NewenHouse, Viroqua, Wisconsin, USA

Designer in charge: Carly Coulson, AIA, LEED AP
Duluth, Minnesota, USA

NewenHouse is a detached, single-family, 3 bedroom, 2 bath, new-build home with 2 floor levels and no basement in Viroqua, Wisconsin, USA.

See also www.passivehouse-database.org: Project ID# 2173

Special features: Solar hot water system, photovoltaic system, rainwater harvesting, a green roof, salvaged and local materials, Energy Star certified and LEED for Homes.

U-value of exterior wall 0.094 W/(m²K)
U-value of slab floor 0.100 W/(m²K)
U-value of roof 0.060 W/(m²K)
U-value of windows 1.080 W/(m²K)
Heat recovery efficiency 92%

PHPP Space Heating Demand 12 kWh/(m²a)
PHPP Primary Energy 10.4 kWh/(m²a)
Pressurization Test n₅₀ 0.51 h⁻¹
2.0 Description of Construction

NewenHouse in Viroqua is the first prototype constructed by Sonya Newenhouse PhD, the developer of a series of kit homes that bring together three building movements: the green building, the small house, and sustainable-simple living. The kit focuses on a financially “attainable” home cost, living smaller and lighter on the Earth for those who want a net-zero lifestyle, and a healthy interior environment.

The site is a flat, vacant lot in an old residential neighborhood near downtown with a large deciduous tree in the front yard. The 83 m² net-treated-floor-area home is positioned facing directly south towards the street and far enough back so the pv and solar panels on the roof are not shaded by the front yard tree. The design is a highly-compact cube with a 7.5m by 7.5m thermal envelope footprint, two floor levels, no basement, and an unheated attic accessible only from the outside. The pitched roof provides a sloped surface for the pv and solar hot water systems and adds a traditional style to the home. Porches and sunshade structures which are thermally-broken from the main house also enhance the cube shape. To the north of the home is a “stuga”, an accessory structure not part of the thermal envelope or certified passive house structure, which is an un-insulated three-season space with screen porch and root cellar used for storage, guest sleeping, and an extra gathering space when entertaining. The “stuga” has its own foundation and is thermally-broken from the main home.

The construction systems of the passive house envelope were developed to reduce material and labor cost, minimize the need for specialized training, and use of local, healthy, recycled-content and low-embedded energy materials. The structural cast-in-place concrete slab-on-grade rests in an insulation raft of EPS insulation and an EPS horizontal frost skirt surrounds the building. A standard 2x4 wood stud exterior wall was constructed on the edge of the concrete slab following typical platform frame construction that was normal and easy for the local carpenters. The roof was first framed flat. These cavities were used for MEP (mechanical, electrical, and plumbing) installation. OSB sheathing was added to the walls and plywood sheathing on the flat roof and all seams were taped on the exterior face so this sheathing layer acts as the continuous air-tight assembly. After this enclosed cube was constructed the carpenters installed the wood roof trusses and added the remote-wall wood trusses to the exterior walls. These wall trusses are a modified larson-truss with the continuous vertical chord along the sheathing eliminated and the number of plywood gusset plates reduced to increase the overall insulation value and reduce thermal-bridging. Dense-packed cellulose was added to the attic, the remote-wall truss cavities, and the 2x4 stud wall cavities. Fiberboard sheathing, a vapor-open weather resistant barrier, vertical wood battens, and cedar rainscreen siding were added to the exterior walls to create a diffuse-open wall assembly. This assembly was modeled in WUFI Pro to verify hygrothermal performance.
3.0 Exterior Elevation Photos

The south exterior elevation features large windows for winter passive solar heat gain, which are shaded in the summer by roof overhangs, sunshade structure, and vertical edible vines. The roof has pv and solar hot water panels.

The east exterior elevation shows smaller windows, a roof attic vent/access panel, a porch over the main entrance door, and the “stuga” accessory structure to the rear of the building.
The north exterior elevation of the main home has just one window at the kitchen and one exterior door at the breezeway between the home and the “stuga”.

The west exterior elevation shows smaller windows, a roof attic vent/access panel, and the ventilation system outside air intake and exhaust vents in the wall.
Interior photo looking north at the lower floor kitchen with exterior door to breezeway, door into bathroom, and stair to upper floor.

## 5.0 PHPP Verification Results

### Building:
- **Location and Climate:** Viroqua, Wisconsin, USA; Viroqua
- **Street:** 422 East Hickory Street
- **Country:** USA

### Home Owner(s)/Client(s):
- **Name:** Sonya Newenhouse
- **Street:** 422 East Hickory Street
- **Postcode/City:** 54665 / Viroqua

### Architect:
- **Name:** Carly Coulson, AIA, LEED AP, Certified Passive House Designer
- **Street:** 10 West First Street, Suite 105
- **Postcode/City:** 55802 / Duluth

### Mechanical System:
- **Name:** Carly Coulson, AIA, LEED AP, Certified Passive House Designer
- **Street:** 10 West First Street, Suite 105
- **Postcode/City:** 55802 / Duluth

### Year of Construction:
- **2011**

### Number of Dwelling Units:
- **1**

### Enclosed Volume V:
- **349.6 m³**

### Interior Temperature:
- **20.0 °C**

### Interior Heat Gain:
- **2.1 W/m²**

### Specific Demands with Reference to the Treated Floor Area:

<table>
<thead>
<tr>
<th>Specific Space Heating Demand</th>
<th>Applied Method</th>
<th>Annual Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Space Heating Demand</td>
<td>11 kWh/(m²a)</td>
<td>15 kWh/(m²a)</td>
</tr>
<tr>
<td>Heating Load</td>
<td>16 W/m²</td>
<td>10 W/m²</td>
</tr>
<tr>
<td>Pressurization Test Result</td>
<td>0.5 h⁻¹</td>
<td>0.6 h⁻¹</td>
</tr>
</tbody>
</table>

### Specific Primary Energy Demand (DHW, Heating and Auxiliary Electricity):

<table>
<thead>
<tr>
<th>Specific Primary Energy Demand</th>
<th>104 kWh/(m²a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Primary Energy Demand</td>
<td>69 kWh/(m²a)</td>
</tr>
<tr>
<td>Specific Primary Energy Demand</td>
<td>67 kWh/(m²a)</td>
</tr>
<tr>
<td>Specific Primary Energy Reduction through Solar Electricity</td>
<td>6 %</td>
</tr>
<tr>
<td>Frequency of overheating:</td>
<td>over 25°C</td>
</tr>
</tbody>
</table>

### Specific Useful Cooling Energy Demand:
- **15 kWh/(m²a)**

### PH Certificate:
- **Fulfilled?**
  - **Yes**

### Frequency of Overheating:
- **1 %**

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We confirm that the values given herein have been determined following the PHPP methodology and based on the characteristic values of the building. The calculations with PHPP are attached to this application.

Signed: Carly Coulson

Issued on: 1-Oct-11
6.0  Floor Plan & Cross Section Drawings

1. dining room
2. kitchen
3. living room
4. study
5. bathroom
6. laundry
7. detached entry deck
8. screen porch
9. storage room
10. bedroom
11. sleeping loft
12. HRV
13. vegetative roof
14. stair
15. root cellar
16. attic (unconditioned)
17. photovoltaic panels
18. solar hot water panels

N
1. continuous air tight layer
2. rainscreen cedar siding
3. fiberboard sheathing 13mm 0.051 W/mK
4. dense packed cellulose in remote wall truss 305mm 0.038 W/mK
5. osb air tight layer 13mm 0.130 W/mK
6. dense packed cellulose in 2x4 structural wall 89mm 0.038 W/mK
7. gypsum board 13mm 0.210 W/mK
8. eps insulation 305mm 0.030 W/mK
9. concrete slab 178mm 2.30 W/mK
10. plywood air tight layer 13mm 0.116 W/mK
11. dense packed cellulose in dropped ceiling 324mm 0.038 W/mK
12. eps frost skirt 0.030 W/mK
13. xps insulation 0.028 W/mK
14. poly film air tight layer
15. structural gasket air tight layer
7.1 Construction Description – Slab, Wall, Roof, Airtight Layer

The structural cast-in-place concrete slab-on-grade rests in an insulation raft of EPS insulation with the poly film air tight layer between the foam and lapped up the wall. A standard 2x4 wood stud exterior wall was constructed on edge of the concrete slab with a structural gasket under the bottom wall plates. The roof was first framed flat. These cavities were used for MEP (mechanical, electrical, and plumbing) installation. OSB sheathing was added to the walls and plywood sheathing on the flat roof and all seams were taped on the exterior face. Wood trusses with energy-heel were added to the roof and remote-wall wood trusses to the exterior walls. Dense-packed cellulose was installed in the attic, the remote-wall truss cavities, and the 2x4 stud wall cavities. Fiberboard sheathing, a vapor-open weather resistant barrier, vertical wood battens, and cedar rainscreen siding were added to the exterior walls to create a diffuse-open wall assembly.

7.2 Construction Detail Photos – Slab, Wall, Roof, Airtight Layer

Photo of remote wall wood truss installed on east wall with poly film air tight layer lapped up wall OSB sheathing.

Photo of weather barrier on east wall with rainscreen battens, fiberboard sheathing on south wall.

Photo of EPS foam around concrete slab-on-grade, EPS frost skirt, and poly film air tight layer.

Photo of dense packed cellulose installed in 2x4 stud wall and insulation between floor joists.

Photo of roof plywood air tight layer seams taped, roof trusses before insulation install.

Photo of OSB air tight layer seams taped, plywood window box, and remote wall truss.
drawing scale 1:10
1  energeate wood door
2  inline insulated fiberglass window
3  polyiso insulation board 13mm
4  plywood box, airtight layer 13mm
5  spray foam and fiberglass shim
6  rod & caulk between frame & plywood
7  vapor-open weather resistant barrier
8  rainscreen cedar siding & trim
9  fiberboard sheathing 13mm
10  eps insulation 305mm
11  xps insulation
12  stainless steel angle 152mm length
8.1 Window, Door Frame & Glazing Description

All exterior door openings in the thermal envelope are Energate wood frame models #1042.1.101 and #3.001.1 with a $U_i = 0.90\text{ W/(m}^2\text{K)}$ and Haubler glazing ($4/18/4/18/4\text{ argon}$) $U_g = 0.50\text{ W/(m}^2\text{K)}$ and $g$-value = 0.50. These are defined as windows in PHPP because of the glazing.

All other window openings in the thermal envelope are Inline insulated fiberglass frames model #325 with a $U_i = 1.48\text{ W/(m}^2\text{K)}$ and Cardinal 180 glazing ($3/13/3/13/3\text{ argon}$) $U_g = 0.75\text{ W/(m}^2\text{K)}$ and $g$-value = 0.56. Please note that the window frames were selected for their balance between affordability and performance and the $U_i$-value used above and in PHPP modeling for certification was determined by CSA 440.2 and NFRC testing data, the only testing data Inline had available at that time in 2011. Since then Inline tested these frames according to EN 673 and EN ISO 10077-2 with a $U_i = 1.31\text{ W/(m}^2\text{K)}$ in Aug. 2012.

8.2 Window & Door Photos

Interior photo of installed window with insulation board installed at jambs, head, and sill. Exterior photo of installed window with wood window trim and rainscreen battens over weather barrier.

Interior photo of installed window with air sealing tape over plywood seams and spray foam insulation between window and plywood. Interior photo of installed exterior door.
9.0 Ventilation System – Description

The ventilation system consists of a central HRV unit, the Zehnder ComfoSystems ComfoAir 200, a certified passive house component with a 92% heat recovery efficiency and a 0.42 Wh/m$^3$ electrical efficiency, located in an upper floor closet. It is connected to a whole-house, balanced ventilation system with extract-air diffusers in the kitchen and every bathroom and supply-air diffusers in every bedroom and the living room. All interior doors are undercut to allow for flow-thru between rooms. After construction the system was balanced and commissioned following Passive House Institute Final Protocols.

9.1 Ventilation System – Drawings

[Diagram showing ventilation system layout with labels and flow rates]

**whole house air flow total:**

- 3 peak = 140 m$^3$/h or 82 cfm to run with kitchen and bathroom controls on timer for 10 min
- 2 nominal = 101 m$^3$/h or 59 cfm programmed to run sat & sun 24 hours and mon - fri 5pm - 8 am
- 1 base = 71 m$^3$/h or 42 cfm programmed to run mon-fri 9am - 5pm
9.2 Ventilation System - Photos

Photo of central HRV unit in upper floor closet with insulated ducts to the exterior, and interior extract air and supply air ducts coming from the top of the unit.

Photo of insulated exhaust air duct from HRV to the exterior wall.
10.0 Heating Systems – Description

Space heating is supplied by inexpensive, direct electric radiant panels, one in each bathroom and one in the upper floor hallway. Domestic hot water is supplied by Velux CLI 4000 solar collectors on the roof connected to a 284 liter Velux storage tank with electric back-up in the lower floor bathroom.

10.1 Heating Systems – Photos

Photo of solar hot water tank in lower floor bath.  
Photo of radiant electric space heating panel on bathroom ceiling.

11.0 Construction Costs & Year of Construction

Construction started October 2010 and was completed September 2011. Building Construction Costs were approximately 1815 €/m² net treated floor area according to PHPP (costs include site work, construction, building systems and services, accessory structures, pv and solar hot water systems.)

12.0 Project Team

Sonya Newenhouse, PhD: Owner, Developer, Construction and Project Manager, Designer.  
Kurt Frey, PE: Structural Engineering.  

13.0 Experiences & References

See experiences documented in Owner’s online blog. Links below at Mother Earth Living:  

Project was presented at the 16th International Passive House Conference in Hannover 2012.