Journal of Physics & Astronomy

Review| Vol 6 Iss 1

Solar Radiation Determination for Solar Energy Applications: Case Study for Two Different Sites in Egypt

Haroun AE[1], Ahmed G[2], Emad AA[3] and Zainab MA[4*]

[1]Aswan University, Aswan Governorate 81528, Egypt

[2]National Research Institute of Astronomy and Geophysics, Helwan, Egypt

[3]South Valley University, Egypt

[4]Arab Academy for Science, Technology & Maritime Transport, Aswan, Egypt

[*]**Corresponding author:** Zainab MA, Arab Academy for Science, Technology & Maritime Transport, Egypt, Tel: 00201119532572; E-mail: zeinabmahmoud29@yahoo.com

Received: January 22, 2018; **Accepted:** February 21, 2018; **Published:** February 28, 2018

Abstract

Solar energy is going to be a main substitute for fossil fuels in the coming years for its clean and renewable nature. Egypt has a very high potential of incident solar radiation that could be used efficiently as an alternate source of clean energy. The average annual solar radiation energy incident over Egypt varies from 5 to 9 kW h/m^2/day.

Several empirical models have been developed to calculate the solar radiation using various parameters. The daily average and monthly average global solar radiation are calculated from three important parameters through year 2012. The parameters are temperature, relative humidity and extraterrestrial solar radiation at two different sites in Egypt, Marsa Matrouh (coastal area) and Qena (desert area). Multiple linear regression model was applied for calculations. The Comparison between the measured (Gm) and calculated (Gc) global solar radiation are analyzed for model verification.

Keywords: ***Solar radiation; Empirical model; Solar energy; Extraterrestrial solar radiation***

Introduction

As the world develops rapidly, the energy demand follows. Energy was, is and will remain the basic foundation which determines the stability of the economic development of any nation. The resources of fossil fuels (oil, coal, gas) are not unlimited and with the expected energy consumption for the future, these supplies will be emptied within the next generations. Therefore it is already now necessary to supplement and replace the fossil fuels with renewable energy sources. Solar energy is the most abundant renewable resource.

Citation: Haroun AE, Ahmed G, Emad AA, et al. Solar Radiation Determination for Solar Energy Applications: Case Study for Two Different Sites in Egypt. J Phys Astron. 2018; 6(1):136

The solar radiation received by any surface on earth will varies in intensity and spectrum due to varying several factors including; geographical location, time of the day, season, local landscape and atmospheric parameters such as the cloud cover, the turbidity, the water vapor content, temperature, relative humidity and the zenith angle [1-4]. Most solar energy applications such as the simulation of solar energy systems require, at the least, knowledge of the values of solar radiation on a surface. In this paper, we discussed and calculate the solar radiation using various meteorological parameters. The parameters are temperature, relative humidity and extraterrestrial solar radiation at two different sites in Egypt, Marsa Matrouh (coastal area) and Qena (desert area). Multiple linear regression model was applied for calculations. The comparison between the measured (Gm) and calculated (Gc) global solar radiation are analyzed for model verification.

Data Collection and Methodology

The relevant data was provided by South Valley University Station at Qena, which is one of the stations guides of the Egyptian Meteorological Authority. Solar radiation measurements are determined using CMP3 Kipp and Zonen pyranometer. The CMP3 is used in order to measure solar radiation with high quality blackened thermopile that provides a flat spectral response for the full solar spectrumrange. We used multiple linear regression model to calculate the global solar radiation from extraterrestrial solar radiation, temperature and relative humidity as follow:

$$G=a+b\ Go+c\ T+dRH \quad (1)$$

Where G, Go, T and RH are respectively daily average horizontal globaland extraterrestrial-radiation, temperature and relative humidity while a, b, c and d are empirical constants [5-7].

Results, Discussion and Conclusion

Detailed analysis of the model is given using SPSS program and summarized in TABLES (a, b) for Mars Matrouh and TABLES (c, d) for Qena (TABLES 1-4).

TABLE 1. **Statistical parameters of daily average global solar radiation (G) for equation 1 at MarsMatrouh (Model summary and coefficients).**

Model	**R**	**R square**	**Adjusted R square**	**F**	**Sig**
1	818	670	667	205.862	000

(a)

Model	**Unstandardized coefficients**		**Standardized coefficients**	**t**	**Sig**
	B	**Std error**	**Beta**		
(Constant)	1159357	389.		3.	0
Go	0.525	0.042	0.802	13.	000
T	4.	14.900	0.015	0.248	1
RH	-3.157-	7.300	-015-	-432-	1

(b)

TABLE 2. **Statistical parameters of daily average global solar radiation (G) for equation 1 at Qena. Model summary (Coefficients).**

Model	R	R square	Adjusted R square	F	Sig.
1	0.969	0.940	0.939	1596.051	0

(c)

Model	Unstandardized coefficients		Standardized coefficients	t	Sig.
	B	Std error	Beta		
(Constant)	-688.023-	304.419		-2.260-	0.024
Go	0.807	0.025	1.033	31.904	.000
T	-17.437-	6.057	-.082-	-2.879-	.004
RH	-0.466-	2.216	-.006-	-.210-	.834

(d)

TABLE 3. **Statistical parameters of daily average global solar radiation (G) at Mars Matrouh for equation 1.**

Statistical error	
correlation	0.92
MBE%	-6.
RMSE%	20.
MAE%	8.
ME	-2.
d	0.56

TABLE 4. **Statistical parameters of daily average global solar radiation (G) at Qena for equation 1.**

Statistical error	
correlation	0.97
MBE%	0.29
RMSE%	2.
MAE%	2.
ME	0.97
d	0.99

According to this table, in view of the great value of correlation this formula can compute the daily average global solar radiation (G) with a good accuracy (FIG. 1 and 2).

Model performance was assessed to compare the calculated and measured global solar radiation from the mean bias error (MBE), the mean absolute error (MAE) and the root mean square error (RMSE) also additional statistical parameters were used to assess model performance such as modeling index (d) and modeling efficiency (ME). According to the obtained results, a good agreement was observed between them as illustrated in the following table Mars Matrouh and Qena (TABLES 3 and 4).

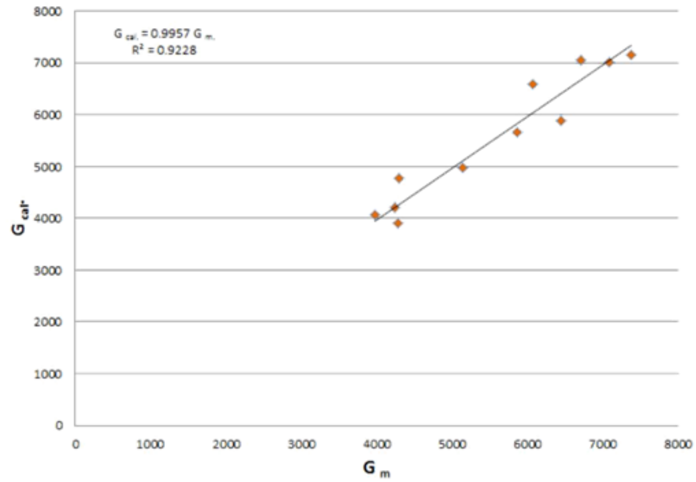

FIG. 1. **Comparison between measured (Gm) and calculated (Gc) global solar radiation values for monthly average data through the study period at Mars Matrouh.**

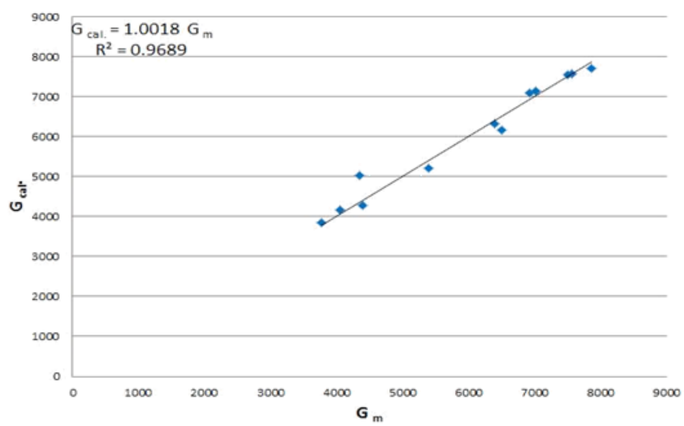

FIG. 2. **Comparison between measured (Gm) and calculated (Gc) global solar radiation values for monthly average data through the study period at Qena.**

REFERENCES

1. Shimokawa. Effect of atmospheric parameters on the silicon solar cells performance. Solar Cells. 1986; 19:59.
2. Nann S, Emery k. Solar energy materials and solar cells. Solar Cells. 1992; 27:189.
3. Gonzalez MC, Carrol JJ. Effect of spectral irradiance distribution on the performance of solar cells. Solar Energy. 1994; 33:395.
4. Parreta A, Sarno A, Vicari LRM. Optics communications. Solar Cells. 1998; 153:153.
5. Gonzalez MC. Solar cells spectral irradiance distribution. Solar Cells. 1998; 15:13.
6. Emery K. Energy materials and solar cells. Solar Cells. 1996; 10:59.
7. Nann S. Communications. Solar Cells. 1998; 19:13.