Solar Harvest:
Boulder's First Net-Zero Energy Home

No wood burning appliances or fossil fuel-powered boiler, furnace or hot water heater
Highest Energy Star rating of any Colorado home to date: 97.7 out of 100 points
Possibly first U.S. home approved under code in a cold climate to have no "backup" heating system

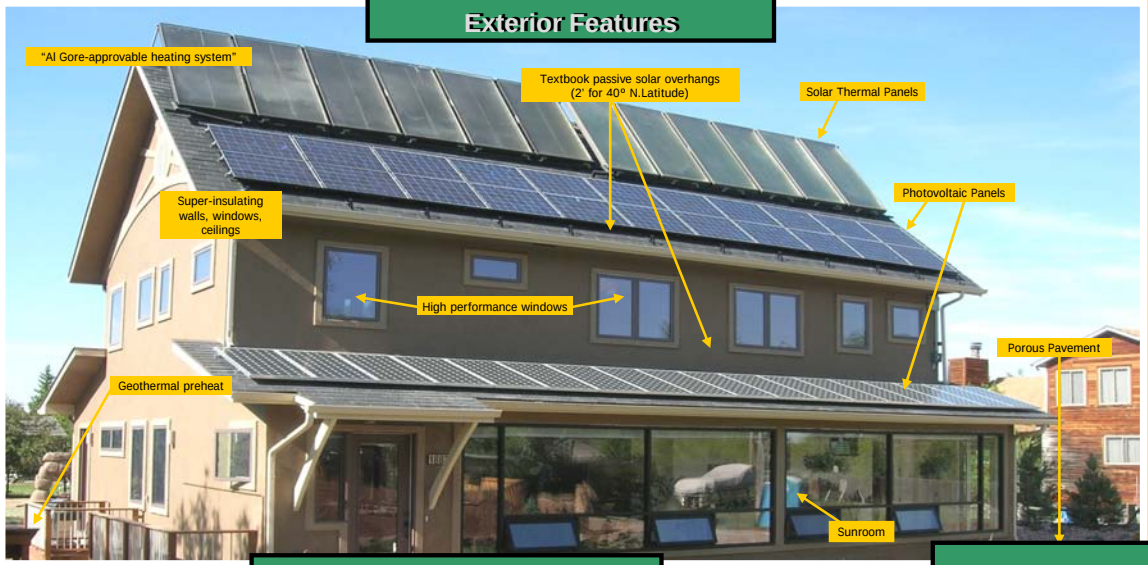
Major Specifications

- **Approved** under modern code in a cold climate based on engineer's calculations that 68° F could be maintained indoors for 8 consecutive 2° F, sunless days
- **Floorplan:** 4585 ft² heated, detached single-family dwelling with 5 bedrooms; 3 full baths; 2 half baths; living room; kitchen; & basement play and meeting space
- **Solar Electric:** 6.84 kW Sharp Photovoltaic array, grid-tied, with half the panels on 20-degree roof and half on 40-degree roof; 1.9 kW PVs to be installed August, 2007
- **Natural gas** clothes dryer & range to replaced with electric models in August, 2007
- **12 reclaimed Novan** 4'x8' flat-plate collectors, at 55 degrees, in a drainback system to 6,000 gal solar storage room
- **Passive gain:** 275 ft² of sunspace vertical glazing with distribution ducts and electro-commutated motor fans
- **Wall assembly:** super-insulated 2x6 walls with added indirect thermal mass
- **Design heat load:** 29,000 BTUs/hr., for 4,700 square feet of conditioned space
- **Indoor air quality:** Extensive, engineered ERV (energy recovery ventilation) system with geothermal pre-heat/pre-cool fresh air intake. Direct exhaust to exterior only from kitchen, bathrooms exhaust through ERV. Natural ACH 0.1 or lower.
- **Health & safety:** Formaldehyde-free cabinets and carpet, AFM Safecoat paints and stains, low-odor floor finishes
- **Salvaged materials:** hardwood flooring, interior doors, 3 exterior swinging full-lite doors, cabinets, bathtubs, sinks, and windows in garage
- **FSC-Certified** wall framing lumber, cabinet veneers, and casework wood; Roseburg I-joists for floors, engineered trusses for roofs; Pau Lope railing material, ACQ treated lumber for sill plates and landscaping ties
- **Windows:** Fibertec fiberglass frames with Alpen HeatMirror glazing. Overall unit NFRC U-values of 0.18 on the west and east, 0.12 on the north and extremely low air leakage ratings. (With outside temp of zero F and 15 mph wind, and indoor 70 deg F, the interior surface of double HeatMirror is 64 deg F.)
- **Summer cooling:** Tamarack attic fans and natural "chimney effect" of nighttime airflow from windows through operable skylight; Coolerado 220V high-efficiency cooler for when nighttime temperatures too high for passive cooling installed 7/25/07
- **Electrical efficiency:** pin-type CFLs with occupancy sensors, Energy-Star major appliances and electronics "kill switches" where possible
- **Occupied since:** November, 2005
- **COST:** same as a typical custom home in Colorado + 8%

Solar Thermal

- **12 reclaimed Novan** Roof-mounted **flat plate collectors** feed **6,000 gallon super-insulated tank** located in the basement in a drainback system
- **Large tank** provides 100% of domestic hot water and the ability to heat 4700 square feet of living space to code, as well as 103° F water 24 hours a day, 7 days a week in the 360 gallon outdoor spa
- When "fully charged" at 190° F, the tank's potential energy is about 4 million BTUs. "Depleted" is considered 100° F.
- **Cost:** $6,000-$7,000 for tank and heat exchangers, additional $6,000-$8,000 for pumps, controls, labor and installation.

Exterior Features



Rolls of 3/4 " x 60' flex copper serve as heat exchangers

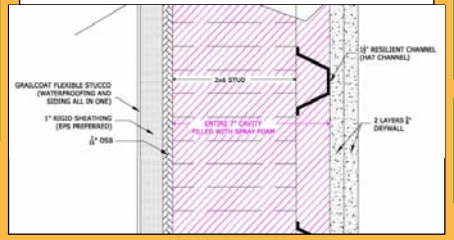
Since Solar Harvest, new big tank installations use reconditioned stainless steel tanks from the dairy industry. Installed underground, in basements, & in accessory structures, the tanks are superinsulated with InsulSoy 1.7 lb low-permeance foam to about R-90. The stainless steel tank offers a more durable & dependable system.

Wall Assembly

- **2x6 FSC-certified stud walls** with 1½" resilient channels at 24" O.C.
- **Icynene** spray-foam insulation 7" in walls and 12" thick in ceilings
- **Double** 5/8" sheetrock for distributed indirect thermal mass
- **Exterior profile:** 1" rigid foam encased with 1/8" GrailCoat Stucco waterproofing membrane
- Wall assembly creates **R-34** above-ground walls and **R-45** ceilings; Basement walls rate **R-30** with GreenBlock Insulated Concrete Forms

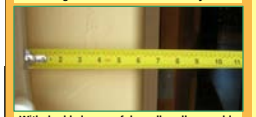
"Build tight, ventilate right"

"If you want to fill a bathtub with hot water, first put in the drain plug." (Amory Lovins)



Wall profile at framing

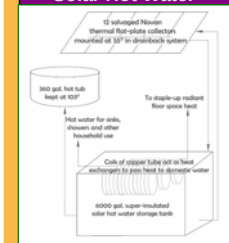
Framing and channels filled with Icynene



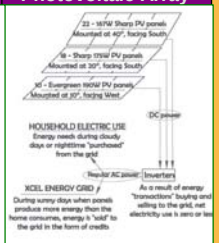
With double layers of drywall, wall assembly is a little thicker than a standard 2x6 wall

Energy Schematics

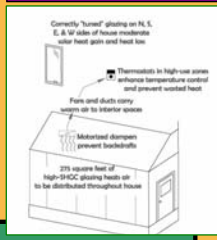
Solar Hot Water



Photovoltaic Array



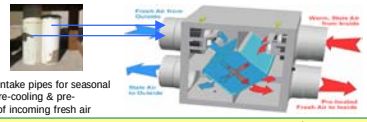
Passive Heat



Summer Cooling

Geothermal Exchange

- **Geothermal pre-heat and pre-cooling** system: 260 feet of 6" PVC pipe buried 6 to 8 feet below ground
- With this system, the ERV can achieve **95% heat recovery**, proven in Solar Harvest this winter: when exterior temperatures were 4° F, incoming air to ERV was measured at 38° F
- This system ensures that the ERV will continue running even with exterior temperatures below 28° F



2 6" PVC intake pipes for seasonal thermal pre-cooling & pre-warming of incoming fresh air

Project Team

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