

How an Award Winning Proven “Energy Efficient Home” Operates

CASE STUDY

2014-2015



3 Acres Unimproved



1969 Sq. Ft. Modular House Nov. 2015

Most people have heard or read about how energy efficiency ideas, materials and construction can make a difference in their operating cost through their brochures promotion, utility company ad, promotion, magazine article and TV show. Government began the use of Labeling with a logo like “Energy Star”, LEED, HERS rating, “Watersense”. All are good efforts by the Building and Product industries to inform the public, tag and notify potential buyers of their achievement, materials, less usage of utilities and energy efficiency savings. The public is still skeptical of green labels.

What is most often not mentioned is the actual true cost to operate annually? I purchase this factory built modular home to be practically ZERO cost to operate? What would be the 1st year cost of its operation? Who can I talk too to independently validate the claim? The factory or a site built contractor an Architect? Have they built one, will they share the results? Will they share the homeowners name and phone number of their proven previously built homes?

The Architect, Factory and/or Contractor intent is in designing a new energy efficient home, typically, offers a list of the energy efficient items used in the building as it is created. It stops there however at the list; the elusive sum total or combined overall annual utility cost performance of operation is not promised it is proposed with conditions. Since it was not built or completed; just a computer model printout is created and shared results. They might offer some anticipated, projected proposal from the printout in the purchase process however no guarantees are offered. There are a limited number of true Zero Energy homes with success however their numbers are very small, geographically difficult to confirm or see, as well as obtaining the published results, rarely if ever available. I think the fear is if it did not perform to the intended expectations of the construction group; why expose failure and it could result in strife between the builder and his homeowner for a promise not kept.

FUTURE OF ZERO NET ENERGY HOMES

The California residential building code (Title 24) through the California Energy Commission and California Public utility Commission is seeking residential builders in a few short years to comply with by their AB-32 /2020 to meet of “Net Zero” performance. The architect, factory and builders will be compliant to share proven results and guarantee them in 2020. Net Zero or (ZNE) is the ability of the home without solar to operate by a reduction of 80% of a standard built home from 1990. The remaining 20% would be the utility’s responsibility of supplying renewal electricity from their own resources within their distribution system. Many Architects and Builders are gearing up to comply and meet this requirement for ZNE results of their upcoming residential home performance requirement. I believe it will be called a Zero Ready home.

We took the challenge and have built our own version of an award winning modular home in 2014. We made every effort to be 2020 compliant today on this future code requirement since 2009. This modular home is factory built which is quick to build, requires less on site contractors to assemble it and less inspection by government agencies. This type of construction reduces on site construction waste, built within a controlled environment devoid of inclement weather, on site trash reduced and a reduction in the carbon footprint from the elimination of the number of On Site sub-contractors driving to the property as traditional builders. All items are notable achievements for sustainability using factory construction. It is tested for wind @ 60 miles an hour and vibrations like a small earthquake courtesy of the highways during its delivery from the factory to the building site. A tight well-made modular house goes on a test ride before the sale.

THE HOME

The home is 1969 square foot factory built modular located in Paso Robles, CA on 3 acres at a 796 elevation. The orientation of the home is north to south. The west facing roof section has a length of 68 feet. The twelve 250 WATT rated PV Solar Panels is rated at 3.0 KW and are set on ½ of this rooftop at a 210 SW with a 15 degree tilt which covers about 33% of the roof surface. Paso Robles is classed as a Climate Zone (4) on the California Energy Commission list of 16 Climate zone. It has 280 days of clear Sunshine. The Climate Zone (16) is the most difficult for comparison.

CLIMATE

The Paso Robles Airport claims the area’s temperature ranges from winter of low to 23 degree to summer High of 110 degree (F) with an annual mean temperature of 60 degrees. Our water is operated by a 40 AMP electric circuit to a submerged pump which feeds to a 3000 gallon storage tank. The house water supply and plumbing uses a “Whirlpool” whole house charcoal water filter. In addition, a “NUVO” “Manor” “NO SALT” series water softener. The septic system consists of a 1200 gallon tank with 90’ of leach line. We have two Dual Flush toilets by American Standard. We installed as our HVAC system a YORK electric Heat Pump rated at 3.5 ton/14 SEER into overhead ducting in the attic with an R-Value of 38 with Radiant Barrier Roof Sheathing. The exterior walls have an R-Value of 23 and the floor has an R-Value of 22.

We hired Fallbrook Energy Group to be our HERS rater. They toured the factory during the homes construction and can come on site to test the results.

HERS RATER RESULTS

The home is CA WUI compliant and we received a California Advanced Home award/rebate under our CA Title 24 Energy Report for 2013 (achieving a (23.8%) better than a standard built home) from PGE. We were nominated by the USGBC-C4 for a green home award. It is > 15% Tier 3 "Energy Star" rating. Our home was submitted as a Case Study for the CPUC "Stakeholder Committee" and does comply with the upcoming ZNE requirement for new home residential builds in 2020. After the house was completed and final two inspections a "Certificate of Occupancy" was issued in April 2014 from San Luis Obispo County Building Department. My wife and I moved into the home. We still had contractors working through December 2014 doing interior finishing work but the house was livable. We began the monitoring of our utility usage with PGE under their Net Energy Metering Contract (NEM) issued May 2014. The PGE "Smart-Meter" categorizes and bills our electrical (kWh) usage by the hour and at the end of year our bill is paid based on our annual usage. We have (4) propane appliances: Propane Tankless water heater, (2) sealed combustion fireplaces, and a Bertazzoni propane range. Propane usage and cost is measured in gallons and stored in a 250 storage tank. In California, there are not many modular homes built on land that have this high of energy efficient specification, performance with published results and none in San Luis Obispo County.

Improvement to its On Site operation:

We installed a Weather station to monitor weather patterns on the south side on top of roof near its peak. We installed two thermometers with humidity reading in the attic and under the house to monitor temperature and humidity readings seasonally. We installed a Rain Water tank of 350 gallons with a 6 gallon GPM submerged pump that feeds our drip irrigation front, side and rear system for landscaping consisting of 133 drought tolerant plants. The total daily one hour operation results in consumption of 133 gallons of rainwater out of the tank in the summer. In addition, we routed the Whirlpool Washing machine 2" drain pipe to feed our front 4" drain pipe which deposits its waste water to our 4x6 rock filled underground earthen infiltration sump. It assists the front yard landscape watering. We added a 110 VOLT 5 person HOT Tub Spa in November 2014 for personal usage. *Update:* The SPA accounts for a 32% in electrical usage monthly increase in our 2014 to 2105 comparison prior to its purchase. The home without the SPA is very energy efficient. The kWh purchased for 2015 was 1688kWh versus 2014 1158kWh.

RESULTS 2014 - 2015

We have summarized below our 1st year experience living in this energy efficient factory built modular house. We wanted to showcase the combined efforts of how building a tight modular envelope, energy

efficient features, solar, rainwater harvesting, washer machine drain waste water harvesting, pumps, timers, interior features, thermometers and appliances interact to monitor and then achieve practically Zero cost to operate. We have learned the importance of monitoring and trying different approaches to make additional improvements where we felt could reduce the electrical/propane usage. The actual living experience and starting with a known winner does help determine the best course of actions taken to achieve additional improvements.

1. Solar thermal window Bedroom shades
2. 60% window tinting film on South and West facing windows
3. HOT water recirculation pumps (experimentation) tried the Chili Pepper and Laing Eco Circ E-1.
4. Appliances are "Energy Star" certified
5. Thermometer in the attic measures daily temperature and humidity (records/stores High/Low)
6. Thermometer under the house measures daily temperature and humidity (records/stores High/Low)

ANNUAL ENERGY USAGE

Annual Solar PV Production

= 4773 kWh generated / Purchased from PGE= 3853 kWh. The home without Solar PV production would have been increased to 8626 kWh purchased from PGE.

2014-2015 HOURLY USAGE OF ELECTRICITY

Peak (6AM – 6PM) = 25 kWh @ \$0.41
Off Peak (6PM - 8PM) = 576 kWh @ \$0.29 (Most troubling is the need for Electricity from the Utility at this time slot)
Net Off Peak (8PM – 6AM) = 3252 kWh @ \$0.21 (Most troubling is the need for Electricity from the Utility at this time slot)
PGE Cost to operate One Year: \$611 @ 3853 kWh annual usage

USAGE OF PROPANE

166 gallons @ \$1.80 or \$300 annually
Conversion of Gallons to kWh
(27) * 166 = 4482 kWh

- **If I eliminate the SPA and the Well based on usage after 8PM to 6AM the house would be practically Zero**

Total combined annual utility expense = \$911.00 or 74.91 monthly average

No Water or Septic cost to report!

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USGBC Dec. 2014 "Green Home Nomination"