

Measurement and Analysis of Solar Irradiation and Other Related Meteorological Parameters in Ras Al Khaimah, UAE

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Abstract—This paper presents measurement of actual solar radiation, ambient shaded temperature, relative humidity and barometric pressure in Ras Al Khaimah-UAE (25°47'N 55°57'E) throughout the period from January 2013 until December 2015, throughout this period maximum and minimum values of solar irradiance and temperature are shown, monthly average solar irradiance and temperature values throughout the three years were calculated. The maximum solar irradiance value during the three years was found to be 1289 W/m² while the maximum recorded temperature during the three years was found to be 50.1 C and the minimum recorded temperature throughout this period was 8.1 C, average relative humidity was calculated during 4 different months in 2014. The results showed relatively high solar radiation values throughout the three years.

Keywords—Solar Irradiance, Ambient Temperature, UAE, Solar Energy.

I. INTRODUCTION:

Nowadays worldwide energy plays a crucial role in determining the level of economic and social development among nations [1]. Throughout the past ten years installed capacity of solar energy power sources has increased from 6496 MW installed capacity in 2006 to 223948 MW installed capacity in 2015 worldwide according to IRENA [2]. Due to its location in the solar belt UAE is known for its high solar radiation levels throughout the year, in this study [3] it is shown that more than USD 1.5 billion can be saved by 2030 if at least 10 % share of renewable energy out of the total energy consumption is utilized.

Measured weather data such as solar radiation, humidity, temperature and pressure is important in the process of sizing and designing different solar systems such as PV and CSP. Abu Dhabi the capital of the UAE has set a target of generating 7 % of power from renewable energy resources by 2030 [5].

The tendency of moving forward into nonconventional power sources came as a result of the environmental problems caused by the conventional power sources. The huge increase in power demand and consumption has led to a global understanding and agreement that humans has to adapt clean power sources more seriously into their lives which in return will lead to an improvement in lifestyle both economically and environmentally. One major issue that resulted from using fossil fuel is the global climate change, due to an increase in greenhouse gases concentrations such as CO₂, CH₄ and N₂O the heat radiated from the ground is being trapped by these gases which in return increases the earth temperature [6] other devastating issues are acid rain and air pollution. The UAE is considered to be one of the highest energy consumers per capita worldwide [7], most of the energy is used for cooling purposes due to hot and humid weather conditions. Being among the top 10 oil producers worldwide and having less than 0.1% of its power demand powered from renewable energy sources the UAE considers the research in the renewable energy sector as an important step towards more sustainable region.

II. EXPERIMENTAL SETUP AND PROCEDURE:

These set of data as mentioned earlier were taken at RAK, UAE and specifically at RAK Research and Innovation Center (RAKRIC). The location of our weather station is latitude: 25° 5' N, longitude: 55° 5' E, AMSL: ~8 m, local time GMT+4, operating since 2007. At RAKRIC we have 7 different research facilities; such as PV test facility, solar water desalination test facility CSP test facility...etc. these data are used as a reference to enhance the different researches conducted at the center [4]. The set of data shown in this article are measured by the following instruments: CMP11 Pyranometer by Kipp and Zenon is used to measure the global horizontal irradiation (GHI), with spectral range of 285 to 2800 nm and sensitivity of 7 to 14 $\mu\text{V}/\text{W}/\text{m}^2$, Vantage Pro2 Plus 6162 Wireless Weather Station used to measure shaded temperature, relative humidity and barometric pressure. Wireless weather station include two components: the Integrated Sensor Suite (ISS) which houses and manages the external sensor array, and the console which provides the user interface, data display and calculations. The ISS and Vantage Pro2 console communicate via an FCC-Certified, license free, spread-spectrum frequency hopping (FHSS) transmitter and receiver. The console may be powered by batteries or by AC powered adapter. Weatherlink software has to be used to interface weather station to the computer, to log weather data and to update weather information on the internet figure 1. All of the instruments are set 4 meters above the ground figure 2 is the data logging diagram. As an assessment of solar radiation, temperature and relative humidity in RAK, UAE and from the 10 second recorded raw data, maximum and minimum values were obtained and average values were calculated, the daily average and monthly average radiation was determined as an average of the whole day/month; the calculation involved data from night time (close to zero W/m^2 during night). In order to make the assessment more clear and accurate the data were taken during three years period from 2013 to 2015, this would also give space for comparison. Radiation during three selected days were generated in order to study the data variation during short period of time.



Fig. 1: Davis Vantage Pro2

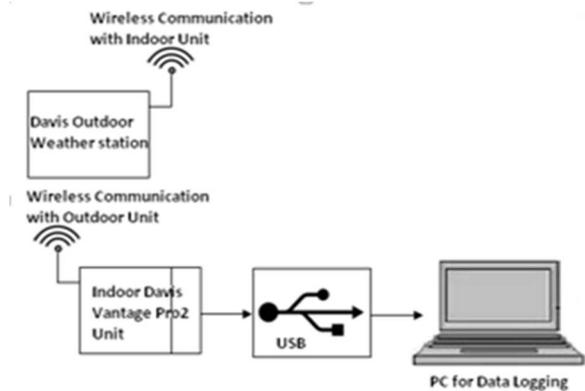


Fig. 2: Data Logging

A. Shaded Ambient Temperature.

As can be seen from the figures below, the temperature in Ras Al Khaimah ranges from 11 °C as minimum temperature during particular times of the year and until around 50 °C as a maximum temperature during other times of the year, during January and February the instantaneous temperature didn't exceed 30 °C while in July and August the minimum recorded temperature didn't go below around 28 °C throughout the three years. During 2013 the maximum temperature was 45.9 °C recorded in July, in 2014 the maximum temperature was 48.3 °C recorded in July, and in 2015 the maximum temperature was 50.1 °C recorded in August. The minimum temperature throughout the three years was 8.1 °C recorded in January 2015. Figures 3, 4, 5 represents the temperature values during 2013, 2014, 2015 respectively. Figure 6 represents the daily average temperature during 2015 for the complete year.

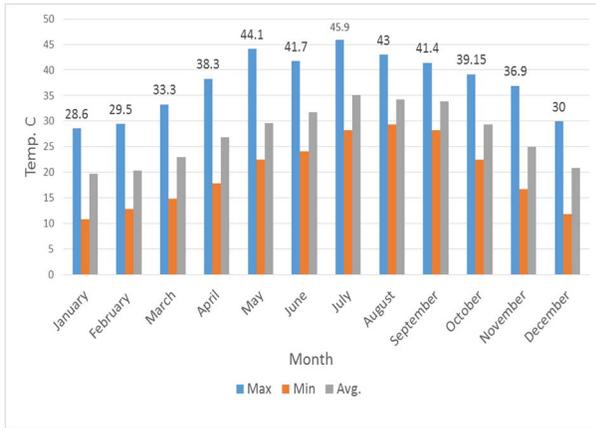


Fig. 3: temperature during 2013

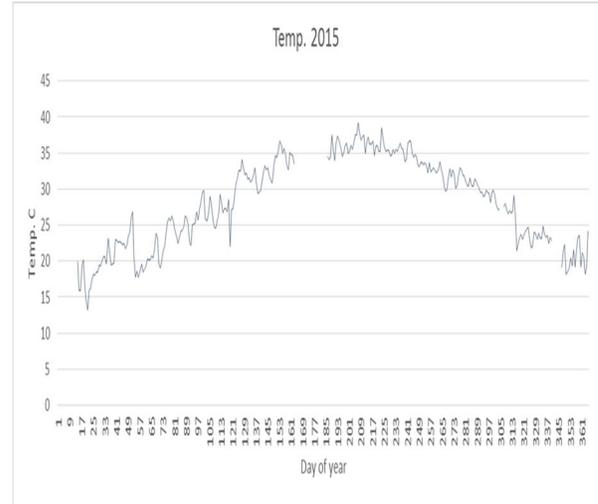


Fig. 6: temperature during 2015

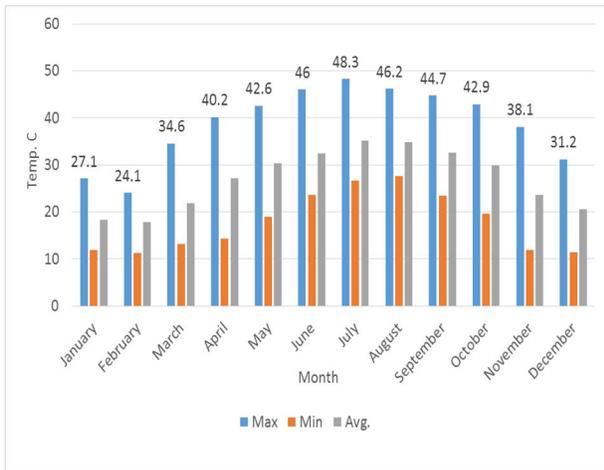


Fig. 4: temperature during 2014

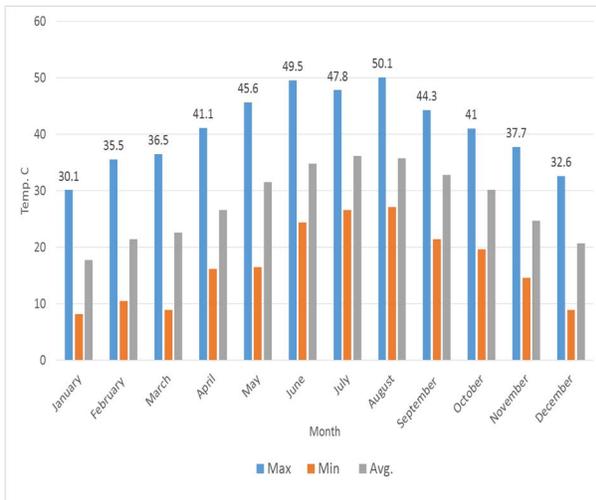


Fig. 5: temperature during 2015

B. Solar Irradiance.

Throughout the three years the radiation levels are relatively high although from the figures it can be noticed that the average radiation is not very high this is only due to zero radiation values during night time which affects the average values, but the maximum values below shows that the radiation levels can reach high values throughout the year. The maximum recorded radiation value during the three years was 1289 W/m² in May 2013. Figures 7, 8, 9 shows the maximum and average monthly radiation values during the years 2013, 2014, 2015 respectively. While figure 10 represents instantaneous radiation values for three consecutive days, from 10-12 August 2015 as can be noticed from the figure the peak radiation usually is at afternoon.

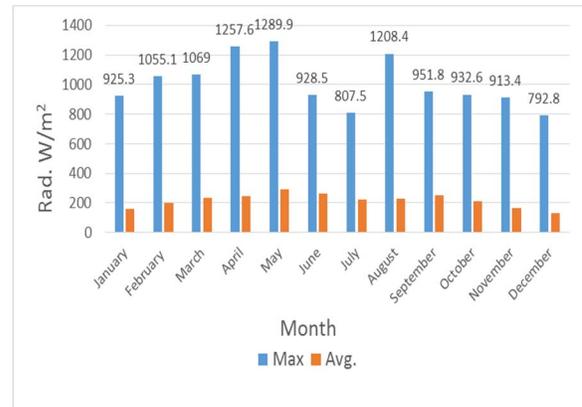


Fig. 7 Radiation During 2013

III. CONCLUSION

Throughout the period from January 2013 until December 2015 radiation, temperature, Barometric pressure and relative humidity data have been measured, formatted and analyzed in Ras Al Khaimah, UAE. The data indicates high solar irradiation throughout the year, especially from April until August, the temperature and relative humidity values are also very high throughout the year and especially in summer. This high temperature can have negative effect on different solar systems by reducing their efficiency. Due to high solar radiation values, solar energy can be one good solution for the responsible sectors to adapt, never the less high humidity and temperature values represent two important challenges that has to be dealt with in order to utilize this important potential income in the next coming few years. The data can be also used for adjacent areas to Ras Al Khaimah in which these nearby cities and countries have somehow relatively close conditions.



Fig. 8 Radiation During 2014

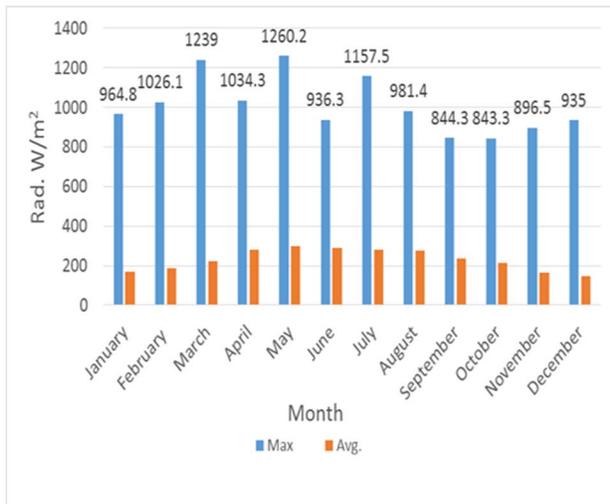


Fig. 9 Radiation During 2015

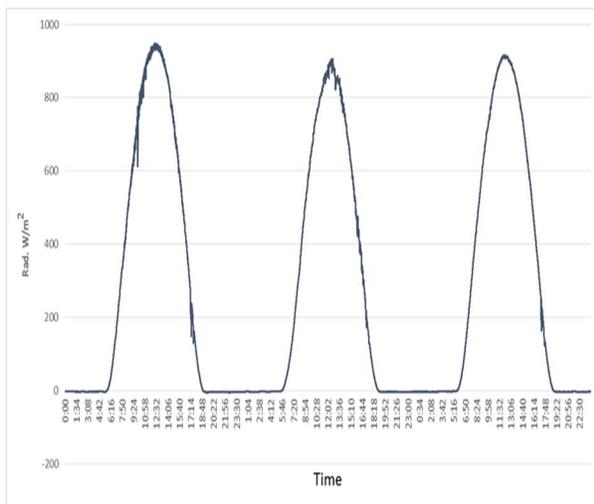


Fig. 10 Radiation from 10-12 August 2015

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