>
<td>0.0</td>
<td>0.0</td>
<td>Payback of XPS Insulation</td>
</tr>
</tbody>
</table>

1. XPS payback curve has not updated prior to project; payback agent: cSPF 50%.
2. Other insulation types include fiberglass, cellulose, and urethane foam.

---

### Payback of XPS Insulation

![Payback Graph](image)

---

### Habitat for Humanity Passive House

1. **SILL DETAIL**
2. **WALL SECTION**
3. **SECOND FLOOR PLATFORM DETAIL**
4. **EAVE DETAIL**
Habitat for Humanity Passive House

SILL DETAIL - ALTERNATE

SECOND FLOOR PLATFORM DETAIL

ALTERNATE

EAVE DETAIL - ALTERNATE

WINDOWS

Thermotech

322 Gain+

.64 SHGC (solar heat gain coefficient)

Glazing U-value .16

Frame U-value .16

THERMOTECT WINDOWS
Habitat for Humanity Passive House

WINDOWS – NORTH AMERICAN CASEMENT

Habitat for Humanity Passive House

WINDOWS – EUROPEAN TILT-TURN

Habitat for Humanity Passive House

HVAC SYSTEM

Air Source Heat Pump
Mitsubishi Hyper-heat MSZ-MUZ FE 12

HRV
Zender ComfoAir 350 HRV

Soil heat exchange system
Two 125' loops of 1" pex around the base of the footings filled with water/glycol mix & tied to Laing 30W AC Pump & water-to-air coil (~40F Temp Rise)

Solar Hot Water
Sunward Solar water heating system mounted on roof with 40g electric hot water heater as back-up

Habitat for Humanity Passive House

HEAT RECOVERY VENTILATION

Habitat for Humanity Passive House

HVAC SYSTEM

Air Source Heat Pump
Mitsubishi Hyper-heat MSZ-MUZ FE 12

HRV
Zender ComfoAir 350 HRV

Soil heat exchange system
Two 125' loops of 1" pex around the base of the footings filled with water/glycol mix & tied to Laing 30W AC Pump & water-to-air coil (~40F Temp Rise)

Solar Hot Water
Sunward Solar water heating system mounted on roof with 40g electric hot water heater as back-up
The levels of CO2 in the air and potential health problems are:

- 250 - 350 ppm – background (normal) outdoor air level
- 350 - 1,000 ppm - typical level found in occupied spaces with good air exchange.
- 1,000 – 2,000 ppm - level associated with complaints of drowsiness and poor air.
- 2,000 – 5,000 ppm – level associated with headaches, sleepiness, and stagnant, stale, stuffy air. Poor concentration, loss of attention, increased heart rate and slight nausea may also be present.
- >5,000 ppm – Exposure may lead to serious oxygen deprivation resulting in permanent brain damage, coma and even death.

Wisconsin’s Department of Health
MODULAR CONSTRUCTION
Beginning of floor system-open web joists, LVL to reduce columns in basement

4" Foam blocking on outside perimeter of floors – open web joists – urethane adhesive on floors

EPDM gasket on floors.
EPDM gasket at floor and wall intersections

Spraying the foam seal - attaches the sheetrock to framing and makes air-tight assembly

Sheetrock air-sealed to framing

Lifting wall section off framing table

Assembled walls on floor for ½ of 1st floor

Insulated headers – built load specific
Full sheetrock air-seal behind tub

Foam sprayed on sheetrock joints at tub to complete air-seal

OVE framing
(partial double plate is temporary for lifting)

20” raised Heel folding truss w/ EPDM gasket between walls and ceiling

13 3/8” window buck
clapboard drainage under window

Installed dense pack cellulose
Air seal around plumbing vents

Radon vent and ERV ducts

Silicone sealing of wires penetrating exterior insulation

Exterior insulation details

Air sealing of wall sheathing

Wide strapping on corners
Folded shed roof

Eave framing on shed roof

Front door area
8.17.2010
10 working days

On the launch pad Claremont, NH
6:30 AM 9.10.2010

Section

Foundation and wall insulation detail
Coming in for landing

Charlotte, VT
1:30 PM 9.10.2010

First Modular Passive House in USA
Habitat for Humanity Passive House

“Heating System”
$30 for January, average temp 72
Habitat for Humanity Passive House

http://passipedia.passiv.de