

# Should Your Next Home be a Net Zero Energy Home?



By Beth Shady

If you are in the planning stages of building a new home or doing a significant remodel to an existing one, you are most likely considering some form of an energy efficient method to heat, cool and power your home. Net zero energy is the simple concept that a home generates the same amount of energy that it consumes on an annual basis. This is accomplished when the right combination of very efficient mechanical, lighting, building materials and appliances are matched with properly sized solar systems to achieve an annual net zero energy balance.

David Knight of Monterey Energy Group, a mechanical engineering and energy efficiency consulting firm located in Pacific Grove, California, started Net Zero Energy Certified (NZEC) in 2009. I sat down and talked with David to learn more about the mechanics, costs and benefits of net zero energy.

**BS: One of the common concerns we hear with regard to solar power and green building is that it is too expensive and that the payback takes so long that it hardly seems worth it. Is building net zero energy affordable for the average homeowner?**

**DK:** If you had asked me that question two years ago I would have said that concern was absolutely true. Today, however, recent significant reductions in the cost of grid-tied solar electric systems (approximately 50% last year) combined with a 30% uncapped federal tax credit have made these systems very affordable compared to the grid.

In addition, solar electric panels are putting out more energy per square foot, which makes them easier to integrate into the building. Another factor is that the overall efficiency of homes keeps improving. Better insulation, energy efficient lights, windows and HVAC equipment, all standard in today's new homes, when combined reduce the demand for energy.

**BS: What mechanical equipment innovations do you see that make all electric DHW and space heating with solar power more viable?**



*Umbraculi vix lucide fermentet chirographi. Catelli insectat apparatus bellis, etiam Augustus corrumperet cathedras, quamquam perspicax apparatus bellis insectat lascivius concubine. Medusa praemuniet umbr.*

**DK:** The introduction of the air-to-water heat pump to the U.S. market has been a boon to the net zero energy concept for hydronic heating contractors. These electric devices, for example the Daikin Altherma, use variable speed inverter technology to efficiently produce hot water for domestic and space heating. These units are reversible and can also be used for cooling, which opens up a huge untapped market for hydronic contractors, who can now use chilled water for air conditioning.

In colder climates, there is a 30% federal tax credit for geo-exchange heat pumps. These systems not only convert electricity into hot or cold water but their capacity and efficiency remain constant, regardless of the outside temperature, due to the constant temperature surrounding the earth.

**BS: How does a grid-tied solar electric system work?**

**DK:** These are simple, very low maintenance systems that convert sunlight into electricity. When the sun is out and your home energy consumption is typically low, the excess energy generated literally spins your electric meter backwards; you are essentially selling electricity back to the grid. Think of it like rollover minutes on your cell

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phone bill. When the sun goes away, you buy electricity back from the grid. The grid, not batteries, is the storage medium. Most utilities in the U.S. have net metering programs that account for your energy production and consumption on an annual basis. This is one of the keys in making net zero energy homes practical.

**BS: What factors do you take into consideration when determining whether or not a net zero energy home is practical?**

**DK:** There are several factors to consider. One is the local climate, which determines the heating and cooling loads as well as the solar production. Adequate roof space and site orientation, ideally unshaded and south facing, are also very important. Local incentives for installing solar electric systems play a key role, and the grid rate of electricity is also a strong determinant.

For example, in most of California we have a mild cli-

energy. While it is nice to have all four variables, having at least two of the four can make building a net zero energy home a sensible economic decision.

These statistics support Knight's Theory, which is that homeowners would rather produce their own electricity from solar than buy from the local utility company, if the after tax price is the same or less.

**BS: What is the best way to determine the rate of grid-provided electricity versus the cost of solar-produced electricity?**

**DK:** Table 1 represents the comparison between the costs of solar provided electricity to the grid. I call this my SPER chart, which stands for Solar Provided Electric Rate. SPER is calculated by dividing the annual after-incentive cost by the kilowatt-hours produced. SPER is basically your fixed electric rate for the life of the system, typically about 30 years, the same amount of time as your mortgage.

To calculate the average after tax equivalent cost of

**Table 1**

Table 1. Solar Provided Electric Rate (S.P.E.R.)											
City	Preincentive Cost	State Rebate	State Tax Credit	30% Federal Tax Credit	After Incentive Cost	After Incentive Cost Added to 30 yr @ 5%	kWh Produced	SPER (Solar Provided Electric Rate)	Ave. Retail Price of Electricity	After Tax Equivalent Rate Cost	Ave Proj Cost @5% Rise
1	2	3	4	5	6	7	8	9	10	11	12
	PV size					Interest					
	\$					subtract					3
	\$/watt			Rebat %	all credits	Years		annual after incentive cost / kWh	Hand	Hand	Hand
	\$		0.3	from Cost	30	Hand					Years
sample	\$52,250	\$18,250	\$0	\$10,200	\$23,800	\$1,533	11,827	0.13	\$0.19	\$0.26	hand
NY, NY	\$52,250	\$18,250	\$0	\$10,200	\$23,800	\$1,533	11,827	\$0.13	\$0.19	\$0.26	\$0.61
LA, CA	\$52,250	\$22,250	\$0	\$9,000	\$21,000	\$1,353	15,426	\$0.09	\$0.15	\$0.21	\$0.49
Chicago, IL	\$52,250	\$15,675	\$0	\$10,973	\$25,603	\$1,649	12,253	\$0.13	\$0.11	\$0.16	\$0.37
Houston, TX	\$52,250	\$0	\$0	\$15,675	\$36,575	\$2,356	12,669	\$0.19	\$0.12	\$0.16	\$0.37
Phoenix, AZ	\$52,250	\$16,625	\$1,000	\$10,388	\$24,238	\$1,561	16,598	\$0.09	\$0.11	\$0.15	\$0.35
PHI, PA	\$52,250	\$11,875	\$0	\$12,113	\$28,263	\$1,821	12,285	\$0.15	\$0.13	\$0.17	\$0.40
San Ant., TX	\$52,250	\$23,750	\$0	\$8,550	\$19,950	\$1,285	14,210	\$0.09	\$0.12	\$0.16	\$0.37
San Diego, CA	\$52,250	\$22,250	\$0	\$9,000	\$21,000	\$1,353	15,244	\$0.09	\$0.15	\$0.21	\$0.49
Dallas, TX	\$52,250	\$23,750	\$0	\$8,550	\$19,950	\$1,285	14,348	\$0.09	\$0.12	\$0.16	\$0.37
San Jose, CA	\$52,250	\$20,975	\$0	\$9,383	\$21,893	\$1,410	14,310	\$0.10	\$0.15	\$0.21	\$0.49
Detroit, MI	\$52,250	\$22,800	\$0	\$8,835	\$20,615	\$1,328	11,840	\$0.11	\$0.12	\$0.17	\$0.40
SF, CA	\$52,250	\$20,975	\$0	\$9,383	\$21,893	\$1,410	14,509	\$0.10	\$0.15	\$0.21	\$0.49
Jacksonville, FL	\$52,250	\$0	\$0	\$15,675	\$36,575	\$2,356	13,338	\$0.18	\$0.11	\$0.15	\$0.35
Ind, ID	\$52,250	\$4,000	\$0	\$14,475	\$33,775	\$2,176	12,686	\$0.17	\$0.09	\$0.12	\$0.28
Austin, TX	\$52,250	\$23,750	\$0	\$8,550	\$19,950	\$1,285	14,087	\$0.09	\$0.12	\$0.16	\$0.37
Columbus, OH	\$52,250	\$25,000	\$0	\$8,175	\$19,075	\$1,229	11,703	\$0.10	\$0.11	\$0.15	\$0.35
Fort Worth, TX	\$52,250	\$23,750	\$0	\$8,550	\$19,950	\$1,285	14,359	\$0.09	\$0.12	\$0.16	\$0.37
Charlotte, NC	\$52,250	\$0	\$10,500	\$12,525	\$29,225	\$1,883	13,399	\$0.14	\$0.10	\$0.14	\$0.33
Memphis, TN	\$52,250	\$0	\$0	\$15,675	\$36,575	\$2,356	13,492	\$0.17	\$0.09	\$0.12	\$0.28
Boston, MA	\$52,250	\$10,000	\$1,000	\$12,375	\$28,875	\$1,488	12,399	\$0.12	\$0.15	\$0.22	\$0.51
Baltimore, MD	\$52,250	\$0	\$0	\$15,675	\$36,575	\$2,356	12,466	\$0.19	\$0.15	\$0.20	\$0.47
E Paso, TX	\$52,250	\$23,750	\$0	\$8,550	\$19,950	\$1,285	17,994	\$0.07	\$0.12	\$0.16	\$0.37
Seattle, WA*2	\$52,250	\$0	\$0	\$15,675	\$36,575	\$2,356	10,407	\$0.08	\$0.08	\$0.10	\$0.23
Denver, CO	\$52,250	\$22,325	\$0	\$8,978	\$20,948	\$1,349	14,620	\$0.09	\$0.11	\$0.16	\$0.37
Nashville, TN	\$52,250	\$0	\$0	\$15,675	\$36,575	\$2,356	12,641	\$0.19	\$0.09	\$0.12	\$0.28
Milwaukee, WI	\$52,250	\$13,063	\$0	\$11,756	\$27,431	\$1,787	12,325	\$0.14	\$0.12	\$0.18	\$0.42
Wash, DC	\$52,250	\$0	\$0	\$15,675	\$36,575	\$2,356	12,626	\$0.18	\$0.14	\$0.18	\$0.42
Las Vegas, NV	\$52,250	\$0	\$0	\$15,675	\$36,575	\$2,356	16,950	\$0.14	\$0.13	\$0.14	\$0.33
Louisville, KY	\$52,250	\$0	\$500	\$15,525	\$36,225	\$2,334	12,437	\$0.19	\$0.08	\$0.12	\$0.28
Portland, OR	\$52,250	\$16,625	\$0	\$10,688	\$24,938	\$1,606	10,937	\$0.15	\$0.09	\$0.13	\$0.30
OC, OK	\$52,250	\$0	\$0	\$15,675	\$36,575	\$2,356	14,138	\$0.17	\$0.09	\$0.12	\$0.28
Tucson, AZ	\$52,250	\$19,000	\$1,000	\$9,875	\$22,575	\$1,454	16,663	\$0.09	\$0.11	\$0.15	\$0.35
Atlanta, GA	\$52,250	\$0	\$10,500	\$12,525	\$29,225	\$1,883	13,849	\$0.14	\$0.10	\$0.14	\$0.33
Ab, NM*3	\$52,250	\$0	\$5,225	\$14,108	\$32,918	\$1,436	17,170	\$0.14	\$0.10	\$0.14	\$0.33
KC, MO	\$52,250	\$19,000	\$0	\$9,975	\$23,275	\$1,499	13,239	\$0.11	\$0.09	\$0.13	\$0.30
Fresno, CA	\$52,250	\$20,975	\$0	\$9,383	\$21,893	\$1,410	15,475	\$0.09	\$0.15	\$0.21	\$0.49
Sacramento, CA	\$52,250	\$20,975	\$0	\$9,383	\$21,893	\$1,410	14,811	\$0.10	\$0.15	\$0.21	\$0.49
Long Beach, CA	\$52,250	\$22,250	\$0	\$9,000	\$21,000	\$1,353	14,898	\$0.09	\$0.15	\$0.21	\$0.49
Mesa, AZ	\$52,250	\$16,625	\$1,000	\$10,388	\$24,238	\$1,561	16,591	\$0.09	\$0.10	\$0.13	\$0.30
Omaha, NE	\$52,250	\$0	\$0	\$15,675	\$36,575	\$2,356	14,061	\$0.17	\$0.09	\$0.12	\$0.28

mate, thus low heating and cooling systems, good solar incentives and very high grid electric rates. That combination makes it very practical to do a net zero energy home. By contrast, Omaha, Nebraska, has a harsh climate, no solar incentives and an inexpensive electric rate, which means that a net zero energy home is not as practical. In other words, mild, sunny states with good solar incentives and high grid electric costs benefit the most from net zero

producing your own electricity and building a net zero energy house.

**BS: You have made a good case for the homebuilder to use solar power for lighting, air conditioning and appliances. You obviously need electricity for those uses. For space heating and domestic hot water, isn't it more cost effective to use fossil fuels such as natural**

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**gas, propane and fuel oil?**

**DK:** The introduction of the air-to-water heat pump, which I mentioned earlier, can make use of solar electric for space heating and domestic hot water cost efficient and practical. To demonstrate my point, I developed Table 2, which compares the use of an air-to-water heat pump with natural gas, fuel oil and propane. For simplicity, all units have been converted to kwh/year.

As you can see, in the 40 cities surveyed, using solar in conjunction with an air-to-water heat pump is significant-

**do you predict we will see in the near future that will make building net zero energy homes even more feasible?**

**DK:** The improvement in installation efficiency and lower material costs will contribute to lowering the overall installed cost per kwh of solar electric systems. In Germany, systems are routinely installed for about \$3.50 per watt as compared to the \$5.50 per watt rate I used in my SPER chart. However, as prices decline, incentives will probably be lowered as well.

Another improvement we are starting to see is solar electric panels incorporated into conventional building

**Table 2**

Table 2. Comparison Of Fuel Options (in kWh)									
Region	Air to Water Heat Pump C.O.P.	S.P.E.R.	Air to Water Heat Pump With PV	Natural Gas @ \$1.00/Therm	After Tax Equivalent Rate Cost	Fuel Oil @ \$3.00/Therm	After Tax Equivalent Rate Cost	Propane @ \$3.00/gal	After Tax Equivalent Rate Cost
	2	3	4	5	6	7	8	9	10
New York, NY	2.6	\$0.13	\$0.05	\$0.04	\$0.06	\$0.08	\$0.11	\$0.12	\$0.17
Los Angeles, CA	2.8	\$0.09	\$0.03	\$0.04	\$0.06	\$0.08	\$0.11	\$0.12	\$0.17
Chicago, IL	2.3	\$0.13	\$0.06	\$0.04	\$0.06	\$0.08	\$0.11	\$0.12	\$0.18
Houston, TX	2.6	\$0.19	\$0.07	\$0.04	\$0.05	\$0.08	\$0.11	\$0.12	\$0.16
Phoenix, AZ	2.7	\$0.09	\$0.03	\$0.04	\$0.06	\$0.08	\$0.11	\$0.12	\$0.17
Philadelphia, PA	2.6	\$0.15	\$0.06	\$0.04	\$0.05	\$0.08	\$0.11	\$0.12	\$0.16
San Antonio, TX	2.6	\$0.09	\$0.03	\$0.04	\$0.05	\$0.08	\$0.11	\$0.12	\$0.17
San Diego, CA	3.0	\$0.09	\$0.03	\$0.04	\$0.06	\$0.08	\$0.11	\$0.12	\$0.17
Dallas, TX	2.6	\$0.09	\$0.03	\$0.04	\$0.05	\$0.08	\$0.11	\$0.12	\$0.16
San Jose, CA	2.7	\$0.10	\$0.04	\$0.04	\$0.06	\$0.08	\$0.11	\$0.12	\$0.17
Detroit, MI	2.5	\$0.11	\$0.04	\$0.04	\$0.06	\$0.08	\$0.11	\$0.12	\$0.17
San Francisco, CA	2.7	\$0.10	\$0.04	\$0.04	\$0.06	\$0.08	\$0.11	\$0.12	\$0.17
Jacksonville, FL	2.7	\$0.18	\$0.07	\$0.04	\$0.06	\$0.08	\$0.11	\$0.12	\$0.16
Indianapolis, IN	2.4	\$0.17	\$0.07	\$0.04	\$0.05	\$0.08	\$0.11	\$0.12	\$0.17
Austin, TX	2.6	\$0.09	\$0.04	\$0.04	\$0.05	\$0.08	\$0.11	\$0.12	\$0.16
Columbus, OH	2.4	\$0.10	\$0.04	\$0.04	\$0.05	\$0.08	\$0.11	\$0.12	\$0.16
Fort Worth, TX	2.6	\$0.09	\$0.03	\$0.04	\$0.05	\$0.08	\$0.11	\$0.12	\$0.16
Charlotte, NC	2.6	\$0.14	\$0.05	\$0.04	\$0.05	\$0.08	\$0.11	\$0.12	\$0.17
Memphis, TN	2.6	\$0.17	\$0.07	\$0.04	\$0.05	\$0.08	\$0.11	\$0.12	\$0.16
Boston, MA	2.5	\$0.12	\$0.05	\$0.04	\$0.06	\$0.08	\$0.11	\$0.12	\$0.17
Baltimore, MD	2.6	\$0.19	\$0.07	\$0.04	\$0.06	\$0.08	\$0.11	\$0.12	\$0.17
El Paso, TX	2.6	\$0.07	\$0.03	\$0.04	\$0.05	\$0.08	\$0.11	\$0.12	\$0.16
Seattle, WA	2.9	\$0.08	\$0.03	\$0.04	\$0.05	\$0.08	\$0.11	\$0.12	\$0.16
Denver, CO	2.3	\$0.09	\$0.04	\$0.04	\$0.06	\$0.08	\$0.11	\$0.12	\$0.17
Nashville, TN	2.6	\$0.19	\$0.07	\$0.04	\$0.05	\$0.08	\$0.11	\$0.12	\$0.16
Milwaukee, WI	2.3	\$0.14	\$0.06	\$0.04	\$0.06	\$0.08	\$0.11	\$0.12	\$0.18
Washington, DC	2.6	\$0.18	\$0.07	\$0.04	\$0.06	\$0.08	\$0.11	\$0.12	\$0.17
Las Vegas, NV	2.7	\$0.14	\$0.05	\$0.04	\$0.04	\$0.08	\$0.11	\$0.12	\$0.16
Louisville, KY	2.5	\$0.19	\$0.08	\$0.04	\$0.06	\$0.08	\$0.11	\$0.12	\$0.17
Portland, OR	2.8	\$0.15	\$0.05	\$0.04	\$0.06	\$0.08	\$0.11	\$0.12	\$0.17
Oklahoma City, OK	2.6	\$0.17	\$0.07	\$0.04	\$0.05	\$0.08	\$0.11	\$0.12	\$0.16
Tucson, AZ	2.7	\$0.09	\$0.03	\$0.04	\$0.06	\$0.08	\$0.11	\$0.12	\$0.17
Atlanta, GA	2.7	\$0.14	\$0.05	\$0.04	\$0.06	\$0.08	\$0.11	\$0.12	\$0.17
Albuquerque, NM	2.6	\$0.14	\$0.05	\$0.04	\$0.06	\$0.08	\$0.11	\$0.12	\$0.17
Kansas City, MO	2.3	\$0.11	\$0.05	\$0.04	\$0.06	\$0.08	\$0.11	\$0.12	\$0.18
Fresno, CA	2.8	\$0.09	\$0.03	\$0.04	\$0.06	\$0.08	\$0.11	\$0.12	\$0.17
Sacramento, CA	2.8	\$0.10	\$0.03	\$0.04	\$0.06	\$0.08	\$0.11	\$0.12	\$0.17
Long Beach, CA	2.4	\$0.09	\$0.04	\$0.04	\$0.06	\$0.08	\$0.11	\$0.12	\$0.17
Mesa, AZ	2.7	\$0.09	\$0.03	\$0.04	\$0.06	\$0.08	\$0.11	\$0.12	\$0.17
Omaha, NE	2.1	\$0.17	\$0.08	\$0.04	\$0.06	\$0.08	\$0.11	\$0.12	\$0.17

products such as roofing tiles and skylights, which makes it easier for architects to integrate the solar production into the design of the home. Also, a few products are just coming to market in the United States that combine solar electric and solar thermal production in the same panel. These panels not only produce hot water for space and domestic uses but they also increase the electricity production on the panels by cooling them on hot days.

As LED lights, which are about five times more efficient than incandescent, become more reasonably priced, the energy required for cooling will be reduced as well, since more efficient lighting creates less strain on an air conditioning system, which contributes to lowering cooling loads.

We will start to see higher COP's for air-to-water heat pumps at lower ambient temperatures. According to the California Energy Commission (CEC), about 50% of a household's energy use goes to space conditioning and domestic hot water. The higher the COP, the smaller and less expensive the solar electric system will have to be.

Another big trend is the connection between home and transportation, as more homeowners are installing enough solar electric to provide sufficient electricity for at least one electric car.

Finally, real time monitoring for both energy consumption and solar production will allow homeowners to compare not only how much energy they are using but also how much they are producing. This is just now available and NZEC is slated to install our first system at the end of this year.

ly more cost effective than using either fuel oil or propane. This can be seen comparing column 4 with columns 7 through 10. In 31 of the 40 cities surveyed, the cost of using solar with an air-to-water heat pump is the same or less than the after tax rate of using natural gas, shown in column 6. In colder climates, however, a geo exchange heat pump may be a better choice than an air source heat pump. I think that hydronic contractors can now offer their customers an alternative to fossil fuels.

**BS: What advancements, improvements and trends**

All of these factors make building net zero energy homes even more feasible, practical and affordable. ■

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