

## **ECO Designs: Ecology, Economy and User Friendly for the ECO-smart Home Owner**

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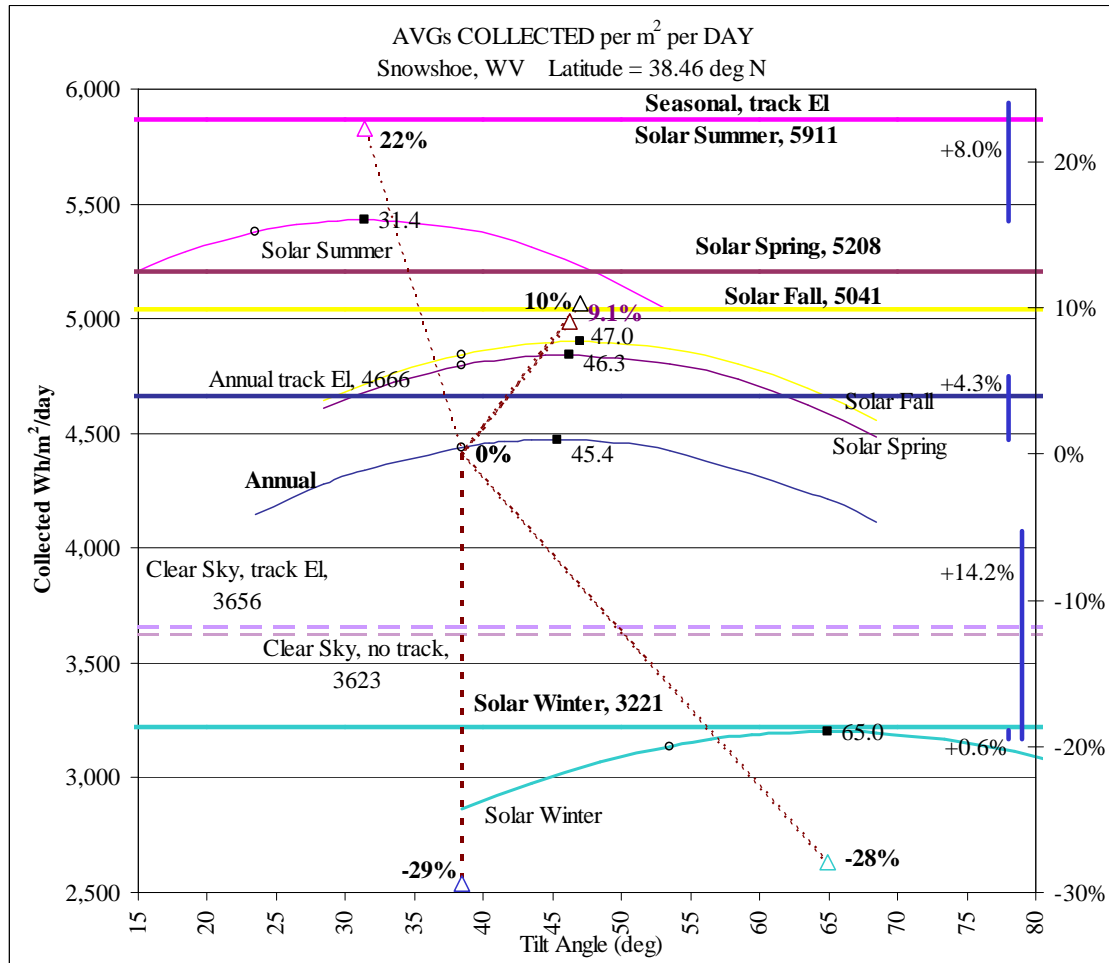
All of my house designs include comfortable, efficient floor plans for one-floor living and feature wheelchair accessibility, radiant floors and high ceilings. My passion is to blend ecological and economic designs and practices with up-to-date green building and solar applications, and to make the home user friendly. One of my objectives is to help consumers become knowledgeable about ecology – to become ECO-literate.

**Green Building** My ECO-designs include many Green Building concepts. For example, I have compiled performance charts for many Insulated Concrete Forms (ICF). I also have comparison charts of Structural Insulated Panels (SIP) of several types, so important to conservation and lower-cost operation. I encourage the use of sustainable materials like natural woods for floors (e.g. bamboo), ceilings (e.g. cedar, pine) and paneling. I recommend using appliances and fixtures with the Energy Star ratings.

I am working on a web article on such green building features, since I believe that consumer education is an important issue. Air management and water management are significant parts of green building and ecology awareness.

**Solar Thermal and Solar PV** We should distinguish between the solar thermal (heating of water, livable space) and photovoltaic arrays for power. The chart on the next page shows the fixed tilt angles for flat-plate collectors; I usually recommend seasonally adjustable mounting. For all forms of flat-plate collectors, the curves illustrate the best fixed elevation angles at Sunset Mountain Village (near Snowshoe, WV). Also, passive solar designs should be applied to houses, for maximum natural light and shading from direct sunlight in summer.

## Annual and Seasonal Solar Insolation, Snowshoe, WV



The solid symbols are the results for the best fixed tilt angles at Snowshoe, WV. The open symbols are the NREL-suggested tilt angles for seasonal and annual operations. The **Annual** curve shows possible fixed tilt angles for the whole year; the best is 45.4 deg. The seasonal curves illustrate the advantages of adjusting the tilt angles and keeping them fixed for the season.

Insolation values (irradiation of all kinds) from the Sun are given in Watt-hours (average) for a day for each square meter of collector; they are based on long-term observations recorded per calendar month for all of the USA. Daily highs can be 35% higher; lows can as much as 90% lower due to heavy overcast or storms.

The scale at the right indicates percentage relative to annual operation. There is a gain of 4.3% by tracking the elevation (tilt) angle throughout the year. In Solar Winter, there would be a reduction of about 29% if the annual tilt angle (45.4 degree) is used. As another example, in Solar Summer, by using the best tilt angle (31.4 degree) the increased collection is 22%. Tracking in Solar Winter yields about 14% gain, due mostly to capturing heat during clear-sky periods.

These calculated results do not include the effects of shadowing by trees, nor blocking by buildings or mountains, etc. Also, effects of azimuth pointing away from solar noon are not included.

1 sq m = 10.8 sq ft

4 ft x 8 ft panel = 3 sq m

### **Services by ECO-Design and SolaworX**

Here is a partial list of my services:

House designs for retirement

One-Floor-Living with pantry, laundry/mud room, decks or patios

Fully accessible rooms and decks, including personal lift if necessary

ECO-house designs and specifications

Super-insulation: R-60 roof, R-30 walls, up to R-11 windows and doors

Hydronic radiant floor and/or baseboards (solar heated)

Ground Source Heat Pump (solar assisted)

Water management      rain water collection and storage, all uses except faucets  
greywater for toilet tanks, garden soaking  
runoff water retention in pond(s)

Solar designs and specifications

Solar thermal windows and walls for space heating

Solar thermal collectors, storage, distribution

flat-plate for domestic hot water, space heating

evacuated tubes for domestic hot water, space heating and cooling

concentrating parabolic troughs for space cooling

Solar photovoltaic (PV) power

water pumps, emergency lighting, refrigerators;

possibly to assist heat pumps; and

for consideration: grid-tied leading to a "Net Zero" house

Cost-benefit analyses

Return-On-Investment (ROI)

Pay-back time

Life-cycle costs for house operation

Certification for Energy-Efficient Mortgage (EEM)

Other designs and construction kitchen and bathroom

deck and patio, garden bridges, garden trellis, garden arbor

water storage reservoirs, covers and insulation

*I usually emphasize solar thermal for water heating and space heating,  
then solar PV for water pumping and battery charging.*

*"Getting off the grid" is not a reality for the vast majority;  
selling PV power to power companies is just catching on in the USA.*

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## Q&A Follow-Up to SMV Article

- Q1 How many panels do I need?
- A1a For domestic hot water, most families need at least two flat-plate collectors (~64 sqft).
  - A1b For PV power, there are many sizes of panels; to power the average house (for most of the time) at least 3kW of power is needed and can require at least 15 kWh insolation of the PV arrays. The total area is about 200 sqft.
- Q2 What will they cost?
- A2a Solar thermal collectors as flat plates cost from about \$2,000 to \$4,000 installed for residential systems (for 40 to 80 gallons per day usage) [flasolar.com]
  - A2b Evacuated tube collectors cost more, (\$3,000 - \$6,000 installed).
  - A2c PV power typically cost from \$2.50 - \$4.00 per Watt.
- Q3 How much heat will they collect?
- A3a Two flat-plate collectors will yield about 250,000 BTU.
  - A3b Evacuated tubes usually come in 1 square meter; they are more efficient than flat-plate collectors and yield 30% more heat.
- Q4 What is the advantage?
- A4a Solar thermal collectors provide very cheap heat to warm water or space. These work well with good insulation and radiant floors. FSEC<sup>1</sup> found that solar water heaters offer potential savings, compared to electric water heating, of as much as 50% to 85% in the water heating portion of the utility bill.
  - A4b Solar PV collectors are effectively used for water pumping, transferring or circulating air, and battery charging. PV power can provide emergency power for safety lighting, medical equipment, fireplace fans, and well pumps.

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<sup>1</sup> FSEC Florida Solar Energy Center