

Net-Zero Energy Home Update

SOLAR HARVEST: THE FIRST THREE YEARS

IN THIS UPDATE

Solar Harvest verified as net energy producer

Major changes since 2005

“What would you have done differently?”

*Net-Zero Energy Homes and HERS:
Is BuildSmart Achievable?*

HIGHLIGHTS

- Solar Harvest produced 1,165 kWh more than it consumed in its first full year as an all-electric home
- Thermal performance continues to exceed expectations: the home was comfortable and performed as a net-producer despite summer heat waves
- 4 more net-zero energy homes were built in 2007 and 2008, all are equipped with live, web-based data monitoring systems

SOLAR HARVEST VERIFIED AS ALL-ELECTRIC HOME NET ENERGY PRODUCER

In April 2007, EcoGauge data monitoring providers teamed up with Boulder-based Continental Control Systems and Service and Solar Enterprises to outfit Solar Harvest with data monitoring equipment. Sensors were located throughout the house and in the mechanical and electrical systems to monitor indoor environmental conditions, energy production, solar hot water temperatures, and energy end-uses. These sensors were then linked to the internet through a web-based data logger.

Soon after installation, equipment began sending live data signals to the web, making Solar Harvest the first net-zero energy home nationwide to provide live performance verification data to the public.

Throughout the summer of 2007, several significant changes were implemented to convert the home to be all-electric (see next article for summary). With these modifications complete, September 1, 2007 marked the start of Solar Harvest's first year of energy monitoring.

The results compiled in September 2008 confirmed that the projections made during design



Visit Solar Harvest's online data monitoring website at: www.ecofuturesbuilding.com/systemsmonitoring

had been achieved: Solar Harvest is a net-zero energy home, and more.

Between September 1, 2007 and August 31, 2008, **Solar Harvest produced 1,165 kWh** more than it consumed.

This excess energy **offset ~17,000 lbs of CO2** at the power plant, and could have driven a family **electric car over 4,000 miles**.

Top 3 Reasons for Converting Solar Harvest to an All-Electric Home

1. Simpler energy conversion metrics for net-zero site and source energy calculations. 1 kWh = 1 kWh, no natural gas conversions necessary.
2. With more renewable energy plants coming online (wind, solar) and projected to continue to increase in coming decades, electricity may soon be the cleaner fuel.
3. More clients are seeking & building all-electric homes: Ecofutures designated Solar Harvest as a test site for products, systems and technology to make net-zero energy homes possible.

MAJOR CHANGES SINCE 2005

- Solar Harvest converted to all-electric home: natural gas stove and clothes dryer removed, replaced with electric appliances (July 2007)
- Standard 40-gallon electric water heater installed (January 2007) to boost Domestic Hot Water pre-heated in the solar tank, typically needed during longer-than-average periods of cloudy, cold weather
- 75 gal. fishtank that previously consumed ~1,600 kWh/year removed (July 2007)
- 1.9 kW PV added (July 2007) on east- and west-facing garage roofs at 10° tilt: these panels produce ~83% per unit area compared to south-facing PV
- Coolerado hybrid air conditioner installed (July 2007) to reduce disruption of guest and occupant sleep schedules to open/close windows and to add cooling during summer heat waves. Very low energy use: ~600 W to provide 1,400 cfm of 61-64° air, regardless of outdoor air temperature
- Earth tubes to ERV outfitted with UV light (December 2006) and filter at air intake (March 2007) to prevent mold and organic material from entering the home

As an all-electric, 4,500 SF home, Solar Harvest's average monthly energy use hovers around 700 kWh — very close to the national average for gas-heated homes — but the OVERALL usage is only about 2.2 kWh per square foot per year, with the net usage being a negative number.

“WHAT WOULD YOU HAVE DONE DIFFERENTLY?”

By Eric Doub, President and Founder, EcoFutures Building Inc.

This is the question we are often asked. The main answers are: the Big Tank, making the system more hands-off, and no radiant floor heating.

I came to realize that there are two ways to store Cloudy, Cold Snap Energy for heating space and hot water. 1. On site in water, in a very large tank; and 2. Off site in the electric grid, in the form of extra electricity generated April through October.

Method 2 has the advantage of bringing the Fiddling and Wondering Index to zero: It is fully automatic. The next homes differed from Solar Harvest in the basic components of (A) Smaller solar storage tanks; (B) Modulating electric boiler backups; (C) Low-velocity hydronic air rather than radiant heat, for quicker response time by the backup heating system.

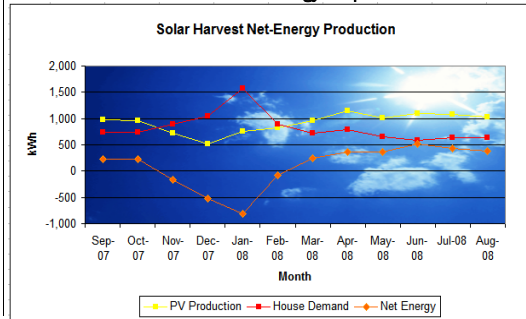
In July 2005, before the Tour of Solar and Green-Built Homes in October and before our family moved into Solar Harvest in November, I wrote a press release with one definition of a zero energy home and my expectations for this home's performance. Looking back at that document, I am astonished at the confidence expressed. Now it is publicly known that these claims are verified. What a joy! And such verification is also the next challenge in the home industry: To go beyond promises and projections, and fully document how net-zero energy can be achieved.

Solar Harvest Data Monitoring Summary

| Year 1 Energy Data Table* | | | |
|---------------------------|---------------|--------------|---------------------|
| | PV Production | House Usage | Net Production |
| September 07 | 969 | 747 | 223 |
| October 07 | 956 | 736 | 219 |
| November 07 | 728 | 887 | -159 |
| December 07 | 517 | 1,046 | -529 |
| January 08 | 757 | 1,569 | -812 |
| February 08 | 822 | 897 | -76 |
| March 08 | 967 | 720 | 246 |
| April 08 | 1,150 | 787 | 362 |
| May 08 | 1,009 | 651 | 359 |
| June 08 | 1,098 | 584 | 514 |
| July 08 | 1,071 | 636 | 435 |
| August 08 | 1,021 | 540 | 381 |
| Total kWh | 11,064 | 9,899 | 1,165 extra! |

* September 1, 2007 - August 31, 2008 was selected as the first year for energy analysis since it accurately tracks when the home is fully all-electric.

Year 1 Net-Energy Graph



“Verification is the home industry’s next challenge. Going from promises and projections to proven performance is essential to move our society towards carbon neutrality.”



Monitoring Equipment Summary

Solar Harvest is outfitted with a web-based energy monitoring system to eliminate the need for an on-site energy-consuming logger like a computer, and to promote the ease of accessibility to information. At any given time, anyone can check on current conditions at Solar Harvest. Work is also underway to improve the accessibility of historical energy and performance data.

Data Monitoring System Components include:

- Web Energy Logger
- WattNode Pulse Output Meters for PV production / household consumption by Continental Control Systems
- Temperature sensors inside house
- Temperature sensors inside top and bottom of big tank
- Temperature sensors at solar collectors
- Run time and power meters at solar collector pumps (these four items calculate the home's "mpg" rating)
- Temperature sensors at the earth tube termination into the house, compared to outdoor air, this calculates temperature rise from the earth
- Temperature sensors on all 4 sides of the ERV exhaust/intake
- Run time meter of the hot water fan coil
- Run time and power sensors at the electric boiler and radiant floor heat
- And others, with more sensor points to be added in fall, 2008

NET-ZERO ENERGY HOMES AND HERS: IS BUILDSMART ACHIEVABLE?

By Alison Ray, EcoFutures Building

There has been some discussion regarding the May 2008 implementation of Boulder County's BuildSmart building code because it places very strict energy-use limits on homes based on size: the higher the square footage, the greater the restrictions on energy use. Homes built over 5,001 square feet must achieve HERS 10 or below—effectively net-zero energy.

Since Solar Harvest, EcoFutures has built 2 custom homes, and has one under construction that, had they been built in Boulder County, would have had to comply with this very stringent HERS requirement. Only one of these homes, however, would rate below HERS 10, though most of them will perform at or near net-zero energy. Even Solar Harvest would rate HERS 11, yet performs annually at ~HERS -10. Two lessons resulted from working with the HERS scale to rate these homes: (1) minor issues remain to be resolved in the rating software to better account for passive solar and thermal mass “charge and coast” performance, and, (2) achieving a low HERS score is chiefly the responsibility of the designer: optimal orientation and correct glazing-to-floor-area ratios should be paramount.



Conditioned square feet: 6,000
Elevation: 7,500
Rated HERS Index: 14
Projected HERS performance: 0



Conditioned square feet: 6,400
Elevation: 5,390
Rated HERS Index: 19
Projected HERS performance: 15



Conditioned square feet: 3,500
Elevation: 7,800
Rated HERS Index: 0
Projected HERS Performance: 0



Conditioned square feet: 2,700
Elevation: 5,400
Zero energy remodel: not rated
Projected HERS Performance: 0

To learn more about products and services listed in this newsletter, please contact service providers directly:

| | | | |
|-----------------------------|--------------------------------|--------------|--------------------------------|
| Continental Control Systems | (WattNode energy monitors) | 888-WATTNOD | www.ccontrols.com |
| EcoFutures Building Inc. | (Net-zero energy design/build) | 303-415-9694 | www.ecofuturesbuilding.com |
| EcoGauge | (Data monitoring systems) | 303-588-3538 | www.ecogauge.com |
| Service & Solar Enterprises | (Solar thermal) | 303-665-6690 | bruceaslack@msn.com |
| Simple Solar | (Solar electric) | 303-541-9852 | www.simplesolar.com |
| SunnySide Solar Colorado | (Data monitoring systems) | 303-881-8129 | www.sunnysidesolarcolorado.com |

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1025 Rosewood Ave. Suite 204
Boulder, CO 80304
Phone: 303-415-9694
Fax: 303-415-9332
Email: info@ecofuturesbuilding.com
www.ecofuturesbuilding.com