# Solar Verification Project

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## INTRODUCTION

*Solar energy panels*

As we drain the Earth's fossil fuels, climate change increasingly puts pressure on scientists to find a cost-efficient renewable energy solution. A nation-wide system using weather resources already in place in combination with the construction of transmission lines and new electricity production sites is proposed. The model created optimizes this system with the projected electric load from 2006-2008.

My project is to collect publicly accessible solar irradiation data for those three years in sites across the contiguous US, analyze the model data vs. the observed data, and verify the model's predictive accuracy.

## MATERIALS & METHODS

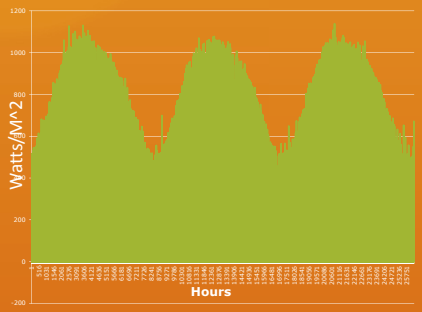
I chose ten sites across the U.S. to collect Global, Direct, and Diffuse shortwave solar irradiation data from 2006-2008. Five of these sites were from the University of Oregon, two from NOAA, two from NREL, and one from ARM.

*Device used to measure Global shortwave solar irradiation data at NOAA's SURFRAD observation site in Boulder, CO*

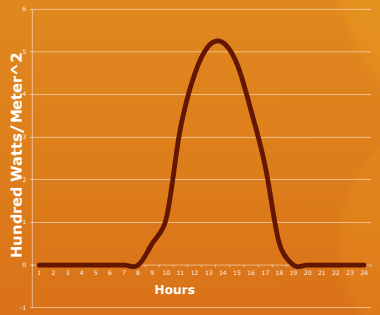
Sites were chosen primarily according to the availability of reputably sourced data during 2006-2008. I also took location into consideration and tried to get a representative spread over the contiguous U.S. Unfortunately the ARM data from Ringwood, OK was so low quality , I was unable to use it in my research.


*Map of ten data collection sites*

The model data is hourly, and some of the data I collected had been taken every 3, 5, or 15 minutes (varying depending on the site). In order to compare the observed data with the model, I matched up timestamps and averaged the datasets over the top of the hour by adapting a computer program written by Dr. Clack in IDL.




*3 years--2006, 2007, & 2008--of global solar irradiation data from the NREL observation site in Golden, CO. Irradiance peaks in summer and is much lower in the winter months of each year.*




*24 hours (midnight to midnight) of global solar irradiation data from the NREL observation site in Golden, CO. The peak is around 2:00 in the afternoon.*

## RESULTS

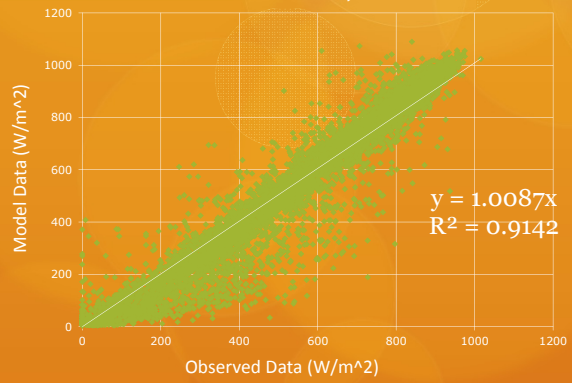
Results show that all nine sites' observation data generally fit with the model data. Specifically, Penn State PA showed a strong positive correlation between the model data and observed data for global irradiance over the three years, $r(12135)=.81$, $p<.001$*. Global observation data from Hanford, CA was also strongly correlated with the model data from 2006-2008, $r(5909)=.96$, $p<.001$*. The model performed more effectively over summer months compared to winter months, with summer $R^2$ values averaging 7.714% higher than those in winter across the nine sites.

*Where r(N)=x indicates N data points with a correlation coefficient of x, and p represents statistical significance.

This material is based upon work supported by the S.D. Bechtel, Jr. Foundation, National Marine Sanctuary Foundation, Carnegie Corporation of New York, and/or National Science Foundation under Grant Nos. 0952013 and 0833353. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the funders.

The STAR program is administered by the Cal Poly Center for Excellence in Science and Mathematics Education (CESaME) on behalf of the California State University.

### Hanford, CA




*Regression between model data and observed data from NOAA's observation site in Hanford, CA. Represents the correlation between the two data sets, i.e. to what extent the values are alike.*

## DISCUSSION

Summertime measurements are more accurate than those obtained in the winter months due to the effect of cloud cover on measurement devices such as the one pictured to the left (*see Materials & Methods)*. It was to be expected that the model perform more effectively in summer months compared to winter months, which is ideal for the proposed renewable energy system: solar power is most significant in summer months, while wind energy meets a larger proportion of the load in winter.

The next step in this endeavor is to integrate the data into the model's regression and see if the model improves. Improvement would be predominantly defined as a decrease in error. The model is expected to improve significantly, particularly when a site in the northwest is added, because the model lacked a data source from that area until now.