Project Data and Specifications of the Waldsee BioHaus

Location	Bemidji, Minnesota
Region and climate	*Latitude:* 47°28'14" N *Longitude:* 94°52'39" W *Elevation:* 1,350 ft Very cold climate
Heating degree-days/ cooling degree-days	9,869/296
Year of construction	2006
Typology	School building
Finished floor area	401.3 m^2 (4,320 ft^2)
Owner	Concordia Language Village
Architect	Stephan Tanner, AIA
Foundation	330 mm (13 in) ICFs; 203 mm (8 in) EIFS
Foundation perimeter insulation	N/A
Under-slab insulation	406 mm (16 in) rigid insulation
Wall framing	*Wall type 1:* 2 x 12 stud wall 24 in OC *Wall type 2:* 2 x 6 stud wall 24 in OC
Wall insulation	*Wall type 1:* 286 mm (11.25 in) water-based spray foam insulation; 203-mm (8 in) EIFS *Wall type 2:* 140 mm (5.25 in) water-based spray foam insulation; 51-mm (2-in) VIPs
Roof framing	*Lower roof:* 305 mm (11 7/8 in) TJIs *Upper roof:* 305 mm (11 7/8 in) TJIs with 203 mm (8 in) perpendicular sleeper trusses
Roof insulation	*Lower roof:* 305 mm (11 7/8 in) water-based spray foam insulation, 51 mm (2 in) VIPs *Upper roof:* 711 mm (28 in) water-based spray foam insulation
Windows	Optiwin Passivhaus-certified, 3Wood windows; pine structural frame, cork insulation, larch outer layer; low-e, argon-filled, triple-pane glazing; average overall U-value of frame and glazing: 0.79 W/(m^2K) (0.14 Btu/[h ft^2 F])
Ventilation system	85% efficient HRV
Heating system	19,400 Btu/h ground source heat pump
DHW system	19.8 m^2 (213 ft^2) solar flat-plate collectors for DHW and hydronic in-floor heat

Active System requirement to become *net zero site energy*
3.5 kW PV system (not installed but wired in)

Active System requirement to become *net zero source energy* 9.2 kW PV system (not installed but wired in)

Active System requirement to become *plus energy/carbon neutral* 10.8 kW PV system (not installed but wired in)

Active System desired, which will produce more than enough energy to make BioHaus *plus energy/ carbon neutral* 25 kW PV system (not installed but wired in)

fresh air is warmed to 58°F by these passive means. The residual energy needed to meet the building's annual heating requirement of 4,350 Btu/ft^2 is supplied by a ground source heat pump and passive-solar gain. During the spring and fall seasons, when the temperatures are milder, the windows can be flung open and the ventilation system can be shut off.

Although all residents are asked to conserve hot water, shower times are not limited. The sometimes high demand for hot water is met with a solar-powered water heating system, with the ground source heat pump as a backup.

The only energy source for the BioHaus is electricity. At present, this electricity comes from the grid. A PV system will be installed when financing becomes available. This system will generate more electricity than the BioHaus uses, making the house plus energy and carbon neutral.

The BioHaus by the Numbers

Here are the final results of the PHPP 2004 calculations for the Waldsee BioHaus:

- *specific heating energy requirement:* 13.7 kWh/m^{2}a (4.35 kBtu/ft^2/yr);
  specific primary energy requirement: 83 kWh/m^{2}a (26.3 kBtu/ft^2/yr);
  Peak heating load: 16.9 W/m^2 (5.4 Btu/h/ft^2)
  airtightness: 0.18 ACH_{50}; and
  surface area-to-volume ratio (A/V): 0.68.

The sometimes high demand for hot water is met with a solar-powered water heating system, which juts up from the flat roof. A ground source heat pump acts as a backup.

Guaranteeing IAQ

An efficient ventilation system does not in itself guarantee good IAQ, since the house and its furnishings may generate more pollutants than the system can filter out. To achieve the best possible IAQ, Tanner specified low-emitting building products and materials. This strategy—which also serves to meet regulatory requirements—is especially important when designing spaces to be used by children, who are sensitive to environmental contaminants, and who are developing allergies and other chronic illnesses at increasing rates, partly in response to exposure to these contaminants.