SolCast Analysis of Blue Ridge Farm

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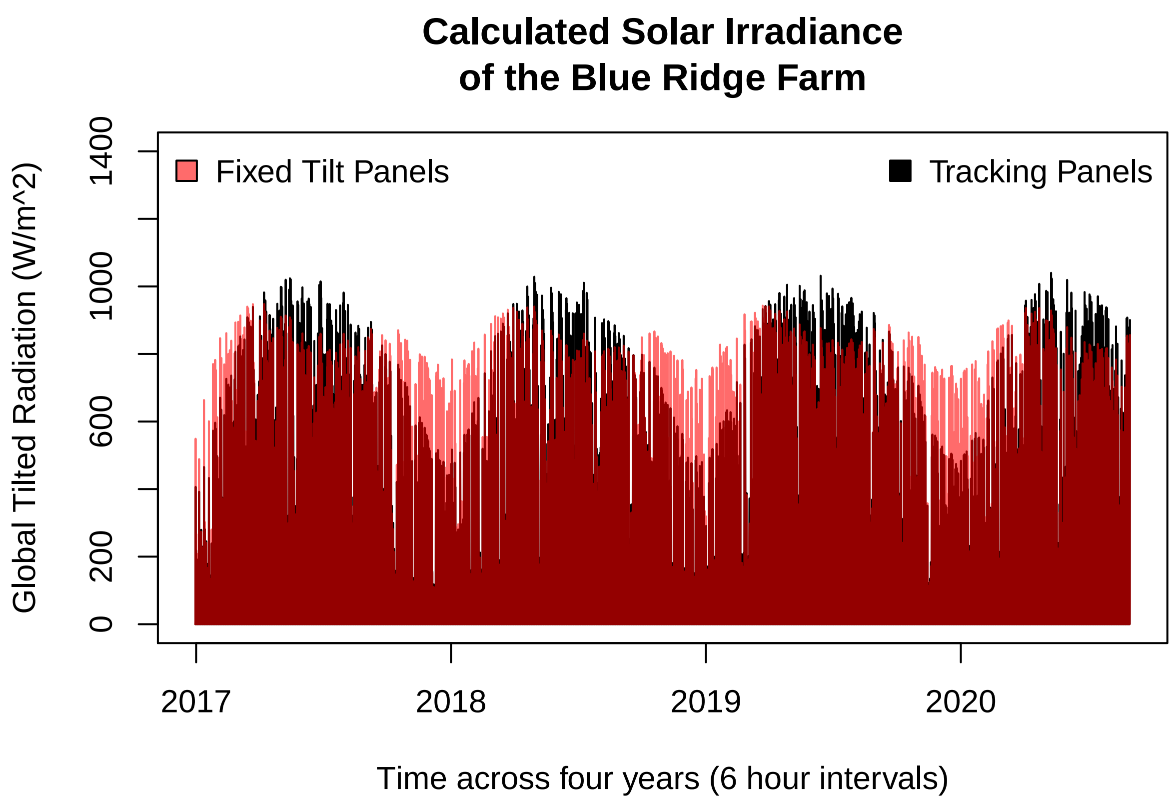
Introduction

We are interested in building a solar farm at Blue Ridge Rd in Chesapeake. This document is meant to analyze the physical parameters of such an installation. The data used here are solar irradiance and related data, all from a company called SolCast. Solcast uses satellite data combined with advanced meteorological models to estimate historical, current, and future irradiance of a given site. The error in their models tends to be low and is described in detail on their website: https://solcast.com/historical-and-tmy/validation-and-accuracy/ In brief, when compared to a ground measurement station that is close to the proposed site (a station in Hampton, VA), Solcast tends to overestimate irradiance by 1.14% and has an average error of less than 12% (Root mean squared error). The closest Solcast competitor has the same average bias and an average error that is over 2% greater.

Besides calculating solar irradiance, Solcast also calculates expected solar yields for utility scale installations. If a user uploads their site's power generation data, then Solcast's algorithms can learn how the site responds to cloud cover and other environmental factors. This produces better predictions for the given site and also allows for large maintenaince problems to be spotted. See this webpage for more information from Solcast: https://solcast.com/solar-radiation-data/inputs-and-algorithms/#pv-tuning-technology



The above figure is a calculation of what could have happened had we installed a solar system already. It calculates the power per square meter of solar panels across several years. The predictions are mostly based on solar irradiance and weather at the chosen location.

Looking at the above figure, you can see that the absolute amount of power we could generate depends on how many panels we could fit in the field. That in turn depends on their size and how big a shadow each row of panels would cast. Shadowing of one row of panels by another row is to be avoided as it can severely impact performance. If two or more panels are connected to the same DC/AC inverter, each panel will only output the power of the weakest panel in the link.

Let's consider a few possiblities just to gain some initial calculations. Given a panel that is 2 meters deep (300W Utility grade from Invensun), we could probably pack the rows of panels with 63.3 inches between them, assuming the average angle of the sun at this latitude. Assuming the worst case scenario, winter solstice, we could pack the panels with 154 inches between them. These are some wide numbers and the exact optimum for our location would require a search based algorithm that takes the above figure and a table of sun horizon and azimuth angles into account. I can write such an algorithm, given time, but let's start with this set of best/worst case numbers.

We have perhaps 50 acres upon which we could build the panels. This is my low estimate that assumes we cannot use the full acreage, due to tree shading and installation space for inverters/batteries. The Inversun panels are 39.0551 inches wide and will be about 63.3 inches deep if tilted to our latitude of 36.9º. If each panel requires another 63.3 to 154 inches behind them, then the total area needed for each panel will be between 4,944.376 inches^2 and 8486.673 inches^2. One square inch is $\frac{1}{1.5942*10^7}$ of an acre. Thus our min and max panel areas become $7.88*10^{-4}$ acres and $1.35*10^{-3}$. When divided across the 50 acres, we could install perhaps 37037 to 63451 300W panels.

Does that mean we'd get 300W times the number of panels? Not quite. 300W refers to the maximum output of the panels under ideal conditions. We have to consider the efficiency of the panels, which is likely around 20%. We also have to assume some loss of transmission efficiency, perhaps 10% loss. So our calculation will be $Number\ \ of\ \ Panels * m^2\ \ per\ \ panel * 0.2 * 0.9 * Irradiance\ \ per\ \ hour$

```
# Calculations using R code:
panel_area = 1.956*.992 # meters squared
low_end = 37037* panel_area*.2*.9
high_end = 63451*panel_area*.2*.9
fixed_tilt_low <- low_end*data$GtiFixedTilt # per hour basis
fixed_tilt_high <- high_end*data$GtiFixedTilt
tracking_low <- low_end*data$GtiTracking
tracking_high <- high_end*data$GtiTracking

#Summarize the MegaWatt/hours, remove the night hours (zero)
summary(tracking_high[tracking_high > 0])/1000000
```

```
##     Min.  1st Qu.   Median     Mean  3rd Qu.     Max.
##  0.02216  2.19395  8.82012  9.49364 16.37706 23.57942
```

```
summary(tracking_low[tracking_low > 0])/1000000
```

```
##     Min.  1st Qu.   Median     Mean  3rd Qu.     Max.
##  0.01294  1.28063  5.14839  5.54153  9.55946 13.76355
```

```
summary(fixed_tilt_high[fixed_tilt_high > 0])/1000000
```

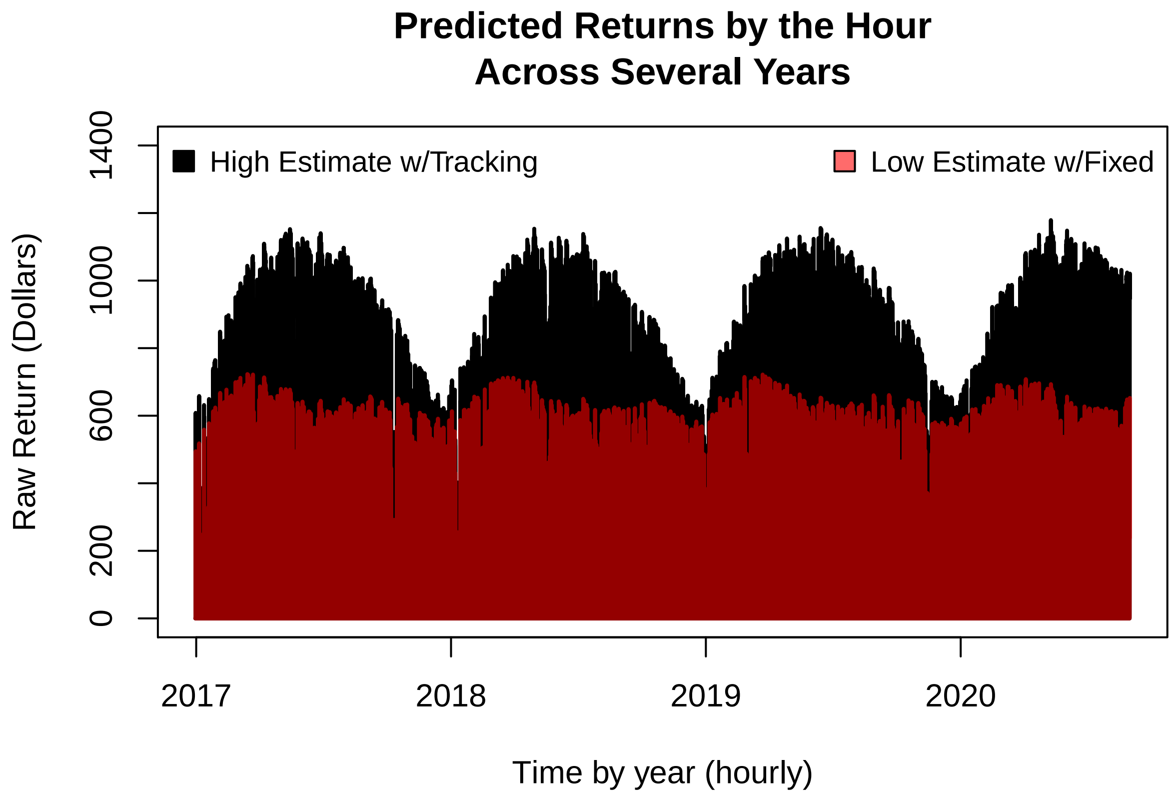
```
##     Min.  1st Qu.   Median     Mean  3rd Qu.     Max.
##  0.02216  1.97234  6.69266  8.33167 14.22743 24.77612
```

```
summary(fixed_tilt_low[fixed_tilt_low > 0])/1000000
```

```
##     Min.  1st Qu.   Median     Mean  3rd Qu.     Max.
```

```
## 0.01294 1.15127 3.90657 4.86328 8.30470 14.46208
```

At 5 cents per kW/h our monetary returns could be plotted as below:



The below table sums up the predicted returns for each year. Note that I pulled these data in September of 2020; hence, without the last three months it has less predicted return. Focus on the '17 – '19 results which all look relatively stable.

Year	High_Estimate	Low_Estimate
2017	2190836	1144270.4
2018	2158446	1116469.0
2019	2274045	1173516.0
2020	1642040	801437.7