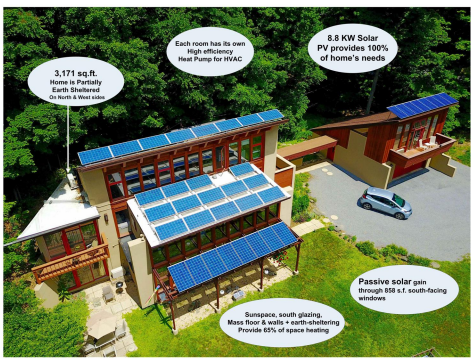
ACTIVE & PASSIVE SYSTEMS COMBINE IN ZERO NET ENERGY HOME

ENERGY MODELS VS. ACTUAL PERFORMANCE



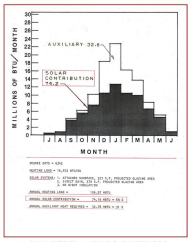
DIRECT GAIN & MASS FLOOR STORAGE

EARTH SHELTERING & MASS WALLS STABILIZE INDOOR TEMPERATURE

HELIOS is the architect's own home which evolved over time from a passive solar home, to a home which also reduced its hot water needs, to a home with reduced heating and cooling energy loads, and finally to a net zero energy home.

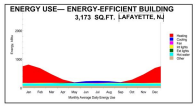
Helios was first constructed in 1984 as a passive solar home with the intent of employing proper building orientation, partial earth sheltering, solar gain through a two story sunspace and south facing windows, and building mass to reduce the heating load in rural northwestern New Jersey. This design resulted in a home which consumed only 35% of the energy needed for space heating a comparable conventional home. In 1998 a solar hot water system was added to provide 60% of the hot water needs. With the advent of high efficiency mini-ductless split-system heat pumps, this equipment was installed over time to replace the existing heating systems in the home.

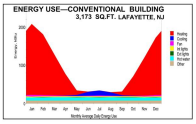
When solar photovoltaic (PV) systems became more affordable in 2008, a 5 KW (DC) system was installed, and with further economies in solar PV an additional 4 KW (DC) system was installed in 2015. The result is a net-zero energy home which has been carefully monitored over a full year of actual use to verify that all energy for space heating, cooling, hot water, and plug loads is provided by solar energy. The only energy not yet covered is the electricity needed to charge the owner's electric car. When community solar is permitted in New Jersey the owner plans to purchase the necessary energy from a community system to also satisfy the electric vehicle.



1984 MODEL – LCR & SLR METHODS PREDICTS 69% PASSIVE SOLAR CONTRIBUTION FOR SPACE HEATING

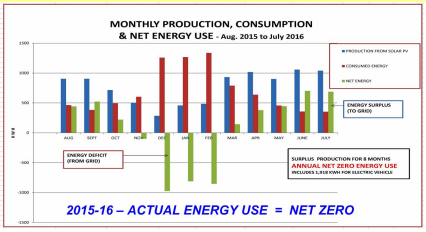
1984 ACTUAL = 65 %





2007 MODEL – ENERGY-10 SOFTWARE PREDICTS SOLAR CONTRIBUTION 81% BETTER THAN CONVENTIONAL HOME

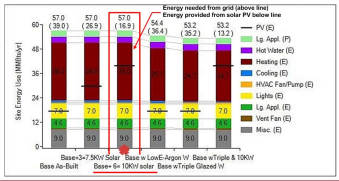
2007 ACTUAL = 70%



2015-16 – ACTUAL ENERGY USE = NET ZERO

2015 MODEL – BE-OPT SOFTWARE PREDICTS ENERGY USE OF 16.9 Mbtu/yr With 10 KW SOLAR PV SYSTEM

2015-16 ACTUAL = ZERO ENERGY USE



LESSONS LEARNED

Monitoring this passive and active solar home over the past 30+ years we've learned some important lessons:

1. ENERGY MODELS we used are approximations which predict solar energy performance usually on the conservative side. But they do help guide us with decisions about how to enhance building component and system sizes.

2. MONITORING ACTUAL ENERGY USE is critical to evaluating the building's performance and modifying systems as we work towards the goal of net zero energy. Also monitoring encourages energy conservation.

3. EARTH SHELTERING is more beneficial than expected in stabilizing indoor room temperatures, but high quality waterproofing is required.

4. A SUNSPACE with two-story vertical glazing provides an excellent buffer to the interior. Since the conditioned spaces are between the southern sunspace and the northern earth sheltered wall, minimal space conditioning is needed.

5. MASS FLOORS & WALLS (with rigid insulation behind) effectively store direct solar gain to stabilize the interior rooms' temperature.

6. A SOLAR HOT WATER SYSTEM is a very cost-effective way to reduce energy use, requires minimal maintenance and should be backed-up with a heat pump water heater.

7. A SOLAR PHOTOVOLTAIC SYSTEM with micro-inverters is the best way to achieve a net zero energy home. A properly sized system should be modeled using energy software, and the system should be monitored daily to assure optimal performance.

8. DECENTRALIZED HIGH EFFICIENCY HEAT PUMPS (mini-ductless systems) with SEER as high as 26 and operating temperatures down to minus 15 degrees F. provide an extremely cost-effective way of heating and air conditioning when and where required (instead of wasteful whole house HVAC).

9. AN ELECTRIC VEHICLE is in everyone's future, so the solar PV system should be sized to include the vehicle's power needs. Charging while the sun is out results in zero cost per mile, and the EV battery can provide emergency power when needed.

ENERGY MODELS VS. ACTUAL PERFORMANCE

YEAR	ENERGY MODEL PREDICTION	ACTUAL PERFORMANCE (Better than predicted due to energy conservation)
1984	107 MBTU 69% Passive solar contribution	81 MBTU (est.) + Wood stove
2007	74 MBTU 81% Passive solar & Solar Hot Water Contribution	63 MBTU (est.) incl. Propane heater
2015	16.9 MBTU with 10KW proposed Solar PV	ZERO NET ENERGY with 9KW Solar PV & high efficiency heat pumps

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