

## Westbrook House Utility Use 2021

We completed our 25th year in our passive/active solar house. Below are some of the utility trends. For more information about our house visit: <https://enerjazz.com/house>

We built the house in 1996 and moved in late September of that year. It's a passive solar design with structural insulated panel (SIP) walls and roof, solar water heating, a ground source (geothermal) heat pump, and an energy recovery ventilator (ERV). We added a wind turbine in 2006, but sold it in 2014 because we have too many tall trees (turbulence). We added solar electric (PV) in late 2012.

The table below is for the data junkies. Subsequent trend charts are more visual.

Westbrook House Annual Utility Data											2,713 sf, 3>2 people	
Year	kWh house	kWh util	kWh wind	kWh solar	Elec Cost/Yr	Average Cost/Mo	kBtu/sf	kWh/sf/yr	kWh/DD	Water Use/Yr (gallons)		
1997	8,952	8,952	0		\$ 739	\$ 61.55	11.3	3.3	1.8	34,700		
1998	10,195	10,195	0		\$ 781	\$ 65.09	12.8	3.8	1.9	27,900		
1999	9,309	9,309	0		\$ 644	\$ 53.63	11.7	3.4	2.0	45,500		
2000	9,966	9,966	0		\$ 684	\$ 56.99	12.5	3.7	2.0	38,400		
2001	9,875	9,875	0		\$ 753	\$ 62.79	12.4	3.6	2.1	36,000		
2002	10,404	10,404	0		\$ 893	\$ 74.45	13.1	3.8	2.1	29,000		
2003	10,257	10,257	0		\$ 934	\$ 77.87	12.9	3.8	2.1	37,000		
2004	10,624	10,624	0		\$ 988	\$ 82.37	13.4	3.9	2.4	26,000		
2005	11,205	11,205	0		\$ 1,177	\$ 98.08	14.1	4.1	2.3	38,000		
2006	10,633	10,555	78		\$ 1,443	\$ 120.28	13.4	3.9	2.2	33,000		
2007	9,916	9,770	146		\$ 1,305	\$ 108.79	12.5	3.7	2.0	29,000		
2008	9,661	9,419	242		\$ 1,364	\$ 113.65	12.2	3.6	1.9	37,000		
2009	8,403	8,118	285		\$ 1,247	\$ 103.92	10.6	3.1	1.8	30,000		
2010	9,034	8,788	246		\$ 1,222	\$ 101.84	11.4	3.3	1.7	33,000		
2011	8,571	8,238	333		\$ 1,137	\$ 94.73	10.8	3.2	1.5	43,000		
2012	7,573	7,137	228	208	\$ 1,033	\$ 86.07	9.5	2.8	1.6	28,000		
2013	7,791	2,625	216	4,950	\$ 590	\$ 49.21	9.8	2.9	1.5	31,000		
2014	8,742	3,472	7	5,263	\$ 698	\$ 58.14	11.0	3.2	1.7	29,000		
2015	8,670	3,976	0	4,694	\$ 735	\$ 61.27	10.9	3.2	1.7	31,000		
2016	6,817	1,786	0	5,031	\$ 462	\$ 38.51	8.6	2.5	1.5	23,000		
2017	6,326	1,437	0	4,889	\$ 465	\$ 38.72	8.0	2.3	1.5	18,000		
2018	6,932	2,019	0	4,913	\$ 518	\$ 43.13	8.7	2.6	1.4	21,000		
2019	5,603	972	0	4,631	\$ 378	\$ 31.47	7.0	2.1	1.1	25,000		
2020	5,565	1,069	0	4,496	\$ 324	\$ 26.99	7.0	2.1	1.3	22,000		
2021	5,269	809	0	4,460	\$ 293	\$ 24.40	6.6	1.9	1.2	20,000		
Sums and Averages	kWh sum	kWh util	kWh wind		Cost		kBtu/sf	kWh/sf/yr	kWh/DD	Water Use (gallons)		
Total>	216,293	170,977	1781	43,535	\$ 20,807					765,500		
Annual>	8,652	6,839			\$ 832		10.9	3.2	1.8	30,620		
Monthly>	721	570			\$ 69.36					2,552		

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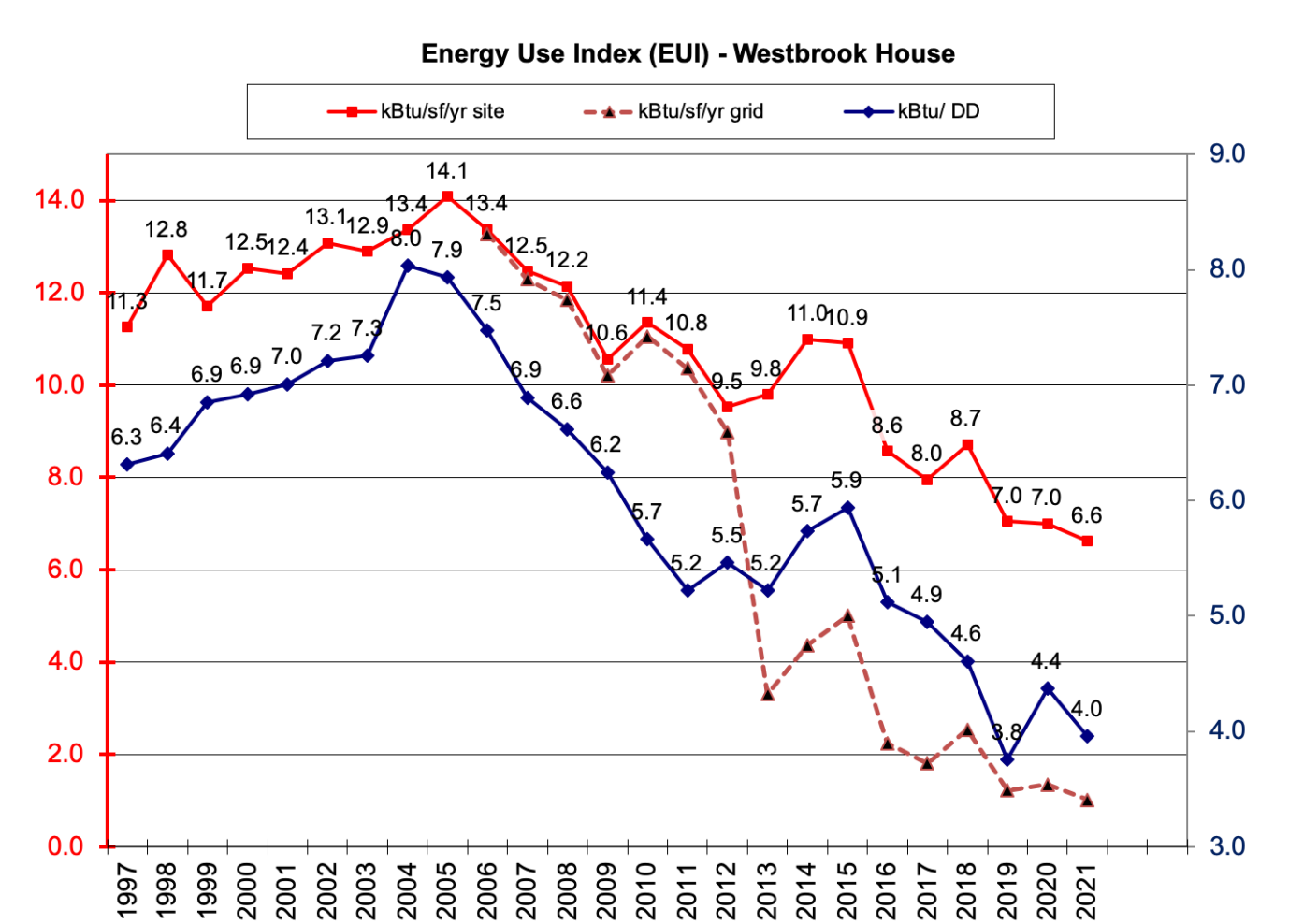
2016 major reduction due to aerobic septic air compressor change.

Note our electric utility (Grayson-Collin Coop) has a fairly high base cost minimum of \$24.40/month and an electric rate of 11.3 cents/kWh. In 2020 they made two significant policy changes. They began to allow excess monthly production from our solar array to carry over to future months. The hours go into a bank. The second change was the introduction of new rate plans. The Free Nights & Weekends plan works perfectly with our solar array. We only paid base fee in 2021 – no monthly energy charge.

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## Energy Use Trend

The chart below shows a few key energy use indices. The red line is our site energy use (converted to kBtu) per year divided by our house size in square feet (sf). This is called the Energy Use Index (EUI). The average for a home in Texas is about 41kBtu/sf/yr (we were 6.6 in 2021). Our use is better than the qualification level of the rigorous European PassiveHaus standard. The dashed red line is our site energy use from the grid. After we installed energy generation in 2006 this number began to drop. The addition of solar PV in late 2012 really dropped this line. The blue line shows our site energy use divided by the number of relevant cooling/heating degree days in a year. This helps account for yearly weather variations.

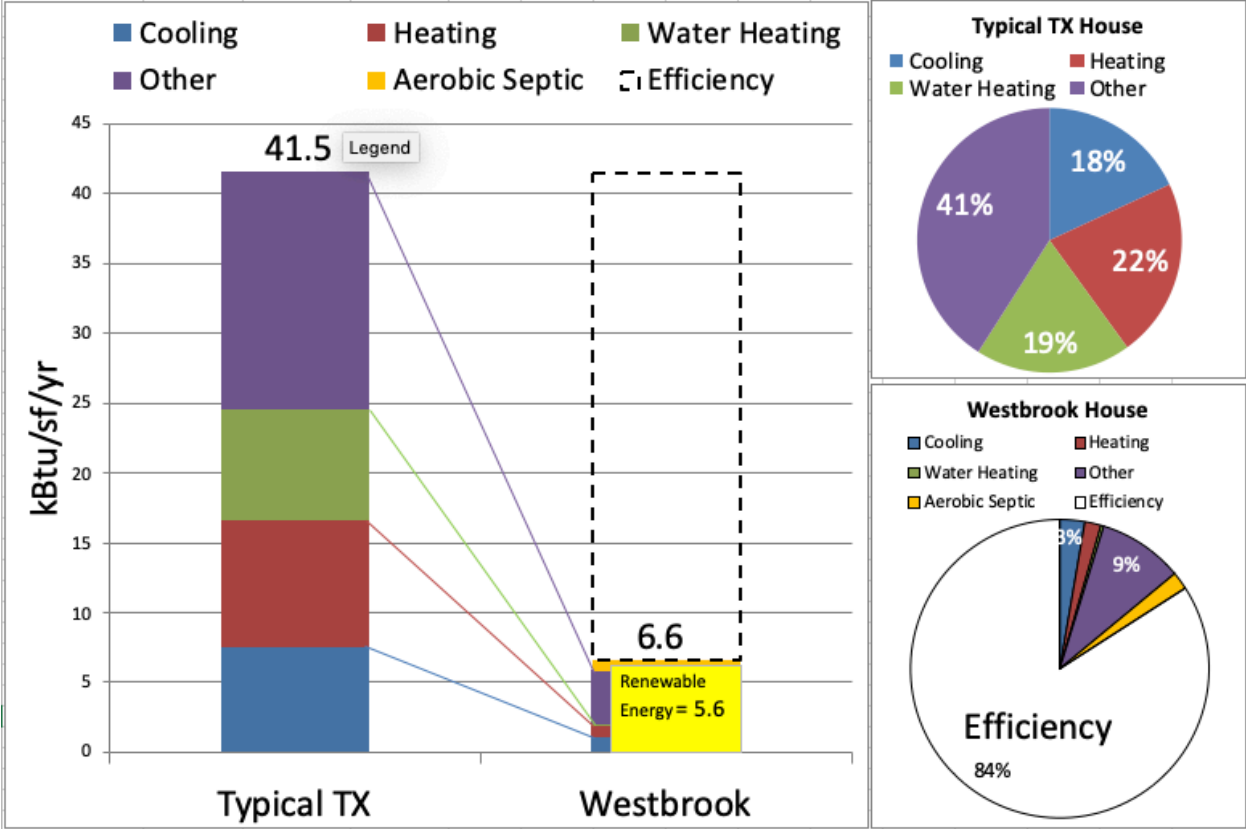


A few observations on the energy chart above. The peak year of 2006 revealed that our heat pump was low on Freon and was operating poorly. Also our daughter reached age 12 in 2006, which accounted for some of the increased use in other areas. About the time we repaired the heat pump we also began to lower our internal loads with more efficient TV's and computers. In early 2019 we replaced our 23 year old ground source heat pump with an even more efficient ground source heat pump.

2011, 12, and 13 were low use years as our daughter was away at college for most of that time. She lived with us again from mid-2014 until late 2015 and she now has a place of her own.

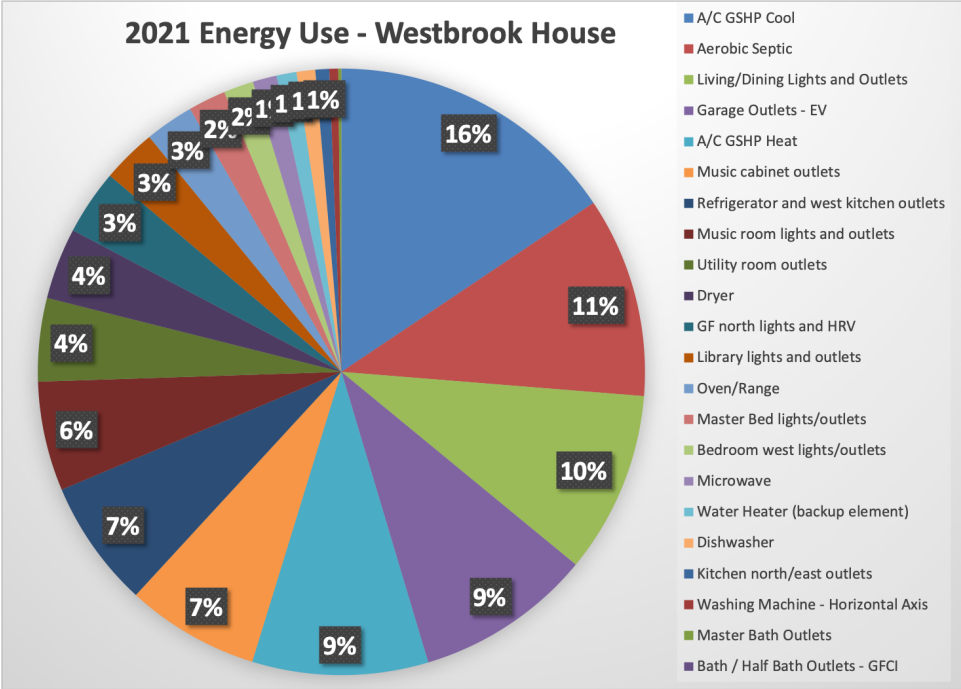
Below is a good summary of our house use vs a typical Texas home. The good design of our house makes it over 80% more energy efficient than a typical house. We have solar water heating, which provides the vast majority of our hot water for just the energy use of a couple of small fractional horsepower pumps. Our solar PV panels produced 85% of our house annual energy needs.

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**Energy Use**

Where do we use the energy? We have circuit level monitoring and generated a pie chart of our 2020 energy use.



For the house only (no EV charging) we needed 5,269 kWh. We generated 4,460 kWh with solar, covering 85% of our energy needs with renewable energy. Total with EV was 5,816 kWh (77% solar produced).

The majority of our energy went to cooling (16%). Heating was fairly small (9%) thanks to our passive solar design. Our aerobic septic aerator is still a very large energy consumer (11%), but that is lower than prior years because I replaced the aerator with a more efficient

model in 2016. Most houses outsource their waste processing energy to the municipal wastewater treatment plant. One of our largest loads (10%) is the main living/dining area where we spend most of our time with lights and the TV.

## Energy production

We added a Skystream Wind Turbine in 2006. I was a beta tester for them and my site did not meet the required criteria (300 foot clear radius around the tower), but I got it for a very low cost. The production was about 1/10<sup>th</sup> of what it would have been on a clear, open site. I sold the turbine in 2014 to someone with a better site. The turbine never could cover even 4% of my energy needs, instead of the 30% or 40% it would have covered on a better site.

In late 2012 I installed a 3.5kW solar photovoltaic (PV) array – later expanded to 3.7kW. This system is producing about 85% of the house energy needs. I could have boosted the size of the system a bit and been a net-zero house, but our electric utility provider did not give any credit for excess energy produced when we installed it. My system was optimally sized for the best financial return. This policy has also shifted our behavior. If we see we're going to give some energy back to the utility in a low use month we might run some laundry or other loads late in the billing period and shift the usage a bit. Adding an electric vehicle in 2018 has allowed us to utilize all our solar production and not give any energy back to the utility without compensation. In 2020 they began banking excess hours, and in 2021 we grew our bank to almost 900kWh. This data includes charging an EV, which we mostly do at night.

## Utility Policy – Energy Carryover and Free Nights & Weekends Rate Plan

As I mentioned, our utility made two big changes in 2020. First they allowed any monthly excess energy production to be carried over indefinitely. It's placed into a kWh bank and used in any subsequent months.

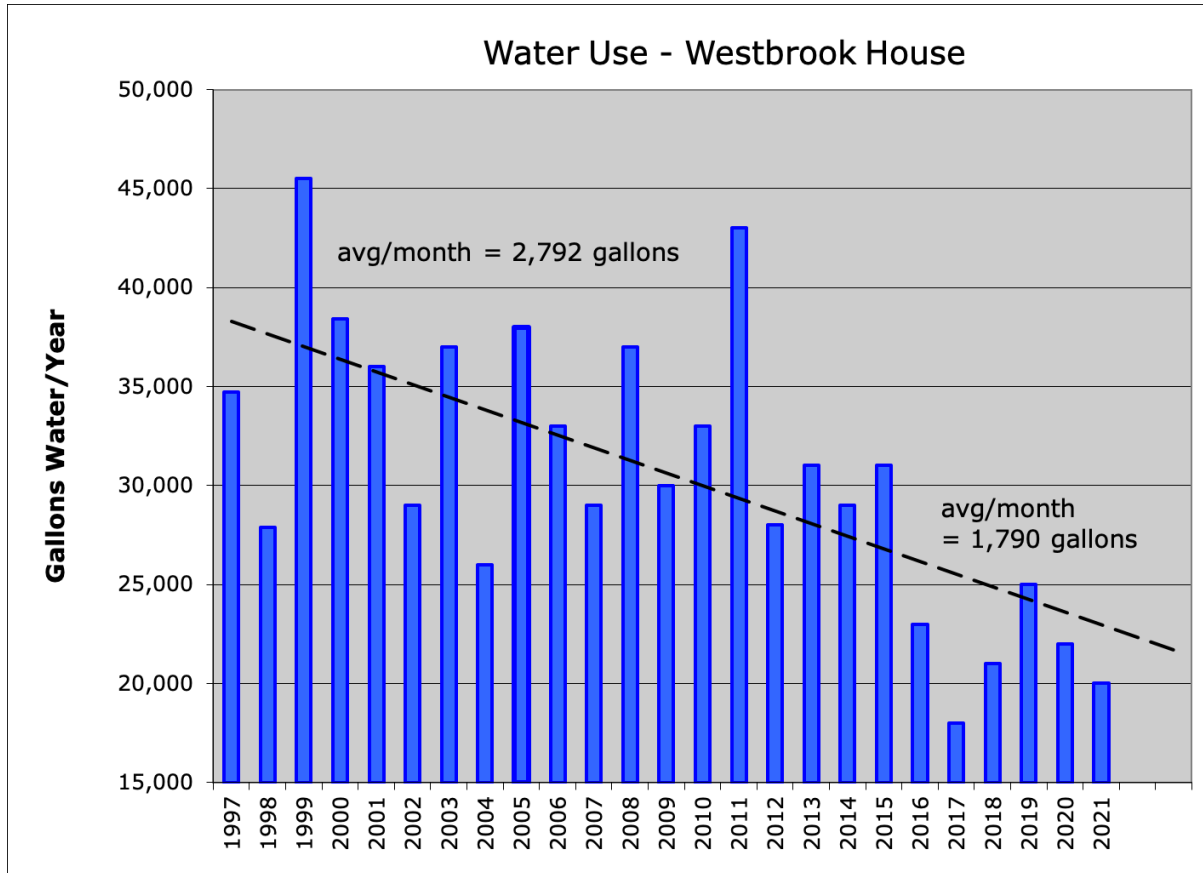
Second, they implemented a Free Nights and Weekends Plan. The rate on weekdays between 6am-10pm jumps to 16.4 cents/kWh, but the rate is zero overnight and all weekend. That means our weekday solar production is reversing the meter and being credited at 16.4 cents/kWh. Our house efficiency and use patterns, combined with our solar generation make this a perfect match. The utility benefits by not having to purchase expensive peak daytime power to send to us. Other ratepayers benefit from this reduction in expensive peak power purchase.

Date	Total Net kWh	Day Net kWh	N/WE Net kWh	Elec Cost (\$)	Base Fee + tax	kWh Bank Add	kWh Bank Used	Bank After kWh
8/14/20	197	(63)	260	\$-	\$ 24.40	63	-	63
9/14/20	243	(41)	284	\$-	\$ 24.40	41	-	104
10/22/20	86	(110)	196	\$-	\$ 24.40	110	-	214
11/14/20	57	(18)	75	\$-	\$ 24.40	18	-	232
12/14/20	194	(2)	196	\$-	\$ 24.40	2	-	234
1/14/21	224	63	224	\$-	\$ 24.40	-	63	171
2/14/21	284	59	284	\$-	\$ 24.40	-	59	112
3/14/21	208	13	208	\$-	\$ 24.40	-	13	99
4/14/21	(97)	(153)	56	\$-	\$ 24.40	153	-	252
5/14/21	(10)	(74)	64	\$-	\$ 24.40	74	-	326
6/14/21	97	(36)	133	\$-	\$ 24.40	36	-	362
7/14/21	152	(65)	217	\$-	\$ 24.40	65	-	427
8/14/21	(122)	(188)	66	\$-	\$ 24.40	188	-	615
9/14/21	218	(49)	267	\$-	\$ 24.40	49	-	664
10/14/21	160	(74)	234	\$-	\$ 24.40	74	-	738
11/14/21	85	(71)	156	\$-	\$ 25.40	71	-	809
12/14/21	23	(84)	107	\$-	\$ 26.40	84	-	893
<b>Total</b>		<b>(893)</b>	<b>3,027</b>	<b>\$-</b>	<b>\$ 417.80</b>			
<b>Avg/Mo</b>		<b>(53)</b>	<b>178</b>	<b>\$-</b>	<b>\$ 24.58</b>			
<b>Day</b>	M-F	6am-10pm			\$ 0.164	/kWh		
<b>Night/WE</b>	M-F	10pm-6am;SS all day			\$ -	/kWh		

For 2021 we didn't purchase any energy. We used a little from our bank in Jan-Mar, then added to the bank the rest of the year. We had some net usage at night, but the cost to us is \$0.

## Water Trend

We have 3,200 gallons of rainwater collection which handles most of the outdoor uses. We have 2.2 acres, but almost all of it is native with no irrigation. We only irrigate a garden and refill an outdoor pond with the collected rainwater. Our average municipal water use is about 1/6<sup>th</sup> of a typical home in our area. Most months our bill is the minimum \$23.65 (2,000 gallons or less), with an annual average of \$24.08/month total for water.



## Summary

Efficiency should always be the first step. Our passive solar, high efficiency design doesn't require much energy. Solar water heating produces the vast majority of our hot water. A relatively small 3.7kW solar PV system produces 85% of our home energy needs.

Living light on the planet does not mean we make a sacrifice. In fact, it's the reverse. Our home is so well insulated and air-tight that we enjoy even indoor air temperatures and a pleasant humidity level year round. We have much less dust and pests due to the tight shell construction with Structural Insulated Panels (SIP).

Our organically tended native plants and garden are healthier and greener than some of our neighbor's non-natives despite the constant irrigation by neighbors. And our diverse plants create a habitat for roadrunners, coyotes, bobcats, owls, hawks, butterflies (including the Monarch), bees, hummingbirds, armadillos, possums, skunks, snakes, and many more animals. And that creates a wonderful habitat for us.

My book, *The Joy of Efficiency* (<https://joyofefficiency.com>) covers all the details of our home design, construction, and operation.



Skystream Wind Turbine (2006-2014)

Hampered by too many nearby trees. Sold in 2014.

Solar PV (3.7kW) installed in 2012



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