

SOLAR OREGON

2010 Goal Net Zero HOME TOUR



Morning Sun

Net Zero Home in the 'Burbs'

When Doug and Emily Boleyn built their first home in the early 1970's, they expected that would be their 'forever' home. They picked the lot for its eastern mountain views and sunny southern slope – perfect for solar. They designed the house to be super energy efficient (for its time) and to provide passive solar heating. PGE even helped install a large active solar thermal system to their roof, and studied the data for years to assess solar performance in our area. As time went on and technology improved, the Boleyn's added a sunroom and eventually replaced the thermal system with PV panels plus an active hot water system. But, even though they achieved a net



energy use (EUI= 10) only 25% of a typical home, Doug and Emily were intrigued by the challenge to get to 'net zero.'

Fast forward to 2007. While driving around Happy Valley, the Boleyn's noticed a particular new development going in that allowed custom designs. With generous lot sizes, neighborhood walking trails and an upscale commercial center just blocks away, they were hooked. They settled on a lot with eastern mountain views and a sunny southern slope – perfect for solar. Sound familiar?

In 2008, Doug and Emily worked with Matt Daby, then with Mascord Designs, to put together their plan. Every aspect was carefully considered for maximum efficiency. Emily studied the book, 'Efficient Design,' co-authored by Matt, as they

worked out the details. Doug was excited to be starting from scratch and taking advantage of all the advances in solar technology.

As they worked on the plan, they started looking for a builder, experienced in efficient building techniques, who would be interested in the challenge of doing a LEED Platinum custom home. Doug met John Mead, of Cellar Ridge Custom Homes, at a solar presentation at a church in McMinnville. Both being OSU engineering grads, they hit it off right from the start. John was brought in on several of the final design meetings with Matt. They were off and running.

The new house, named 'Morning Sun' by the owners, was built in 2009. The extremely tight shell features double staggered 2 x 4 framing in the walls (R-32), a slab concrete floor on the lower level, insulated by 4" of foam board (R-15+), and 14" Trus-Joists in the ceiling filled with sprayed on foam plus fiberglass batting (R-49). Compare that to their original home with R-11 walls and R-19 ceilings!

The windows provided characteristics especially valued by Doug. To capture passive solar gains, he wanted a high solar heat gain factor, coupled with low U values. John Mead did his research and discovered Serious Materials windows, now distributed by Viking Windows in our area. Morning Sun is the first known residence in Oregon to use this product, which allowed them to tune the windows based on their orientation. Eastern and southern facing windows allow heat gain with very low losses; north and west facing windows block the excess gain. Emily especially likes their handsome dark gray fiberglass frames, and



casement styling.

The mechanical systems, provided by Perfect Temp out of McMinnville, meet the strict design specifications perfectly. The Boleyn's wanted to be able to zone the house, to allow them to close off the guest suite separately from the main living areas. With such a tight shell, they also required fresh air with minimal heat loss. Morning Sun features two ductless mini-split heat pump units, which feed four individual zones: lower level guest suite, master suite, office, and main living area (entry, kitchen, living room, dining room and loft). A heat recovery ventilator supplies the fresh air through a heat exchanger.

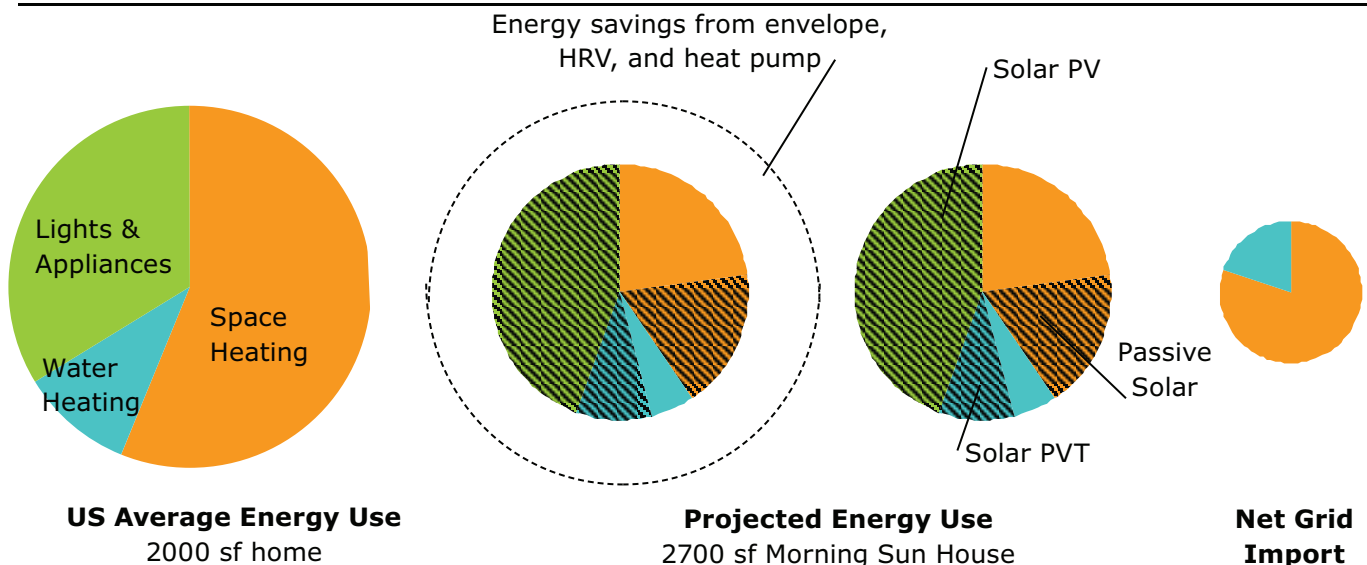
Doug and Emily wanted to be sensitive to the neighborhood HOA by installing a solar system that appeared fully integrated to the roof, yet would supply both electricity and hot water. The solar design solution provided by Sunlight Solar of Bend, using PVT Solar's Echo Solar system, more than met their needs. With 21 Sunpower PV panels topped by a row of 7 thermal panels, they produce 4.7 KW of electricity, plus space and water heating. From the street, the system appears to be a single



set of panels. During daylight hours when the house calls for heat, the system directs warm air captured behind the PV panels into the home. Water is pre-heated for the tankless gas hot water heater by passing through an air-to-water exchange system. The Boleyn's just love being home on sunny days and feeling the direct heat pouring into the house through the special vents. Emily says this system has all the comfort benefits of a sun room, without worrying about mechanically opening and closing the space. The new system is even remotely controlled over the internet!



So, did the Boleyn's meet their goal for net zero? Based on actual data for the first 90 days of occupancy of their new home, Doug estimates the Energy Utilization Index will be between 3-4 kbtu/sf/year. Goal achieved.



Net Zero Strategies–Morning Sun Residence

Lifestyle	Remarks
Thermostat settings	Night/unoccupied = 66; Day time/occupied = 70
Clothes drying	3 loads per week, summer line drying
Phantom loads	Cable boxes, TV, routers
Appliance use	Energy Star Refrigerator, Dishwasher, Clothes Washer, & exhaust fan; Induction cook-top; 30 + yr old freezer

Passive Design	
Southern Orientation	338 sq. ft. south facing windows (43% of total glass area)
Mass	Slab floor on lower level, stone fireplace wall in living room
Exterior Shades	Overhangs tuned for 90% summer shading
Daylighting	Three SolaTubes, two relights bringing south light into north side rooms, extensive use of windows on east, south & west

Energy Efficient Envelope (roof, walls, windows, floor)	
Roof/ceiling	R-49 (2" sprayed on foam plus R-38 fiberglass batts)
Exterior walls	R-32 (8" staggered studs w/out thermal bridging, with blown in fiberglass)
Floors	R-15 rigid foam board under slab floor; R-38 above crawl space (under master suite, laundry & entry)
Windows & Doors	S and E windows: U=.22, SHGC=.54 W and N windows: U=.14, SHGC=.22 Sliding glass doors: U=.22, SHGC=.28 Door to garage: steel insulated Front Entry: steel insulated
Infiltration	2.9 ACH @ 50 Pascal (0.15 ACH natural)
Interior shades	R=5 on selected windows

Energy Efficient Mechanical Systems, Appliances & Lighting	
Heating	Two ductless mini-split heat pumps with four indoor units in individually controlled zones; NG fireplace used occasionally
Cooling	Night flush provided by PVT and opening windows; heat pump used in extreme conditions
Appliances	Tankless natural gas water heater, others listed above
Lighting	90% CFL (all except two incandescent fixtures on dimmers)

Active Solar Systems	
Hot Water	PVT system extracts heat from behind PV modules through heat exchanger to pre-heat water stored in 80 gallon solar pre-heat tank
Photovoltaic	4.7 kW Sun Power 225 black modules (21)
Space Heating Assist	PVT system extracts warm air from behind PV modules and vents heat directly into living space when called for

System Integration

- Dividing the 2700 sq ft home into four heating zones allows the owners to control heating and cooling based on occupancy and needs. The lower level guest suite is further isolated thermally with closeable doors and additional insulation between the floors.
- The heart of the renewable energy systems for Morning Sun are its passive space heating from the generous south windows and the PVT system which provides electricity, space and water heating.
- Fresh air is provided by a combination of the heat recovery ventilator (HRV), the PVT system when operating in the heating mode, and multiple openable windows on all levels.

THE TEAM

Contractor:
Cellar Ridge Custom Homes, John Mead

Designer: Matt Daby of Mathew O. Daby Design

Solar Installer:
Sunlight Solar

Mech Installer:
Perfect Temp

Solar PV/Thermal System: PVT Solar, Berkeley, CA

Mechanical equipment manufacturer:
Fujitsu (Ductless MiniSplit Heat Pumps), Noritz (Tankless Water Heater)

Solar Panel Manufacturer:
SunPower

HRV Manufacturer:
Honeywell

Window Supplier:
Serious Materials

FSC Lumber Suppliers/Installers: Parr Lumber, Wood is Wonderful (Sheridan, OR)

Energy Use Index
EUI in kbtu/sf/year

US Average 46

13.4

With EE Design

3.8

With Solar Design (passive & active)

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