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Comparative Study of Selective Locations (Different region) for Power Generation from Solar Energy in Gujarat

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ABSTRACT

The sun is the primary source of energy. The sun, which is the largest member of the solar system,is a sphere of intensely hot gaseous matter having a diameter of 1.30 x 10^9 m, and at an average distance 1.495 x 10^{11} from the earth. An definite knowledge of the solar radiation distribution at a particular geographical location is of huge importance for the progress and development of many solar energy devices and for estimates of their performance as well as install new solar power plant. In this study, the measured or estimate data of global solar radiation on a horizontal surface and number of Bright Sunshine Hours (BSH) for Gujarat was analyzed of different locations. The solar energy potential (BSH) of several locations in Gujarat is received by compiling data from Agricultural Universities,Anand, S.K.Nagar, Navsari and Junagadh. These Universities are located in different region central Gujarat,North Gujarat,South Gujarat and Saurashtra respectively. Forecasting of power generation from weibull probability density function. Measured data put in the equation of weibull probability density function and find out shape parameter and scale parameter. After apply the Statistical test Corelation-coefficient (R^2) and analysis the data for preference of selective locations.

Keywords*: Global solar radiation, Primary sources,. Corelation-coefficient (R^2), weibull probability density functio, Bright sunshine hours (BSH),solar energy potential*

I.INTRODUCTION

Solar energy is a very large, inexhaustible source of energy. The power from the sun intercepted by the earth 1.8 x 10^{11} MW which is many thousands of times larger than the present consumption rate on earth of all commercial energy sources. This makes it one of the most promising of the unconventional energy sources. In addition to its size, solar energy has two other factors in its favour. First unlike fossil fuels and nuclear power, it is an environmentally clean sources of energy. Second it is free and available in adequate quantities in almost all parts of the world where people live.

Solar radiation has been recognized as the prime renewable resource on earth. The energy source is more evenly spread in the Sunbelt of the World than wind or biomass, allowing for more site locations. The maximum strength of solar radiation at the earth's surface is about 1.213 kW/ m^2 but it is encountered only near the equator on clear days at noon. Under these ideal conditions the total energy received is from 5-7 kWh/m^2 per day. Solar energy is not continuously available because of the day-night cycle and cloud cover. Its intensity varies according to season, geographical location, and position of the collector .Studies on solar radiation have become an important issue for renewable energy issues stemming from oil crises, global warming and other environmental problems, thus increasing the need of reliable and accurate measurements of surface solar radiation. An estimate of the global solar radiation was then obtained through the well-known Angstrom–Prescott equation Although pyranometers and sunshine recorder are nowadays available to directly measure the global solar radiation, the sunshine duration is still an essential climatologically parameter that is still monitored in many meteorological stations. Proposed first theoretical model for estimating global solar radiation based on sunshine duration. Angstrom-type model make it possible to calculate monthly average of the daily global solar radiation on a horizontal surface from monthly average daily total insolation on an extraterrestrial horizontal surface. For estimating the global solar radiation based on longitude, latitude and routinely available meteorological parameter observed value of these meteorological parameters for global solar radiation (GSR) estimation review of some literature reviews reveals that mostly the efforts are to develop an estimation model for a single location or a group of locations for a small region.

II. STUDY AREA

Gujarat is a state in the western part of India. Geographically, Gujarat has the following coordinates: 20° 6' N to 24° 42' N (north latitude) and 68° 10'E to 74° 28'E (east longitude). The boundaries of Gujarat are surrounded by the Arabian Sea in the West. Rajasthan in the North East, Madhya Pradesh in the East and Maharashtra in the South East. It shares a common border with Pakistan on the Northern side. It has an area of 1,96,204 km^2 with a coastline of 1600 km with the longest coast line.(Govt. of Gujarat, 2014). The population of Gujarat State was 60,383,628 according to the 2011 census data. Gujarat is counted among the fastest growing Indian states in terms of economy. The following locations of four region of Gujarat are selected for the research work for solar radiation and bright sunshine hours analysis. The detail coordinates are as follows.

Sir No.	Name of Location	Name of region	Latitude ^{0}N	Longitude ^{0}E	Elevation (m)
1	Anand	Central Gujarat	22.32	73.00	197
2	S.K.Nagar	North Gujarat	24.12	72.28	201
3	Navsari	South Gujarat	21.07	73.4	222
4	Junagadh	Saurashtra	21.31	70.36	55

The data were collected from the various agricultural Universities located at Anand, S.K.Nagar, Navsari, Junagadh for detail analysis.

II. MATERIALS AND METHODS

(1)Method of Estimating of Global Solar radiation base on BSH(Measured):

In this present study, data of the monthly mean of daily global solar radiation and sunshine duration from Agricultural universities of study locations were collected and utilized. The data obtained cover a period of five years (2009-2013). The first correlation proposed for estimating the monthly average daily global radiation is based on the method of Angstrom-Prescott type regression equation-related monthly average daily radiation to clear day radiation in a given location and average fraction of possible sunshine hours is given by,

$$\frac{H}{Ho} = a + b\frac{S}{So} \quad \text{(1)}$$

where H is the monthly average daily global radiation on a horizontal surface (Kwh/m²/day), H_o the monthly average daily extraterrestrial radiation on a horizontal surface (Kwh/m²/day), S the monthly average daily hours of bright sunshine, S_o the monthly average day length, and "a" and "b" values are known as Angstrom constants and they are empirical. The monthly average daily extraterrestrial radiation on a horizontal surface (H_o) can be computed from the following equation (2).

$$Ho = (24/\pi)I_{sc}\,[1+0.033\cos(360n/365)]x[\cos\phi\cos\delta\sin\omega+(2\pi\omega/360)\sin\phi\sin\delta] \quad \text{(2)}$$

Where I_{sc} is the solar constant (=1367 W/m^2), ϕ the latitude of the site, δ the solar declination, ω the mean sunrise hour angle for the given month, and n the number of days of the year starting from the first of January. The solar declination (δ) and the mean sunrise hour angle (ω) can be calculated by the following equations (3) and (4) respectively in equation (2):

$$\delta=23.45\sin[360\,x(284 + n/365)] \quad \text{(3)}$$

$$\omega = \cos^{-1}(-\tan\phi\tan\delta) \quad \text{(4)}$$

For a given month, the maximum possible sunshine duration (monthly average day length (S_o) can be computed by using the following equation (5).

$$S_o = 2 / 15\ \omega \quad \text{(5)}$$

IV. WEIBULL DISTRIBUTION

(1)Frequency Distribution of Solar radiation:

The Weibull distribution has been found to fit a wide collection of recorded radiation data**.** In this paper, the Weibull method is used. The Probability density function of the Weibull distribution is given by,

$$f = (k/c)\,(r/c)^{k-1}\exp(-(r/c)^{k}) \quad \text{(6)}$$

Where r is the solar radiation, k is a shape parameter, and c is a scale parameter determined from the data. These parameters allow the calculation of the expected monthly and annual, solar power density per unit area in a given area. The corresponding cumulative probability function of the Weibull distribution is given by:

$$f(v) = 1-\exp(-(r/c)^{k}) \quad \text{(7)}$$

For this present work, the scale and shape parameters were estimated using standard deviation method (SDM).

Determine the k and c from the following equation:

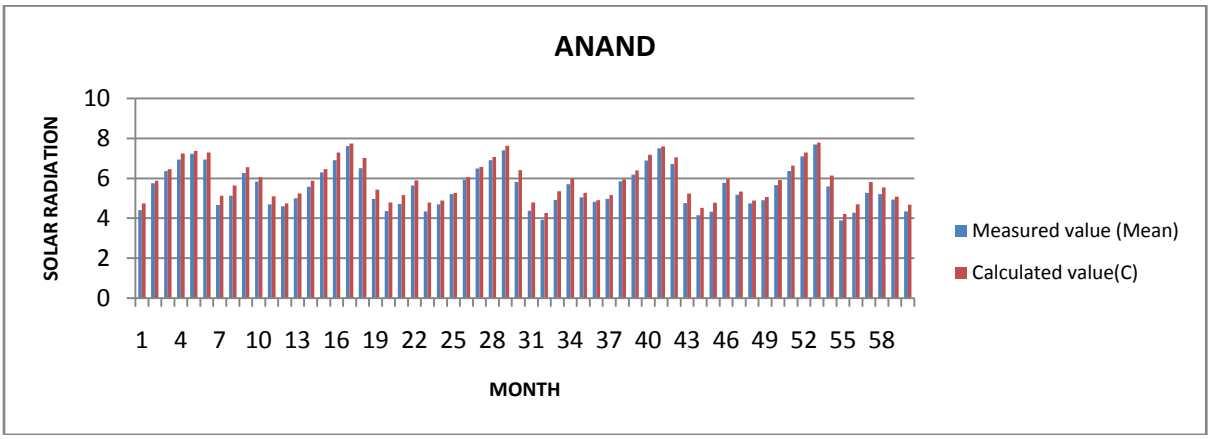
$$k=(\sigma/r_{mean})^{-1.086} \qquad c = r_{rmean}/\,\Gamma(1+1/k) \quad \text{(8)}$$

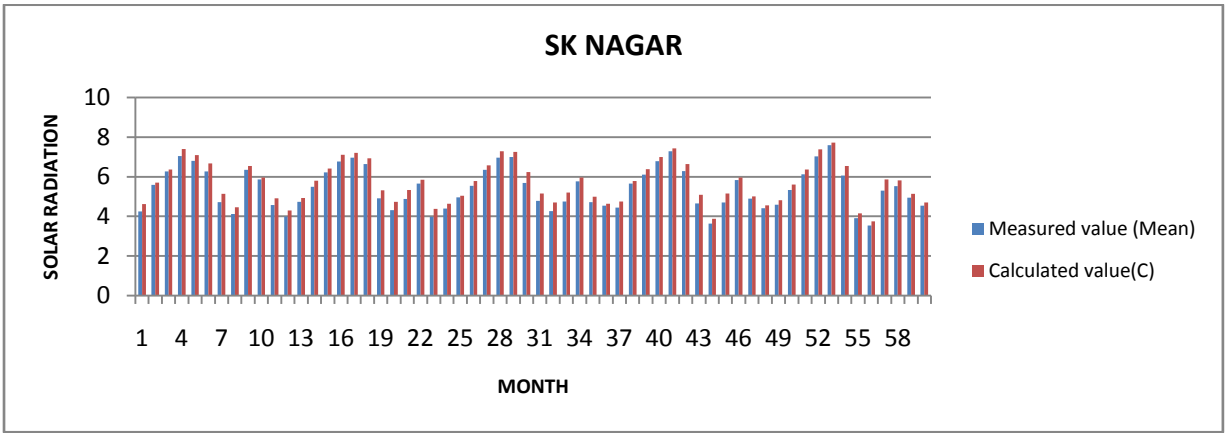
where k = shape parameter ,c = scale parameter(m/s),r ( ) = Gamma Function, σ = standard deviation, r_{rmean}= solar radiation(Mean)

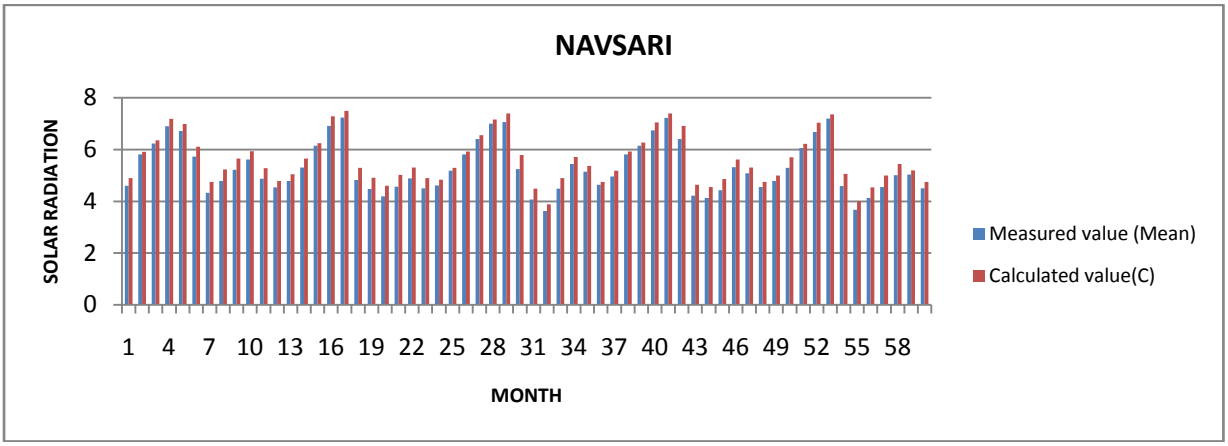
V. GRAPHICAL REPRESENTATION

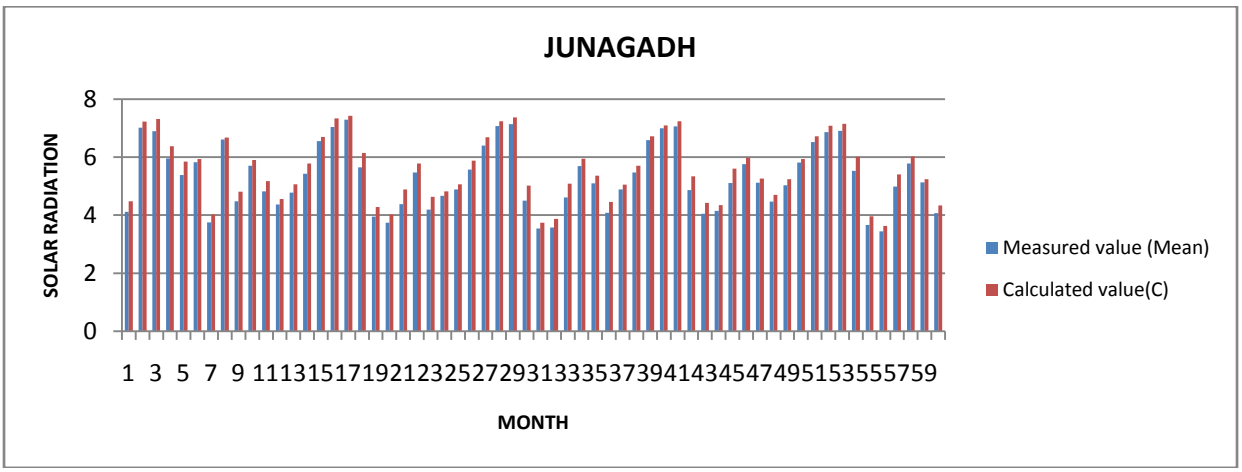
From the recorded data ,the graphical representation of selected locations are as under

Fig. Period (Month 2009-2013) verses Measured and calculated mean (solar radiation)









From the graphical representation the measured value(Mean) and Calculated value(c-scale parameter of Weibull distribution).The statistical analysis of solar radiation data are as under:

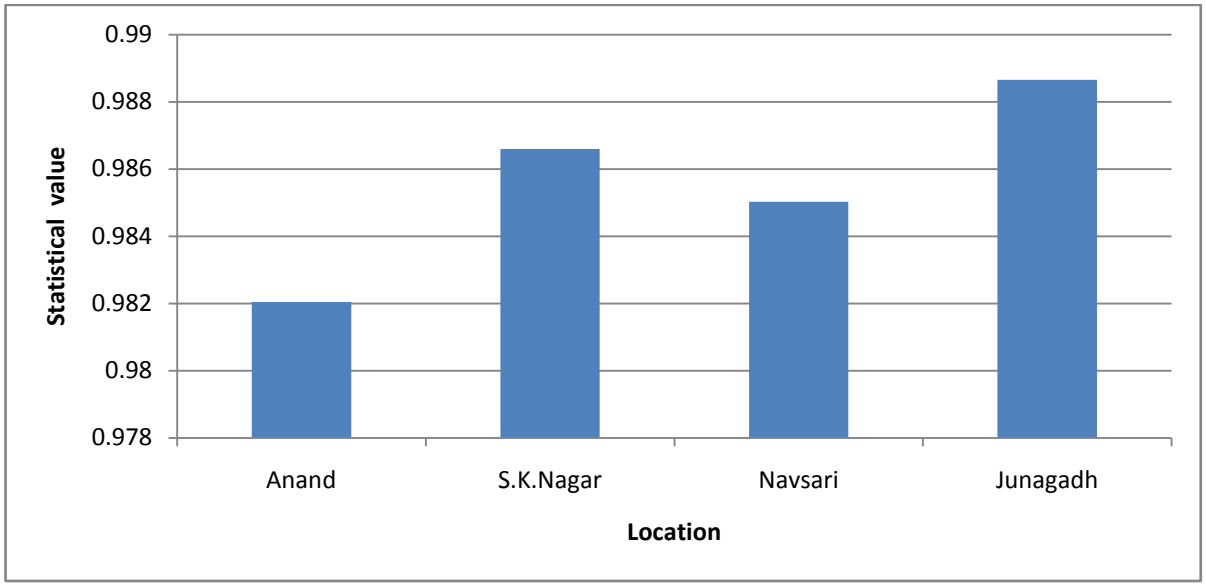
VI. STATISTICAL ANALYSIS

After Statistical Analysis(correlation coefficient R^2 test) the data of selected locations are as under:

Location	Correlation coefficient (R^2)
Anand	0.982052
SK Nagar	0.986599
Navsari	0.98503
Junagadh	0.988658

VII. CONCLUSION

From this study, it is concluded the solar radiationof these locations from statistical test (R^2),preference of these locations for new solar projects(install new solar power plant) are Junagadh(saurashtra), S.K.Nagar (North Gujarat),Navsari(South Gujarat) and Anand(Central Gujarat) respectively.



REFERENCES

[1] A.M. Muzathik, W.B.W. Nik, M.Z. Ibrahim, K.B. Samo, K. Sopian and M.A. Alghoul, Daily Global Solar Radiation Estimate Based On Sunshine Hours, *International Journal of Mechanical and Materials Engineering (IJMME), Vol.6 (2011), No.1, 75-80*

[2] M. Jamil Ahmad, G.N. Tiwari, Solar radiation models – review, International Journal OfEnergy And Environment, *Volume 1, Issue 3, 2010 pp.513-532*

[3] Poudyal Khem N., Bhattarai Binod K, Sapkota Balkrishna and Kjeldstad Berit, Estimation of Global Solar Radiation using Sunshine Duration in Himalaya Region, *Research Journal of Chemical Sciences, Vol. 2(11), 20-25, November (2012)*

[4] Tian Pau Chang, *Investigation on Frequency Distribution of Global Radiation Using Different Probability Density Functions, International Journal of Applied Science and Engineering,2010. 8, 2: 99-107*

[5] personal discussion withRespected faculties of Universities

[6] Gujarat samachar page 5 dated 6/6/16