UNIVERSITY OF CENTRAL FLORIDA
Concentrating Solar Power Program

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Description: Solar concentrating systems use mirrors to focus sunlight onto receiver pipes at the focal point of the mirrors and are one of the lowest-cost centralized solar power options. After many years of applications, solar concentrating technology has the ability to produce electricity for about $0.10/kWh in the desert southwest. This technology holds high promise for Florida and could also produce low cost solar electricity assuming it can meet production goals. The objective of this R&D project is to advance concentrating technologies by conducting an analytical study of Florida solar resource in order to predict the performance of the concentrating solar application and then to perform experimental test and evaluation of the predicted results.

Budget: $52,000
Universities: UCF/FSEC
External Collaborators: FPL

Progress Summary

The project consists of two tasks:
Task 1. Determine the solar resource for any designated installation site in Florida.
Task 2. Calculate the expected amortized cost of energy that would be produced from that site given its location and the solar concentrator equipment anticipated to be installed at that site.

The effort of the past months has focused on the completion of Task 1: The determination of the solar resource for any designated installation site in Florida. These systems have been previously installed in the desert southwest where direct beam data has been accumulated over many years. A problem was identified – the lack of validated direct beam measurements for the State of Florida.

Literature Search Completed: Various methodologies to resolve the problem were investigated through literature search. Over 40 published papers were reviewed for information on the determination of the direct beam resource and the establishment and validation of predicting equations. The five most appropriate to the task, providing validated equations, were used to select the most appropriate analytical approach for Florida.

Method Selected: The Heliostat-2 method was selected as the most viable to provide validated direct beam historical data for Florida. This method (developed a few years ago by Ecole de Mines de Paris) basically consist of using two parameters, turbidity (atmospheric conditions), and elevation as input, to provide an estimation of the total, beam and diffuse radiation based on a "clear sky model". That is, the amount of direct beam and diffuse radiation that would reach the ground for a totally clear sky, given location, time of year, and time of day. The calculation protocol begins with a calculation for the "extra terrestrial insolation value." The air mass is then calculated given the altitude of the site and surface barometric pressure. The turbidity (absorption and scattering) of the air mass is then calculated based on ground temperature and humidity which is used to derive the "clear sky" data. Satellite weather data is then used to modify the clear sky data to provide monthly direct beam averages.

Programming of Algorithms Underway: It was determined to program the equations for each stage in the calculation sequence into two separate calculation platforms: Matlab and Excel. Matlab was selected for its ability to handle and manipulate the very large number of matrices needed to make the calculations for the entire data base. Excel was selected to provide a step by step visualization of each calculation, for a single pixel and time, as a check on the programming and matrix manipulations of Matlab. Turbidity calculations have been completed and published for Europe, but are not available for the US or Florida. Thus, this must be part of the calculation sequence for the model. Programming for the model on these two platforms has been the predominate effort of the past months.

The Excel main file has been created. This program has as input the variables of: year, month, day and hour, latitude and longitude, turbidity and elevation. It calculates from the external radiation values, clear sky values of direct beam, global, and diffuse radiation values. This model now uses generalized turbidity values. The next step is to develop a localized turbidity model for input to this algorithm.