Problem Statement: Should the solar voltaic panels on top of Shiley Hall be changed to a different angle?

Background: The Shiley Hall solar panels consist of twenty-two SolarWorld 250 photovoltaic panels. They are currently mounted at 22 degrees from horizontal and pointed south. The panels generate a total of about 5880 kWh per year. The electricity generated by the panels reduces the amount of electricity that the university must purchase from the power company, which charges $0.1046 per kWh.

Resources: The file HourlyIrradiance.xlsx contains simulated values of total irradiance (in watts per square meter) for a similar panel (SolarWorld 320) for a typical meteorological year in Portland, Oregon for tilt angles between 1 and 90 degrees, where 1 degree is (almost) flat against the roof facing upward. Each column in the file represents the total irradiance for a given angle over the course of a year. Each row in the file represents the total irradiance at a given hour during a typical year for angles from 1 to 90 degrees. For example, the row labeled Hour 0 is the total irradiance for the single hour following midnight of January 1. The row labeled Hour 12 is for the single hour following noon on January 1. (Thanks to the UP Environmental Studies department for supplying the data file.)

The MATLAB command xlsread can be used to load an Excel file into MATLAB.

Note that a Watt is a rate of energy production, so the amount of energy that is produced is the rate (in Watts) multiplied by the time of production. Hence, a Wh (a Watt-hour) is one Watt of production for a period of one hour. Also note that we have not measured the size of the Shiley panels and their condition (cleanliness, shadows, etc.), so their irradiance will differ from those of the xlsx file. You can use the file, however, for judging the *relative* effect of the angle on irradiance and the *relative* effect of angle on monetary value of the electricity produced. So if the file shows that changing the angle will increase the irradiance by say 1%, then it is reasonable to assume that changing the angle of our solar panels will also increase the power by 1%.

Explore the data: Before analyzing a set of data, you should explore the data to understand its form and meaning. How is the data arranged in the file? How many row and columns? Is the data numeric? Are any values missing? What type of information is in the first row and first column, and does this information need to be deleted? After exploring the form of the data, you should then explore meaning. For a given hour, make a plot of the irradiance as a function of angle. For a given angle, make a plot of the irradiance as a function of hour over a day or a week. What general trends do you see?

Procedure: Write a MATLAB script called solarPanel.m that determines the best angle. If the best angle is different from the current angle, also determine the difference it would make (in terms of money, environmental impact, etc.) if the panels were changed to the best angle. Also, determine whether it would help if the angle were changed periodically throughout the year. Put comments in your script file to document your analysis.

Other Considerations: Also consider economic, safety, environmental, and ethical factors that relate to the decision to change the solar panel angle.

Deliverables: Please upload the following items to Moodle (one submission per team):

1. Your team's script file solarPanel.m.
2. A short memo (in .pdf format) designed to persuade an administrator such as UP President Fr. Poorman. Include the following items:
    a. the best angle and the possible impact of changing the angle
    b. your recommendation to either change the angle or to not change it
    c. the relevant economic, safety, environmental, and ethical factors