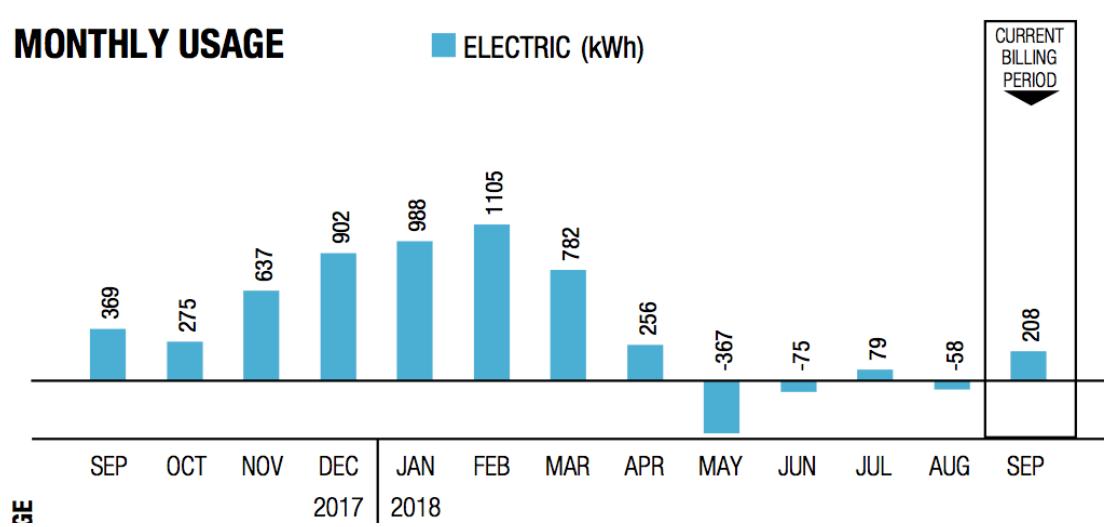


Home solar power and energy efficiency

(Or how I came to have a \$14/month electricity bill)

MONTHLY USAGE

ELECTRIC (kWh)



ACCOUNT # 0000-2344-4550

Please return only this portion with your payment. Inc.

| | |
|----------------------------------|----------------|
| Amount Due 10/24/18 | \$9.40 |
| After Due Date, Pay this Amount: | \$9.77 |
| Winterhelp Donation: | |
| Total Amount Enclosed: | AUTOPAY |

\$9.40 will be deducted from your account on payment due date



a PPL company

PO Box 25211
Lehigh Valley, PA 18002-5211

- Before spending money on solar stuff...
- Where does all my power go?
- Why add solar?
- What's it like to live with?
- Terminology
- What does it cost?
- Free money!
- Payback/Return on investment
- Retirement planning
- Solar hot water
- Off grid or grid tied
- Inverter type
- What would I need?
- What's involved in putting the system together?
- Suppliers
- Useful stuff/toys
- State of solar power in Kentucky
- Questions

Before spending money on solar stuff...

- Energy audit (\$100)
In my case, this led me to:
 - Roof insulation (12+ inches extra fiberglass insulation) (\$1200)
 - LED lights (\$200)
 - Seal round windows and doors (\$30)
 - Seal the air leaks from outlet boxes (same caulk for windows)
 - Seal the AC ducting and insulate the duct in the roof (\$100)
 - Energy star roof shingles

Where Does All of My Power Go?

Typical House in US

- Central Air Conditioner (2 ton): 1450 kWh/month
- Water Heater (4-person household): 310/kWh/month
- Refrigerator (17-20 cubic foot): 205 kWh/month
- Dryer: 75 kWh/month
- Oven Range: 58 kWh/month
- Lighting 4-5 room household: 50 kWh/month
- Dishwasher: 30 kWh/month
- Television: 27 kWh/month
- Microwave: 16 kWh/month
- Washing Machine: 9 kWh/month



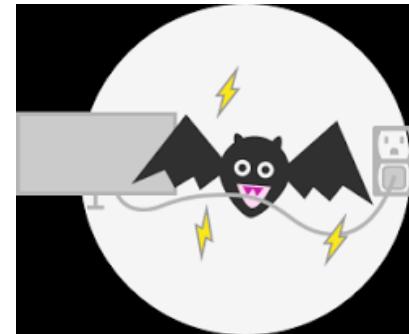
How to make the biggest impacts to your bill

- Change thermostat setting
- Lower water heater temperature/ take shorter showers
- Replace old refrigerators
- Clean dryer/ ducts, replace flexible ducts with metal ducts, eliminate elbows, replace through house
- Use your dish washer over handwashing (electricity usage offset by savings on heating water)
- Can you turn off your wifi or other “always on” items off at night?
- Kill vampire loads



Vampire Loads

- Is it instant on?
- Is it warm all of the time?
- Does it have a display? (old ranges use more energy keeping the clock powered than they did during cooking over a lifetime)
- Does it work with a wireless remote?
- Does it have an indicator light that is on all of the time?



Why add solar?

- Low risk and high return investment:
cash saved on electricity bill is after-tax
lower bills are a big resale benefit
- Good as part of retirement planning
- Hedge against higher electricity prices in the future
- Good for the planet
(But so is walking places, riding a bike and going vegetarian)
- It's deeply cool making your own power
- It is a fun DIY project
- My friends and neighbors will be impressed/horrified

What's it like to live with?



No, you muppet, what's it like to live with
really?

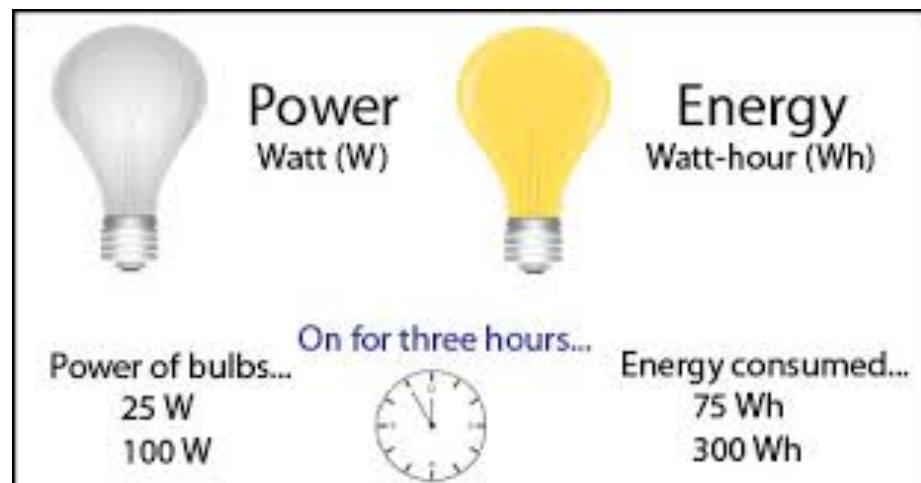
- With my system (7kw on the roof of my house, microinverters, net metering):
- No maintenance (well, maybe hosing off the panels once in a while)
- House is warmer in the winter, cooler in summer
- Electricity bill is a touch more complex to read but a LOT smaller
- Er, that's it. Plug stuff in, it works.

Terminology

- Inverter – a chunk of electronics that turns the direct current (DC) power from the panel(s) into alternating current (AC)
- Kw – kilo-watt, a measure of power. A hairdryer or a drip coffee maker use about 1 kw, the dryer uses about 3 kw. A 3'x5' solar panel makes about $\frac{1}{4}$ kw in really bright sunlight.
- Kwh – kilo watt hour, or a load of 1 kw for 1 hour. When you look at the electricity bill, this is what they are counting. Before I started my house used about 40 kwh per day (2400 sq ft ranch). LG&E currently charge around \$0.12/kwh.

Power Versus Energy

- Power-Rate at which work is done (Think horse power in a car).
 - Rate at which energy is consumed
- Energy-Amount of work complete (Think distance driven)



1000 Wh=1kWh

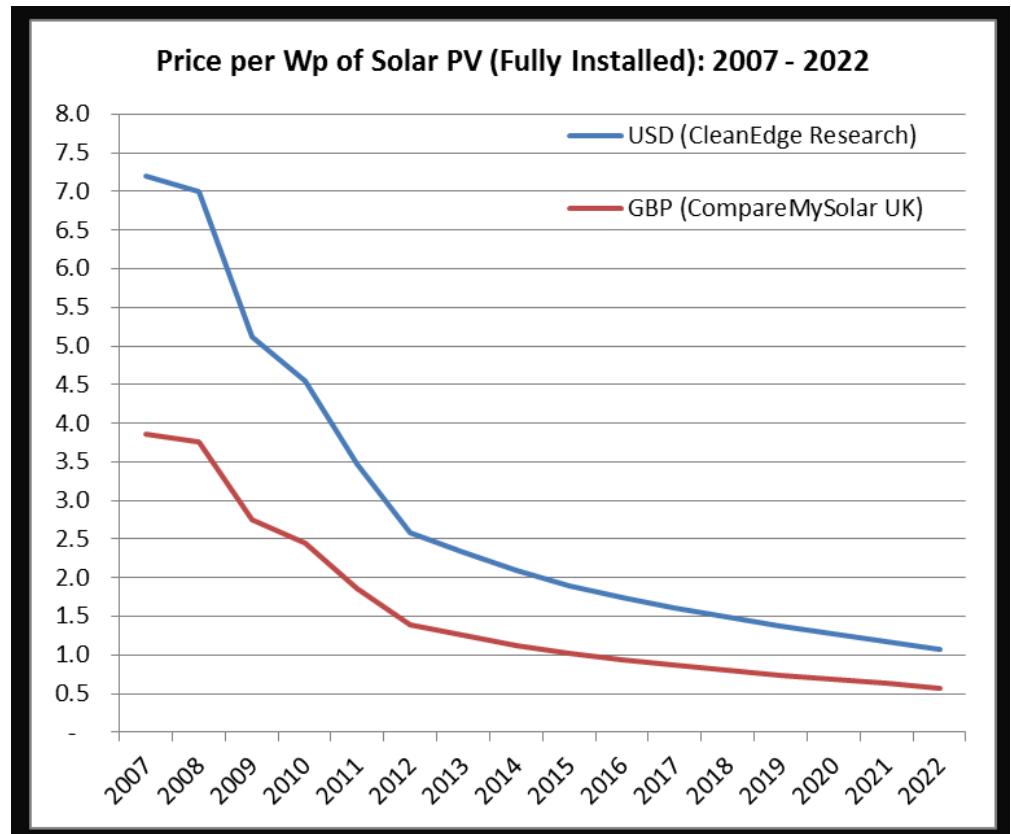
1000kWh=1MWh

k=kilo

M=Mega

What does it cost?

- Quote in 2013 for 3kw ground mount system was \$18.5k.
- Phase 1: 2013 DIY 5kw system (20 panels) - \$11k (with \$4.5k back) – the same system today would be \$8k (with \$2.4k back)
- Phase 2: 2016 DIY 2kw from Craigslist - \$2k
- Neighbor bought 3kw DIY system from Craigslist for \$3.4k
- You can start with a single panel system for about \$200...
- Until the end of 2020 you get 26% back as a tax credit ☺
- Solar hot water systems can be had for about \$2k
- Rough guide – DIY grid-tie is \$1/w, professional grid-tie install is \$3/w to \$4/w and off grid with batteries is going to be around \$6/w to \$7/w.



Free Money!

- First, the Federal government will give you a 26% tax credit on all money you spend on solar (water heating and photovoltaic equipment).
- That 26% also includes tools, wiring, electrical and plumbing changes and so on. It does NOT cover your labor if you install it yourself, nor does it cover replacing your roof.
- Second if you run a business from your house and you live in a rural area (Oldham county for example counts) you can apply to “Rural Energy for America Program” for grants and loans of up to \$20k .

Payback/return on investment

- There is a LOT of rubbish talked about how long solar takes to pay for itself, and it is rubbish because it implicitly assumes the installed solar panels have zero value once you install them.
- The correct way to price them is as an investment, where the install cost is the capital, and the saved money from bills is the (after tax) interest on that capital.
- In Kentucky the new net metering rules come into play on January 1st 2020, and any net meter system installed before then is grandfathered in on the old rules – and importantly this deal can be passed on to anyone that buys the property. This has significant value.

Retirement Planning

- Any steps you take to reduce your future bills are useful as part of retirement planning.
- Buying roof insulation, better windows, sealing behind outlets and solar energy can be thought of as techniques to buy yourself lower bills (and more disposable income) in the future.
- With the Federal tax credit of 26% this year, the government is helping out here more than in any other retirement investment.
- Energy improvements are unlinked to market prices, and indeed tend to be more valuable in times with high energy price volatility.

Solar hot water

- Preheats water before it runs into your hot water tank
- Solar collector on the roof, with a circulator pump and additional hot water tank
- Water heating is 10%+ of house energy use
- Best done as addition to current hot water system (preheat tank)
- Some lifestyle changes ...you want to run the washer, dishwasher etc. at night



Off grid

- Off grid – no electricity bill 😊
- You provide all your own power – and don't depend on the grid.
- Significantly more expensive because it uses (lots of) batteries
- Regular maintenance for batteries
- Bad weather for prolonged periods means using backup generator
- Great if the utility wants more than \$50k to connect you to the grid
- Almost impossible to find a professional installer that will do this for you.



*This is badly wired – don't do this!

Grid tied

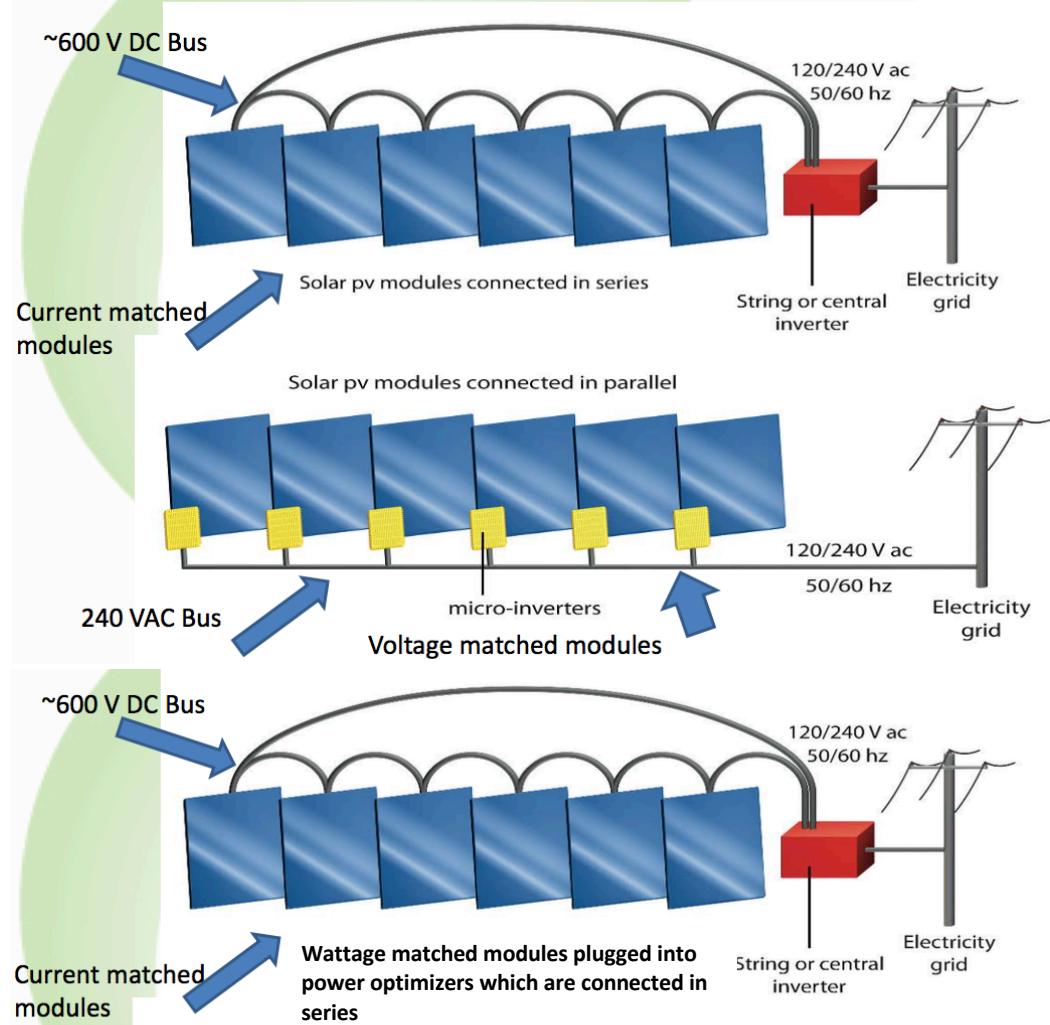
- Grid tied – your house is still connected to the grid
- You still get a bill ☹
- If there's snow on the panels for a week you still have power
- You don't have to replace all your power consumption with solar
- Very low maintenance
- This is what I have...



What would I need for grid tied PV?

- You don't need to replace all the power you use from the grid – start small, but get the meter changed THIS YEAR!
- Sun! So you need a clear view of the southern sky
- Roof or space in the yard
- Size of system is measured in kW – one panel is about 3'x5' and makes about $\frac{1}{4}$ kW.
- System comprises panels, inverters, wiring and a mounting system
- If you needed 25kwh/day, we get about 5 hours of sunshine per day so you would need 25 / 5 or 5kw of solar panels, about 20 panels.

Types of inverters



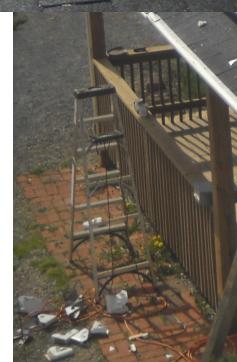
Inverter types

- “Single string” photovoltaic solar power
One or two large inverters fed by multiple panels wired together
Exciting DC voltages (600v+) and issues with shading
- Possibly more reliable due to inverter being inside the house and running at a lower temperature
- “Micro-inverter” photovoltaic solar power
One inverter every one or two panels
Regular house voltages (240v AC)
- More fault tolerant – one inverter failing doesn’t stop power production
- “Hybrid inverter” – grid tied inverter which can also provide power if the grid goes down. There are examples that are micro inverters (IQ-8) and string inverters like Solar Edge.

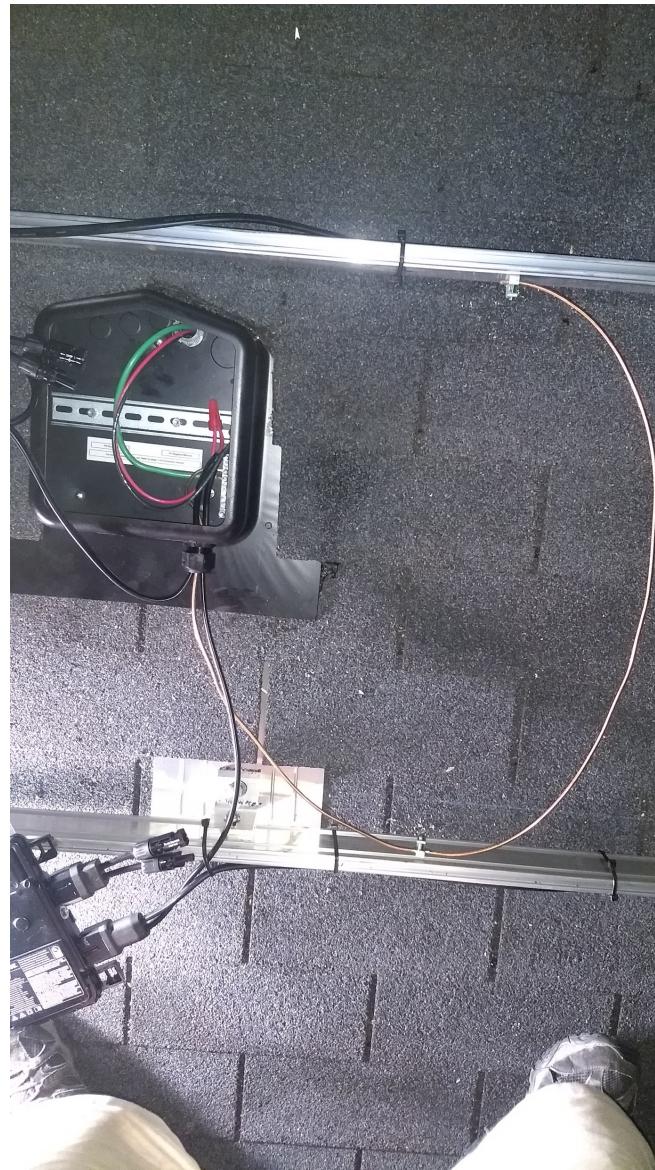
What's involved in putting it together?

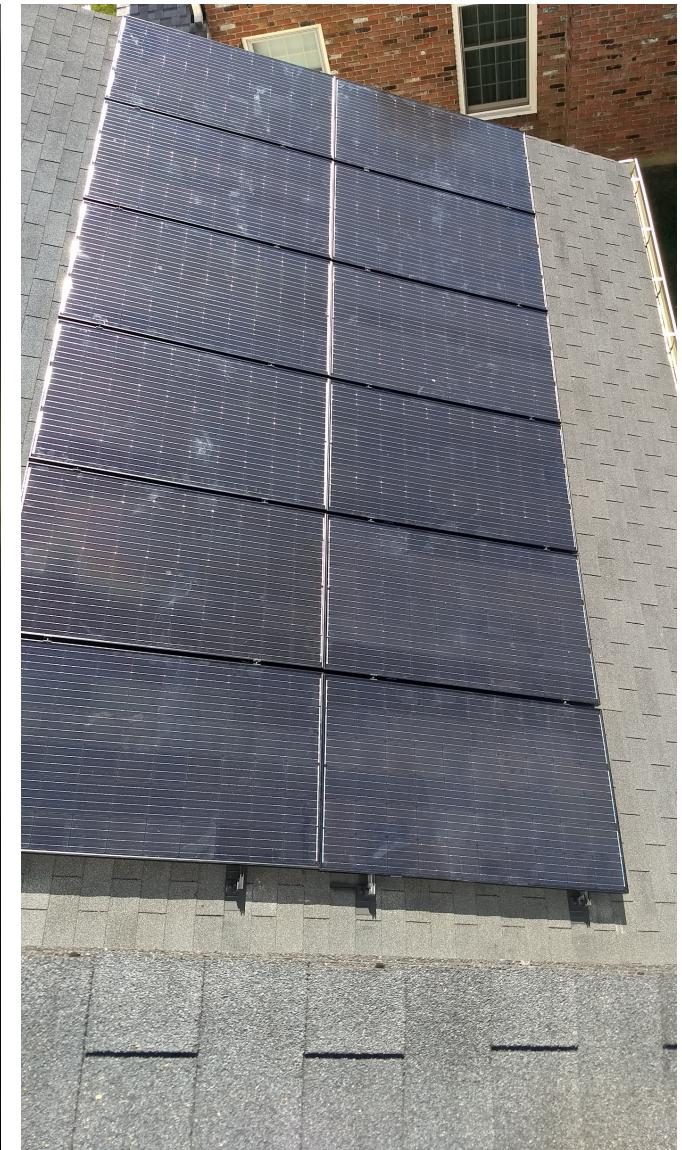
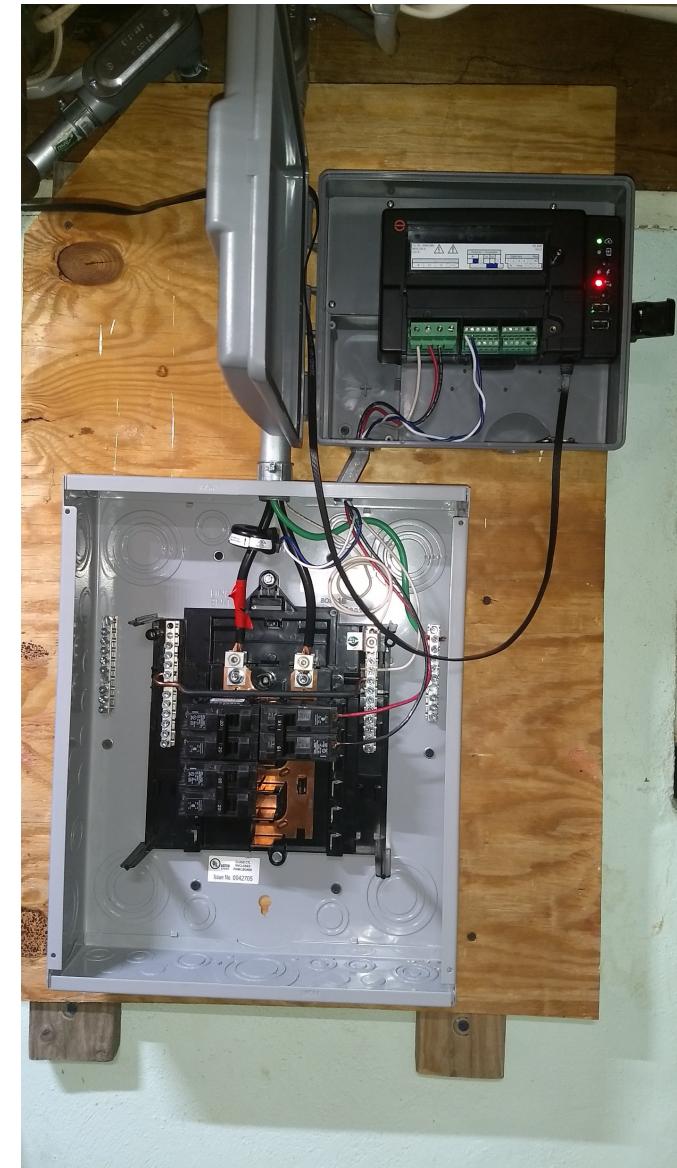
- Plan system
- Apply for net meter (See links)
- Get electrical permit (As a home owner, you can do electrical work except anything requiring a utility disconnection/ reconnection)
- Get building permit (Beware, if you have trusses you will need a structural analysis)
- Order parts
- Install system
- Get electrical inspection
- Get net meter
- Go live!







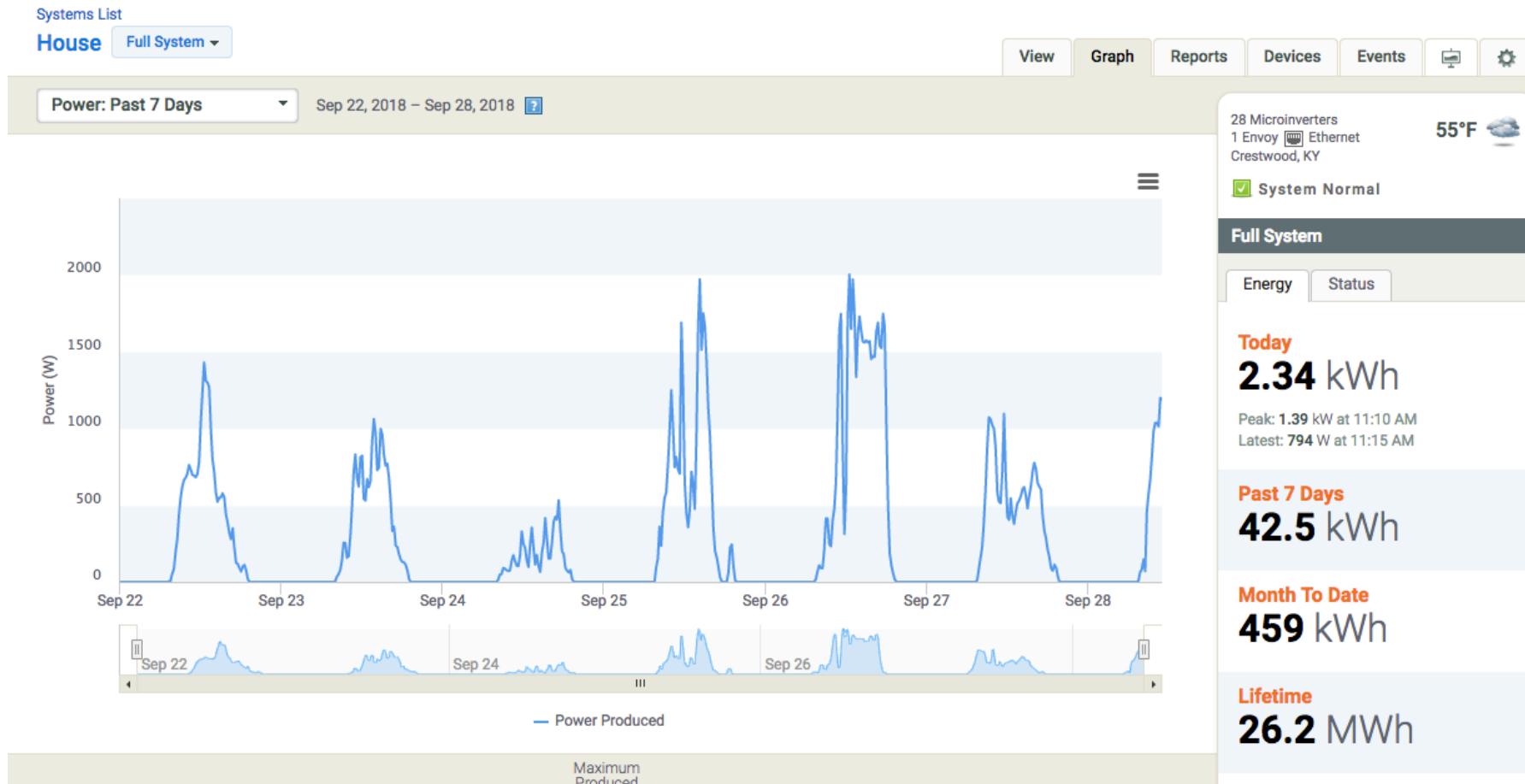




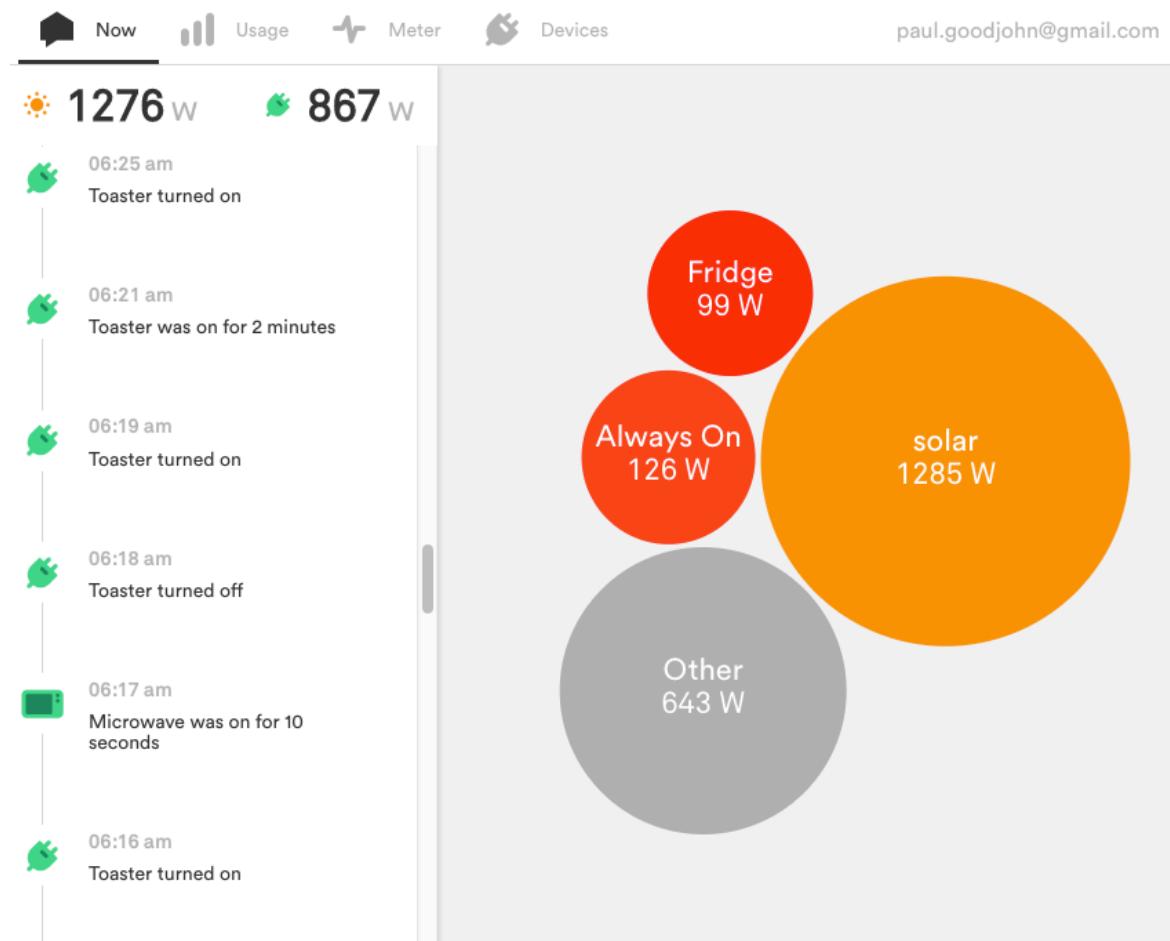
Suppliers

- <https://www.solarblvd.com/about-us/> low cost panels
- <https://www.anapode.com/content/Home> complete system kits
- <https://www.wholesalesolar.com/> low cost parts
- <https://www.invertersupply.com/> low cost racking and inverters
- <http://www.dudadiesel.com/solar.php> solar hot water systems
- And of course <https://www.ebay.com/>
- And my personal favorite: <https://louisville.craigslist.org/>

Toys – Enphase enlighten



Toys - sense

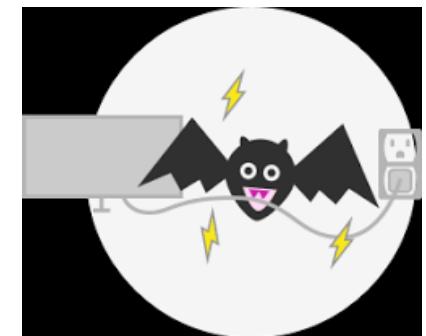


Quantifying the load



\$300

Installs in breaker panel so 240v and 120v
Takes time to learn devices in house
Shows you power use second-by-second
Will show you average cost per day/week/month/year of discovered devices



\$29.99

Installs between load and outlet for 120v devices
Only can monitor 120V loads
Shows you instantaneous power
Time on and total kWh use is stored
Will calculate cost per day/week/month/year

2020-SB100 is in effect!-Act NOW!



“6/2019: Exactly how long homeowners have to install a solar panel before the 25-year grandfathering goes away is unclear.

Starting Jan. 1, utilities like LG&E can ask the state’s Public Service Commission to change the one-for-one credit within their territories, and it usually takes the governor-appointed commission a few months to set new rates. Once the new compensation structure is in effect, new solar systems will be subject to it.”

- https://www.wdrb.com/in-depth/sunday-edition-will-kentucky-s-net-metering-rollback-kill-solar/article_00eddb4a-99e9-11e9-bc33-5f55aefde555.html



"The only change happening on 1/1/2020 is the allowable size system going from 30 kW to 45 kW. Per SB 100, each utility has to apply for and get approval from KY Public Service Commission for the compensation changes for any kWh going back on LG&E's grid. Our current plan is to apply with PSC in second half of 2020. Until the KPSC approval, all installed solar systems prior to that date will be grandfathered under current rate schedule for 25 years.

If you have any questions, please contact me.

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Questions?

