Solar Energy Analyser and Predictor

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Abstract

India is third largest electricity producer in the world, but 68% of this is produced by thermal plants [1]. Being in the tropical region, India enjoys high solar radiations throughout the year which is conducive for producing solar energy. This paper involves the concepts of Data Science and Machine learning to calculate the Energy Payback Period for a solar setup that is a good home/industrial solution to produce clean energy without any fuel.

Keywords

Solar energy, solar radiations, energy prediction, renewable energy, energy payback period.

I. Introduction

India's electricity production grew 34% over seven years and now ranks number 3 globally in electricity production [2]. Renewable energy hold a 29% share in this production and is fast emerging as a major source of power in India. The subcontinent plans an increment in this share with an objective to install 20 gigawatt (GW) of solar power capacity, to give a boost to manufacturing of solar power equipment in India [3]. India has also raised the solar power generation capacity addition target by five times to 100 GW by 2022. The Union Government of India is preparing a 'rent a roof' policy for supporting its target. This project used a Dataset of solar radiations in Utah to predict the total power the solar setup may generate in a year and to further estimate the Energy Payback Period (EPP) for the setup.

II. Procedure

A. Collection of Irradiation Dataset:

At first, the dataset containing irradiation (W/m^2) was downloaded [4] and imported to Jupyter Notebook (an IDE for Python programming) in .csv format.

B. Analysis of the Dataset

Systematic data analysis and graph plots (Figure 1.1 and 1.2) so as to understand the irradiation trend. These plots are later fed to Machine Learning algorithms.

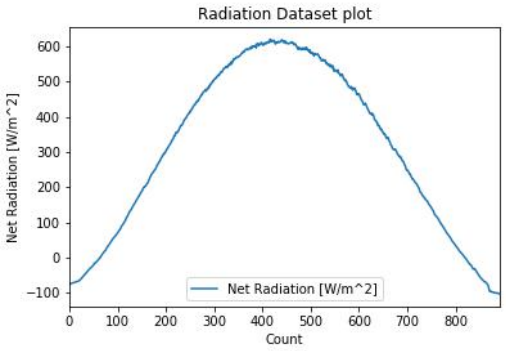

Figure 1.1: Radiation Dataset Plot

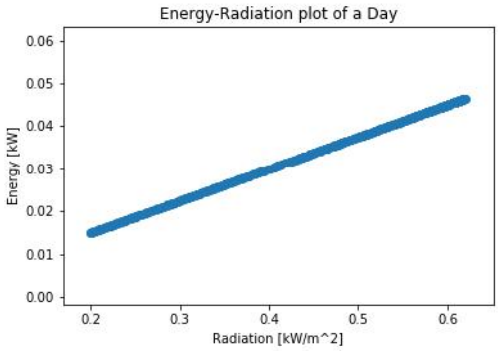

Figure 1.2: Energy-Radiation plot for a day

C. Prediction of Energy Payback Period

75% data was taken to train and 25% to test the efficiency of the algorithm. By using Linear Regression mathematical model to train the machine, a graph was generated depicting the distribution of estimated irradiation throughout the year. Energy was then calculated using the following formula [5]:

$$E = A * r * H * PR$$

E = Energy (kW)
A = Solar panel Area (assumed value 1 m^2)
r = solar panel yield or efficiency (%)
H = Annual average solar radiation on tilted panels
PR = Performance ratio (assumed value = 0.75)

These daily values of estimated energies were then added for the whole interval of 365 days to calculate the yearly energy estimate. Then taking into assumption the cost of solar setup to be Rs. 500,000 [6] and cost of one unit electricity (1 kW) to be Rs. 7 [7], the Energy Payback Period (EPP) [8]was calculated. On the dataset taken into the project it comes out to be 10 years and 3 months which is close to the tested value. [9]

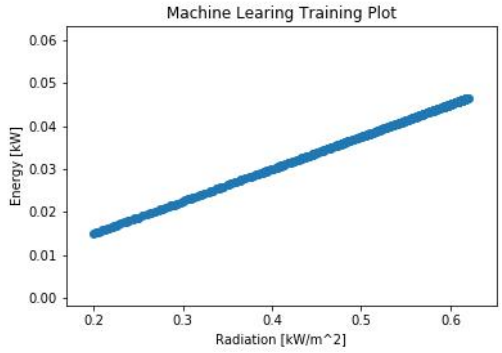

Figure 3.1: 80% Data plotted for training

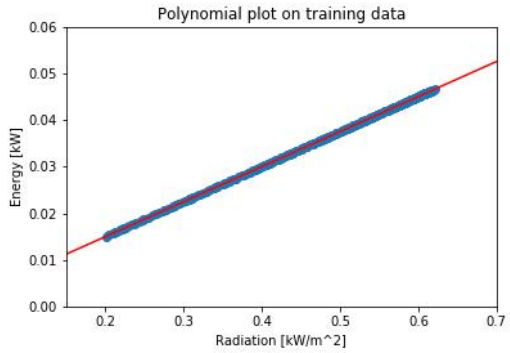

Figure 3.2: Polynomial plot for trained data

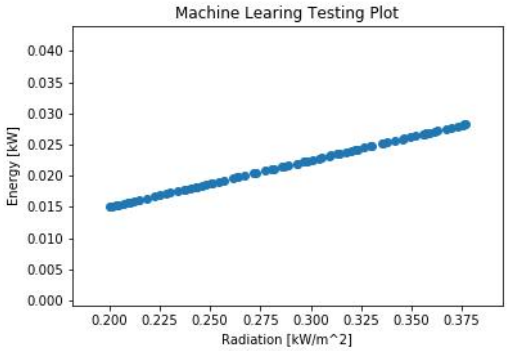

Figure 4.1: 20% data plot for efficiency of the algorithm used

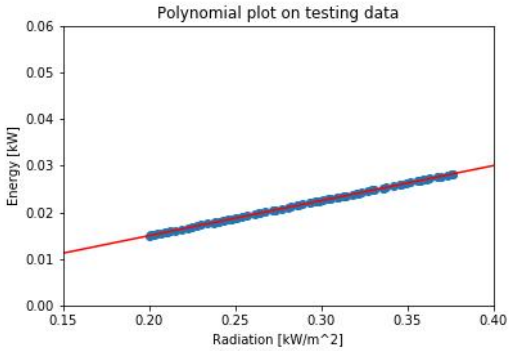

Figure 4.2: Corresponding polynomial plot for 20% test case data

III. Conclusion

With a vision of ensuring 24x7 affordable and quality power for all by March 2019, the Government of India has been supportive to growth in the power sector with major emphasis on the renewable energy vertical. The most feasible form of renewable energy in terms of area required for application, setup cost and other geographical factor is Solar Energy. India has a huge potential to harness this Energy due to its strategic placement in the tropical region.

IV. Future Scope

All the developed countries have announced or are on the verge to announce the shutdown of their thermal power plants due to limited petroleum supplies and high degree of pollution.[10] It's time India takes this step forward by minimalistic usage of petroleum based energy and covering this deficit by more and more usage of Renewable Energy Sources.

V. References

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