

# Designing & Sizing Your Solar Array

21.62 ft



# Solar Fundamentals

Whether you're building a solar home  
or installing solar collectors.

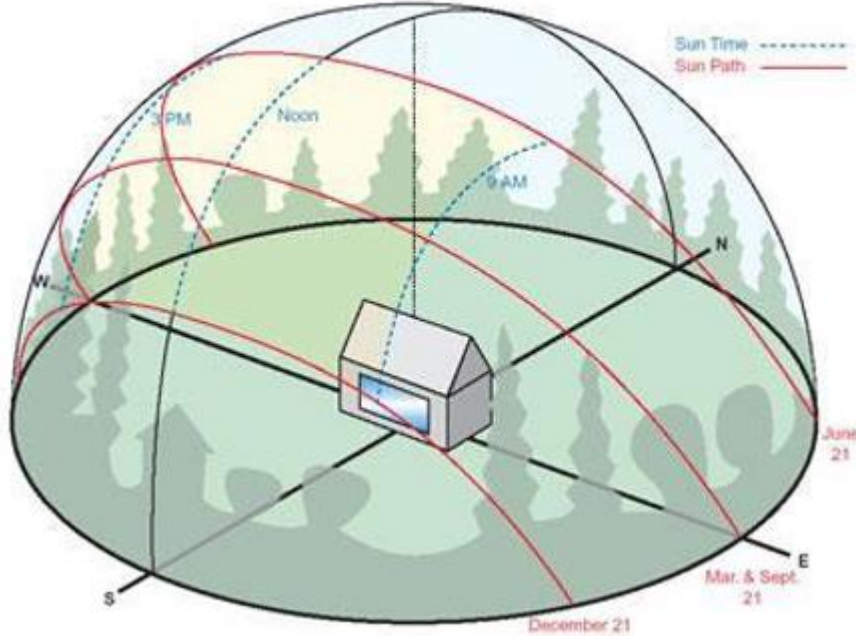
# Seasonal Sun Angles

Optimum yearly avg angle = your degree Latitude. But for Summer it is Latitude – 15° (flatter for i.e. air conditioning). And for Winter it is Latitude+ 15° (steeper for i.e. heating) But if you change the tilt in the PVWatts Calculator you'll see it won't make a big difference in pay-back.

What the graphic shows is that winter sunlight passes through more atmosphere and is weaker ...and that winter days are as we all know, shorter.

# Direction

South is best for overall production, but Southwest will face the period when we use the most energy for air conditioning and when its value to utilities is highest. But as long as we are not credited for that value in Time-of-Day pricing, it won't show up on your bill.



# Sun Surveyor

This app allows you to see the arch of the sun through sky on any day of the year for any position your smart phone is. Sun Surveyor provides powerful tools to **plan, predict, visualize shading by the sun.**

**Interactive Map** - Visual sun overlays, distance and elevation calculations, shadows.

**3D Compass** – gives you the solar array's azimuth (direction)

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*We also loan out a simple shadow tool called the Solar Pathfinder*



# PVWatts Calculator

PVWatts is the PV design tool underlying nearly all corporate solar design apps. You can start by using their default settings of 4KW (DC). That's about eleven 370W panels. Your electricity provider may charge more than the 10.5 cent default, so you can change that to also reflect Summer peak rates. The angle of tilt doesn't effect the outcome as much as the direction your array will face (Azimuth). S=180 degrees, W=270, E=90, just don't face your array North. You'll want an azimuth of between 90 and 270 degrees.

Click on the "Results" Arrow, and the table will show you both how many kWh your array will produce each month of the year, and a fairly good idea as the dollar value of that much electricity. Your house can probably use some multiple of the results of 4KW , so try increasing the KW capacity of your array by that multiple to see how the new results match your monthly electric usage.

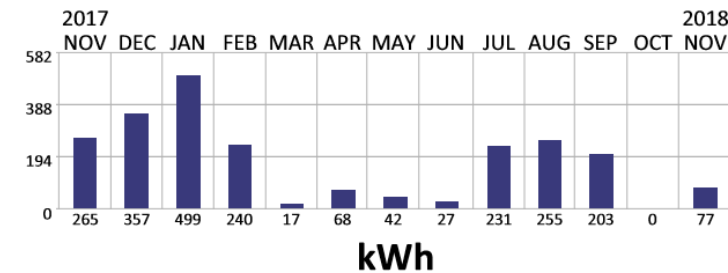
# Utilities don't want to buy your excess generation

- So size your system to not exceed you use during most months.
- Spring and Fall don't require either furnace fan or air conditioning, so if you size for July air conditioning then you will have excess in all other months.

## SUMMARY

Previous balance	\$15.45
Payments - <b>Thank you</b>	<u>-15.45</u>
Balance forward	0.00
Current charges	23.70
City franchise fee	0.94
Sales tax	<u>0.61</u>
<b>Total to be drafted December 6, 2018</b>	<b>\$25.25</b>

## 13 MONTH USAGE

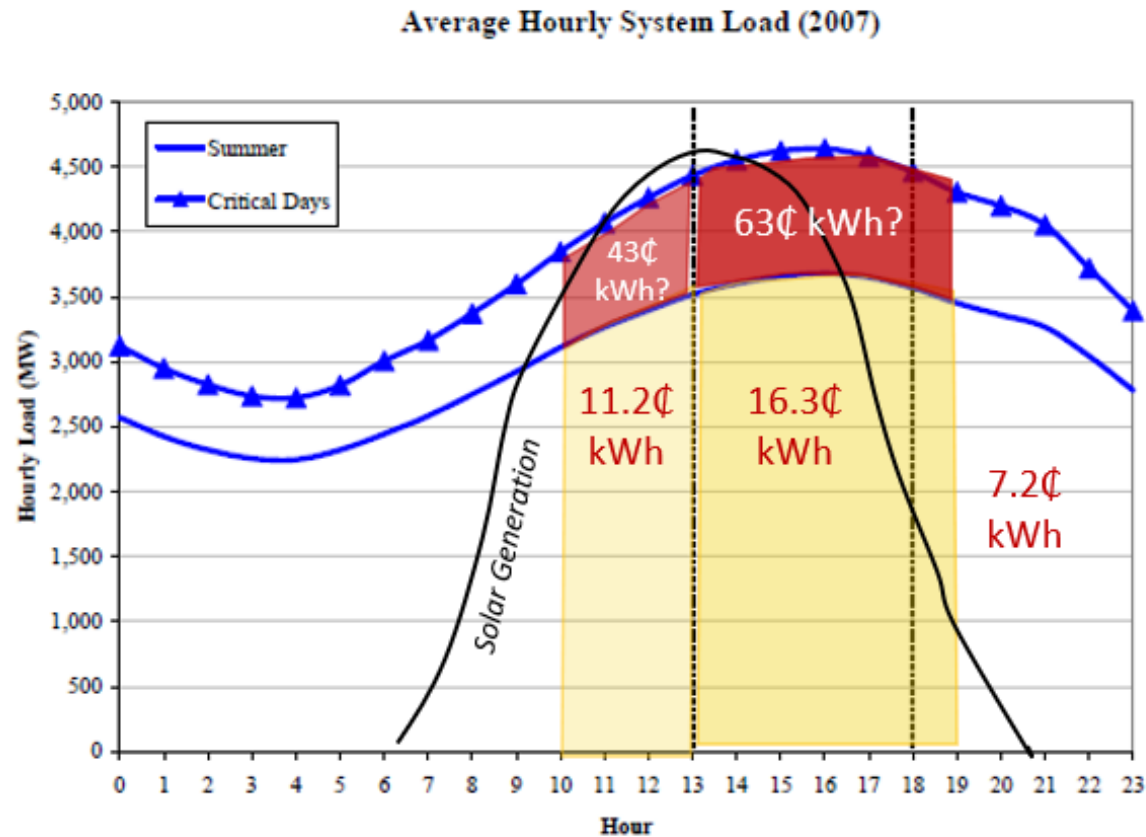


	Current Month	Last Month	Last Year
Days	29	29	29
kWh	77	0	265
kWh per day	3	0	9
Demand kW	7	7	7

*Note: this is not representative of most. We have 14 solar panels and don't have central air conditioning.*



## Value of Solar generation from the KCC-Westar TOU Pilot Study



So if the high value electricity is in the late afternoon, it would make sense to face the array to the SW to reduce your air conditioning load.

# Typical Array Locations

## Ground Mount



## Roof Mount



**Or Custom,**  
Use your imagination

One of the usually unknown advantages for roof mounting a system is that, it can cut your air conditioning by 30%.





## **Landscape Orientation**

You can place panels in “Portrait” or, “Landscape” orientation, and we usually mount them perpendicular to the run of the rails.

## **Portrait Orientation**







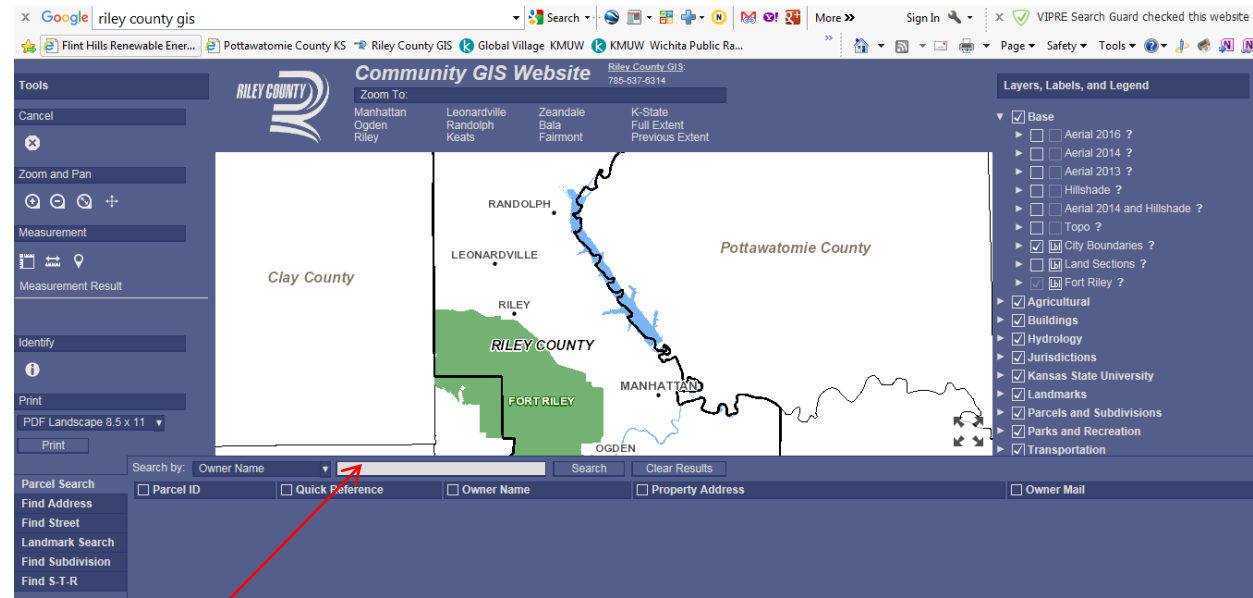
**Triangular Roof:**  
“Brick layout



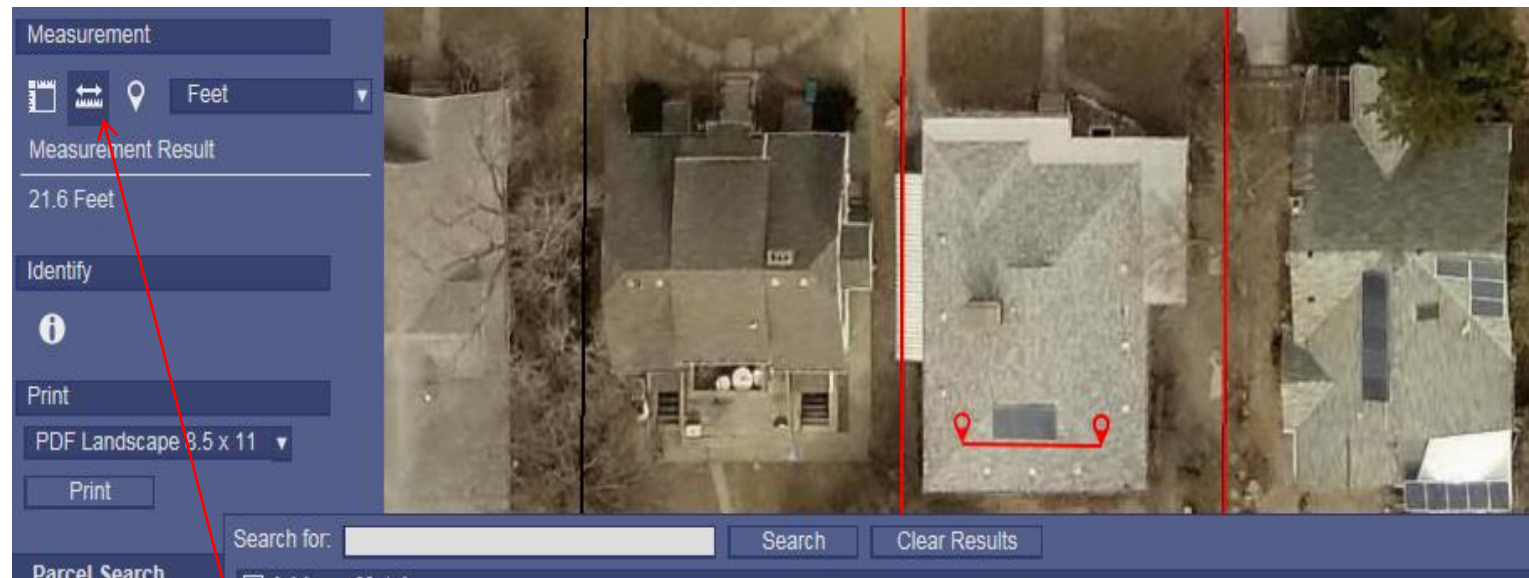
# Remote Measuring

[County GIS websites](#)

Choose Basemap Aerial 20



Search by your address and zoom in



Click and drag to get a measurement

# Array Sizing

## Rail Sizing, 340 Watt PV Panels, 78.25" X 39.33" X 1.57"

Panels in Portrait #	39.33 Inches	Rail Width Ft & In
1	42.33	3' 6"
2	83.66	7'
3	123	10' 2"
4	162.3	13' 5"
5	201.7	16' 8"
6	241	20'
7	280.3	23' 6"
8	319.6	26' 6"
9	359	29' 9"
10	398.3	33'
11	437.6	36' 3"
12	477	39' 6"
13	516.3	42' 9"
14	555.6	46'
15	595	49' 4"
16	634.3	52' 6"

L-Leg Spans		
UniRac		
<a href="http://www.unirac.com/">http://www.unirac.com/</a>		
RAILS ?	SM	SM-HD
MAX SPAN ?		
[portrait]		
Zone 1	96"	100'
Zone 2	96"	100'
Zone 3	96"	100'
MAX CANTILEVER ?		
[portrait]		
Zone 1	32"	32"
Zone 2	32"	32"
Zone 3	32"	32"

ASCE 7-10, IBC 2009

Wind Speed: 130 MPH

Snow Load: 10 PSF

\* Note that the spans work for all roof zones

Rails come in 11', 14', and 17' lengths  
Lengths can be spliced.

Portrait



Every 6 rafters on 16" OC  
Every 4 rafters on 24" OC  
So 8' spans work on most old or new roofs

Landscape



For a good measurement across your roof (not down the slope), Zoom in to your address, on Google Earth or your County's GIS website. Then use the measuring tool, dragging the cursor from one point across to the other on the roof you want to measure. Then compare to the chart on the left.

## Rail Span Chart

Looking at "Rail Width" in the third column, you can see how many panels will fit per row. If you use the "Landscape" table you can also see that two rows will fit in 13'6" of roof slope. In practice, we like to space rows 8" to 10" apart for air cooling. Add the number of panels for all your rows, and you can estimate the cost of all your solar hardware using our [Cost Estimate table](#). We'll buy back or supply extra at our cost.

## Cost Estimate Table

REC 380W with Enphase IQ7+ microinverters & Monitor						
# Panels	Price	After Tax	Watts	\$/W	* Return	ROI
4	\$ 2,961	\$ 2,191	1,440	\$ 1.52	\$ 247	11.3%
5	\$ 3,482	\$ 2,577	1,800	\$ 1.43	\$ 309	12.0%
6	\$ 4,004	\$ 2,963	2,160	\$ 1.37	\$ 371	12.5%
7	\$ 4,525	\$ 3,349	2,520	\$ 1.33	\$ 433	12.9%
8	\$ 5,047	\$ 3,734	2,880	\$ 1.30	\$ 494	13.2%
9	\$ 5,568	\$ 4,120	3,240	\$ 1.27	\$ 556	13.5%
10	\$ 6,090	\$ 4,506	3,600	\$ 1.25	\$ 618	13.7%
11	\$ 6,611	\$ 4,892	3,960	\$ 1.24	\$ 680	13.9%

*There will be additional cost of hiring an electrician to carry the line back to your breaker box which varies by house, so it's safe to add an additional \$1,000 to complete your system. His invoice also qualifies for Tax Credits.*



# Home Building while Thinking Solar

- 1. First is obviously to orient the house so the long axis of the house faces South or Southwest, and in a space that is likely to remain unshaded for the next 25 years.
- 2. The more efficient you design your home, the less power you will need to generate, process and store. And you might look at our most recent Cost Estimate and Rail Span tables (attached) to see how much room and budget you might need. Keep in mind that these systems are easy to expand.
- 3. Make sure that your electric panel is big enough to accommodate not only all your appliances and circuit breakers for uses in your house, but add another 20% amperage for the input onto your panel's busbar. And add extra spaces for additional branches, a 240V monitor, and to be ready for future storage capability. Just go with a 200Amp panel.
- 4. Leave enough room in your utility area for a sizable battery or other storage device (large thermal storage water tank)
- 5. Have your electrician run 1 1/2" conduit from the attic to the utility space so you can easily pull additional cable if you want.
- 6. Have the wire runs already installed, for most homes plan for two or if you are looking to an electric vehicle for example, three 13 solar panel branches. Today, our inverters only require a pair of 240V cables (L1 and L2), no ground or neutral and the wire gauge depending on the amperage and distance of the run, usually 10 or 8AWG.
- 7. New homes typically are followed with new landscaping. Make sure you don't plant big things that will shadow your array.