

Understanding the Cost of Solar Energy

Credit to green econometrics - http://greenecon.net/understanding-the-cost-of-solar-energy/energy_economics.html

August 13th, 2007 · [13 Comments](#)

In comparison to conventional hydrocarbon fuels such as coal or oil in generating electricity, the cost of solar energy is significantly higher. To compare energy cost, a common equivalent is required. Back in our previous post, Coal: Fueling the American Industrial Revolution to Today's Electric, we developed a framework to measure energy costs by converting costs to kilowatt-hours (KWH).

In our example, a ton of coal on the average produces approximately 6,182 KWH of electric at a cost of about \$36 per short ton (2,000 pounds). Under this measure coal cost less than \$0.01 per KWH. In comparison, a barrel of oil at \$70/barrel produces 1,700 KWH at a cost approximately \$0.05 per KWH. Let's provide some measures to understand energy costs.

[Energy Units and Conversions KEEP](#)

Energy Comparison

1 ton of coal = 6,182 KWH

1 barrel of oil = 1,699 KWH

1 cubic foot of gas = 0.3 KWH

Energy Costs

1 ton of coal costs \$36 = \$0.006 per KWH

1 barrel of oil costs \$70 = \$0.05 per KWH

1 cubic foot of gas \$0.008 = \$0.03 per KWH

In comparison to solar energy, the hydrocarbon fuel costs are significantly lower without rebates, tax benefits nor the cost of carbon emissions. A two-Kilowatt (KW) solar energy system costs about \$45,000 and covers roughly half of a typical American household's energy needs. At \$45,000, a solar energy system equates to \$9,000 a kilowatt. The \$9,000 per KW for solar is not very helpful in comparing electric generation costs to other fuels like coal or gas. Since coal, oil, and gas can be measured on a cost per KWH, we should measure solar costs on a KWH basis.

Some of the considerations for a solar energy system include the 20-to-30 year lifespan of the system and the hours of available sunlight. The hours of available sunlight depends on latitude, climate, unblocked exposure to the sun, ability to tilt panels towards the sun, seasonality, and temperature. On the average, approximately 3.6 peak sunlight hours per day serves as a reasonable proxy to calculate the average annual output of electric from solar energy panels.

Solar Energy Costs

Average system costs = \$95 per square foot

Average solar panel output = 10.6 watts per square foot

Average solar energy system costs = \$8.95 per watt

In order to compare the solar energy costs to conventional hydrocarbon fuels, we must convert the \$8.95 per watt into KWH. Let's make two calculations to measure the total electric energy output over the lifespan of the solar energy system. The first adjustment is to convert solar direct-current (DC) power to alternating current (AC) power that can be used for household appliances. The conversion of DC to AC power results in an energy loss of 10 percent for a solar energy system. The second calculation is to approximate total electric output by multiplying the average peak hours of sunlight (about 3.63 hours per day) times 365 days times 20 years (the product lifespan).

For our 5-KW solar energy system costing \$45,000, the conversion to KWH is as follows:

5 KW times 90% = 4.5 KW – (Conversion of DC to AC power)

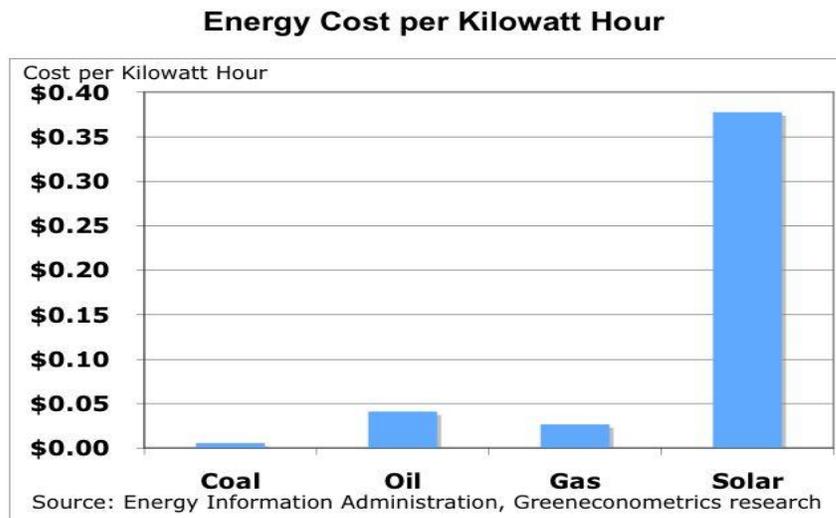
4.5 KW times 3.63 hours = 16 KWH per Day

16 KWH x 365 = 5,962 KWH – (Average Annual Output)

5,962 KWH x 20 years = 119,246 KWH – (Total output over 20 year lifespan)

So a \$45,000 5KW solar energy system produces about 119,246 KWH of electric over its lifespan meaning the average cost equals \$0.38 per KWH. (\$45,000 divided by 119,246 KWH)

Figure 1 Cost of Energy

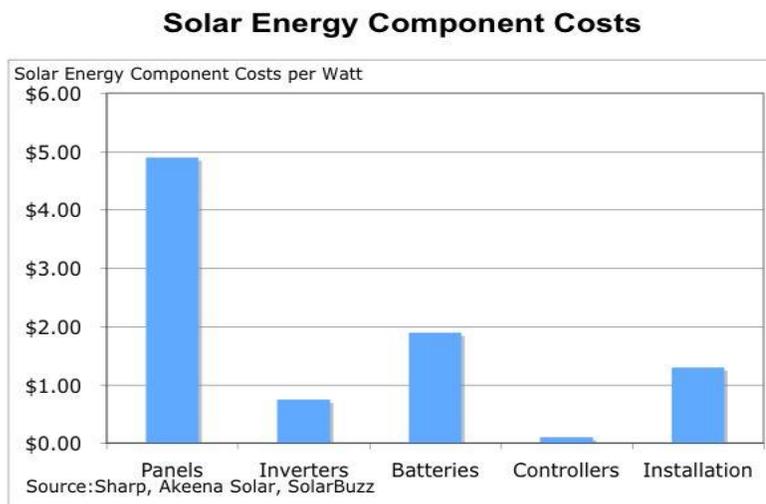


The relatively high solar energy costs in comparison to conventional fuels should improve with utility rebates and government tax incentives. In addition, solar panel prices should continue to decline as volume production increases. Solar cell manufacturers employ similar production methods as semiconductor suppliers and benefit from economies of scale.

There are several components of a solar energy system. Solarbuzz provides some detailed information on solar industry pricing. [Solarbuzz](#)

The single largest cost is the solar panels themselves. The following figure provides an overview of the components of a solar energy system. Sharp Solar provides a very useful calculator for system costs and electric generation by geographical location along with utility rebates for your area. [Sharp Solar Energy](#)

Figure 2 Solar Energy Component Costs



We will explore some of the advances in thin-film technologies, the declining costs of solar panels, and the improving solar conversion efficiencies that should continue to bring solar energy costs on par with hydrocarbon fuels. With the improving cost structure of solar and a better understanding of the cost of carbon emissions from hydrocarbon fuels, we may find a more level playing field in comparing energy costs.

Tags: [Alternative Energy](#) · [Energy Economics](#) · [Home Energy Economics](#) · [Solar Energy](#)

13 responses so far ↓

- [1 Tom](#) // Aug 19, 2013 at 3:27 pm

I like your graphs on expensiveness of solar energy. Although you don't really go on to say how good of an investment solar energy actually is, in the long run.

- [2 The Cheapest & Most Abundant Energy in the World](#) // Dec 3, 2013 at 9:11 pm

[...] by traditional economic measures my grandmother is right, solar isn't very economically competitive. But are these really the only economic measures that matter? If we look at things a little [...]

- [3 A.Salavitabar](#) // Mar 4, 2014 at 10:28 am

I would like kindly ask the cost of solar energy for desalination and energy generation and the area to be allocated per One MWH solar energy generation. Thanks a lot and looking forward to hearing from you

- [4 Jessie](#) // Mar 12, 2014 at 12:17 am

Thank you for showing this, this is really helpful specially for those who are not familiar with Solar cost... great article..

- [5 Jon](#) // Jun 26, 2014 at 5:44 am

I notice these figures date from 2007. Prices of solar have fallen massively since then (now 2014). Perhaps it is time to revisit the figures and update this webpage. I believe solar is now at parity with the retail price of electricity made from oil/gas/coal.

- [6 web page](#) // Sep 1, 2014 at 10:52 pm

We're a group of volunteers and opening a new scheme in our community. Your website offered us with valuable information to work on. You've done a formidable job and our entire community will be thankful to you.

- [7 investor](#) // Nov 24, 2014 at 6:39 pm

The cost per KWH of solar energy is grossly underestimated in the article. Because that initial investment also comes with the loss of opportunity. If the same money were invested in the market, one would expect some 5 times returns. So multiply the cost per KWH number for solar some 2-3 times to get more realistic picture. Solar at this time is completely lacking any commercial viability for most people and businesses.

- [8 Cost Of Solar Power Kwh](#) // Jan 10, 2015 at 9:49 pm

[...] Understanding the Cost of Solar Energy – Green ... – The cost per KWH of solar energy is grossly underestimated in the article. Because that initial investment also comes with the loss of opportunity.... [...]

- [9 Alie](#) // Jan 20, 2015 at 9:51 pm

This is a very skewed view. You are not considering the cost of pollution and environmental degradation related to fossil fuels (coal, oil and gas) energy.

- [10 goodrich4bk](#) // Feb 8, 2015 at 7:05 pm

I have a 3k system on my roof and it produces annually between 4,700 and 4,900 kwh of electricity, so your calculations are clearly understating the kwh generation of better systems on well-oriented roofs (my panels are Suntech). Using my actual experience vs. your hypothetical calculations, a 5k system on my roof will generate between 7,830 and 8,163 kwh annually, or an average of 8,000 kwh/year.

Today, I can buy a 5k system installed for less than \$12,000. And it will perform for MUCH longer than 20 years, which is only the warranty on the modules. In fact, early panels made over 30 years ago are still producing power at above 80% of their original output, and today's panels with 25 year warranties (such as my Sunpower panels) are likely to produce for a longer time at higher outputs.

But let's assume I get 25 years at original efficiency and only another 10 years at 90% efficiency. 5K panels will still produce a total of 272,000 kwh for \$12,000, or 4.4 cents per watt. Now compare this to what I would pay PGE if I didn't have the solar panels: \$.26 per kwh!

Note that by putting a solar system on my roof I have LOCKED IN the price per kwh of 4.4 cents per watt for the next 40 years. When I am on Social Security, this will be a sunk cost, not an ever-increasing cost. Does anybody believe that electricity will be cheaper at any time in the next 40 years than 4.4 cents per kwh? I didn't think so.

As for the stated price of coal per kwh in this article, this is meaningless to a homeowner. PGE charges me 26 cents a kwh regardless of what their wholesale costs are for coal, nat gas, hydro, etc. Unless you are building your own coal fired plant just to power your house, this article is grossly misleading.

Finally, "Investor" correctly notes that buying a solar system up front deprives me of the "opportunity cost" of having the \$12,000 invested in the "market". I put my solar panels on in 2007. If I had instead used the "opportunity" to invest in the market, I would likely have lost half my money in crash of 2008. So, no thanks you Mr. Wall Street "Investor". I'm quite happy with the guaranteed return on my investment of paying \$12,000 in 2007 to get over \$70,000 of electricity for no additional cost over the next 40 years (and that is using a fixed price of \$.26 per kwh times the 272,000 kwhs generated — obviously, if the market price of kwhs goes higher over the next 40 years then my return will be greater).

Oh, and this return is entirely TAX FREE because it represents a savings of a necessary expense and not interest or dividend income from Mr. Investor's wonderful "market".

- [11 buildsolarpanelathome](#) // Apr 18, 2015 at 8:51 pm

I was recommended this website by my cousin. I am not sure whether this post is written by him as no one else know such detailed about my trouble.

You are amazing! Thanks!

Also visit my homepage :: [buildsolarpanelathome](#)

- [12 vertical wind generator](#) // Jun 28, 2015 at 9:01 am

You ought to take part in a contest for one of the most useful sites on the internet. I most certainly will highly recommend this site!

- [13 costs](#) // Jul 17, 2015 at 10:05 am

I was recommended this website by my cousin. I'm not sure whether this post is written by him as nobody else know such detailed about my difficulty. You're wonderful!