Solar PV Estimate for India by 2050

Abstract—**This endeavor is driven by the noble purpose of formulating a comprehensive assessment for India's potential solar PV capacity in the year 2050. This ambitious undertaking embraces a symphony of intricate factors, including the sun's daily bestowal of irradiance upon the land, the efficiency of solar panels, the temporal span of analysis, the projected population of India by 2050, and the proportion of the nation's expanse that could be adorned with solar farms.**

I. INTRODUCTION

The wellspring of inspiration behind crafting an estimation for India's plausible solar PV potential in the year 2050 finds its origins in MacKay's meticulous calculations pertaining to the conceivable solar PV potential for the United Kingdom.

II. CALCULATION OF THE FACTORS DETERMINING THE SOLAR PV POTENTIAL IN INDIA

A. Average Irradiance in India per day

In order to formulate a projection for India's conceivable solar PV potential in 2050, the initial step entails the collection of data regarding the average daily irradiance bestowed upon the nation. The annual irradinace in India varies from 1600-2200 kWh per square metre. Let us take 2000 kWh per square metre per year for the ease of our calculations. Around 25 percent annual diffuse irradiance (DHI) has been indicated by IMD in most of the Indian locations, which brings the figure down to 1500 kWh per square metre per year. To get a value for daily estimate, we divide this figure by 365, which comes out to be 4.1 kWh per square metre per day. On a cloud-free day, the ratio of the average intensity to the midday intensity is about 0.5/1.1, which nearly comes out to be 45%. This brings the average daily irradiance value down to 1.86 kWh per square metre per day. The data of percentage daylight hours for India is not directly available. But the statistics for a few Indian cities is available. So to make a rough estimate for India, we can take the average of the percentage daylight hours of these cities, since the distribution of these cities on the map is fairly widespread. The following are the precentages of daylight hours for different Indian cities: Delhi-65.2%, Chennai-62%, Mumbai-61.1%, Bangalore-56.1%, Kolkata-59.5% and Hyderabad-65.6%. Taking an average, we get the average daylight hours percentage in India to be 61.58%. Taking this into account also, we conclude that the average irradiance received in India is **1.15 kWh per square metre per day**.

B. Population of India by 2050

According to the resources available on the Internet, the population of India is expected to reach **166.8 crore** by 2050. This number will be used to determine the per person estimate of solar PV potential.

C. Efficiency of the solar panels

According to the resources available on the Internet, the efficiency of the solar panels by 2050 would be somewhere around 20-30%. Let us assume the efficiency to be **20%** in order to account for other economic considerations that we have ignored.

D. Total area coverage of solar farms by 2050

According to the resources available on the Internet, the amount of land that would be covered by solar farms in India by 2050 is approximately 50,000-75,000 square kilometres. To account for other economic and political factors, let us take this number to be **50,000 square kilometres**.

E. Time Duration of Analysis

Ideally, we should take time duration to be **24 hours**, but the data we have for irradiance already has kWh per square metre per day unit, so the time duration has already been taken care of there.

III. CALCULATION OF THE PV POTENTIAL

From MacKay's book, we have the following formula for estimating the total conceivable solar PV potential of India in 2050:

$$SolarPV = ((TotalFarmArea) * (Irradiance) * (efficiency) * (AnalysisDuration))/(Population) \quad (1)$$

Plugging in the values in the above formula from the factors derived earlier, we get the total conceivable solar PV potential of India in 2050 as:

6.89 kWh per person per day or **2514.85 kWh per person**

IV. REFERENCES

1) Average irradiance in India - Link
2) Ratio of midday intensity to peak intensity - Link
3) Daylight hours percentage for various cities - Link
4) Population of India by 2050 - Link
5) Efficiency of solar panels - Link
6) Total area coverage by solar farms by 2050 - Link