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Potential of Global Solar Radiation as Future Energy Source in Southern Region of Peninsular Malaysia

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ABSTRACT

Energy sector in Malaysia is still adopting conventional method in electricity generation by using fossil fuel. The effect of fossil fuel utilization in electricity generation is releasing of greenhouse gases (GHGs) in the atmosphere specifically carbon dioxide (CO2). Releasing of uncontrolled GHGs may cause the earth to suffer from global warming. This paper is conducted to study the solar radiation potential at Southern Region of Peninsular Malaysia specifically in Iskandar Malaysia (IM) Region. The daily and annual means of solar radiation is analysed in order to examine the potential of solar energy to be energy source for electricity generation in the future. The results in this study indicate that the annual average of global solar radiation is higher in year 2010 with value of 13.31 MJ/m2/day whilst the lowest value of global solar radiation is recorded in year 2013 at 12.48 MJ/m2/day. The daily maximum global solar radiation values was collected on month of May and September during Southeast Monsoon. The daily minimum global solar radiation values was collected on January and December during Southeast Monsoon. The results also indicate that the maximum and minimum solar radiation captured 694 kWh/day and 651 kWh/day respectively. The results achieved in this study show that the potential to adopt solar energy as future energy source is very encouraging for energy sector.

Key words : Electricity generation, solar energy, solar radiation, greenhouse gases

1. INTRODUCTION

The current state of the electricity supply generation in Malaysia has indeed led to an unsustainable use of resources and environmental degradation. This is because Malaysia is still relying heavily on fossil fuels as fuel source in electricity supply generation. Dependency towards fossil fuels had caused rise in the emissions of GHGs mainly the CO2. If the rise of GHGs is uncontrolled, it could result in global warming with many severe impacts such as floods, droughts, storms, and heat waves that can affect human health and environment [1]-[2]. Based on history being recorded, big flood happened in the Southern Region of Peninsular Malaysia on November 2006 until January 2007 [3]. According to study from Universiti Kebangsaan Malaysia's (UKM) researchers', one of the root causes of this big flood is from the meteorological factor. This served as clear reflection that uncontrolled GHGs emission lead to extreme change of meteorological event.

The energy sector is a main contributor of GHGs emission that arises from electricity supply generation. Therefore, energy sector needs to adopt environmentally technologies reduce the GHGs emissions. The environmentally technologies could protect the environment and are less polluting. There are several environmentally technologies available such as energy efficiency, fuel balancing, fuel switching, and process improvements. All of these technologies could benefit climate by saving 20% of CO2/year by 2020 for energy sector [4]. Indirectly it could benefit the environment by reduction in air pollution.

At Southern Region of Peninsular Malaysia, Iskandar Malaysia (IM) region plays an important role in Malaysia development. IM region covers an area of 22,163 km2 and it was developed with the aim to become a region with low carbon by the year 2025 [5]. In achieving the targeted aim, there are many previous studies on CO2 emissions mitigation were carried out at IM. The finding shows that the adoption of fuel switching with solar energy as fuel source are considered as the best alternatives. In developing this technology, the accurate information of the solar radiation is essential in the development of this technology. Solar radiation information is needed in the estimation of the technology performance, and also the cost analysis of the technology [6]. This paper presents analysis of the solar radiation at IM region for the year 2010 until 2015. The characteristics that consist of daily and annual means of solar radiation is analysed in order to examine the potential of solar energy to be as energy source for electricity supply generation.

2. SOLAR ENERGY DATA

The global solar radiation data were obtained from Malaysia Meteorological Department (MMD) from the year of 2010 to 2015. The observation station is located at Hospital Johor Bahru (also known as Hospital Sultanah Aminah) as shown in Figure 1 with geographical co-ordinates at 1°27'37"N Latitude 103°44'42"E Longitude and 15.3 m above the sea level [7]. The data of solar radiation is collected from a solarimeter readings. At observation station, the solarimeter are placed on top of flat surface at clearing area to enable this device exposed to the full spectrum of electromagnetic radiation coming from the sun. The sensor of the device could measure a full of 180° radius starting from sunrise until sunset [8].

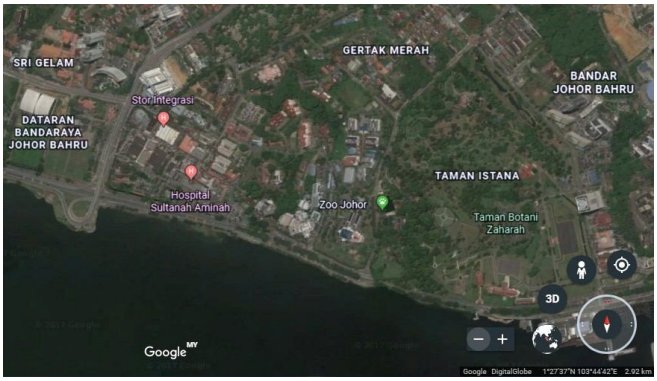
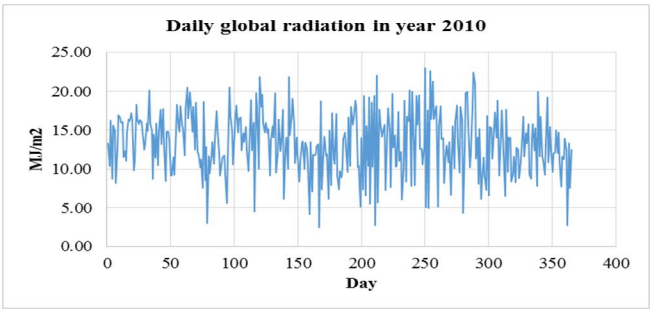


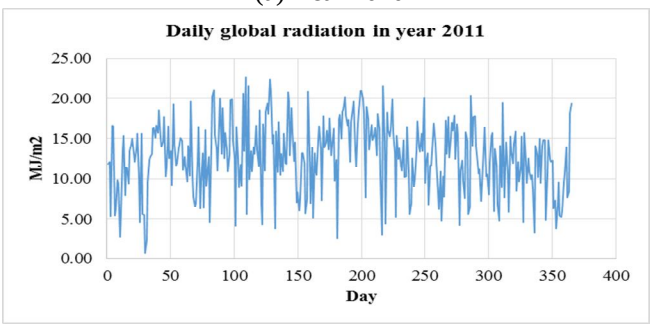
Figure 1: Geographical location of the observation station (Station 47117) – Hospital Johor Bahru [9].

3. SOLAR ENERGY DATA ANALYSIS AND DISCUSSIONS

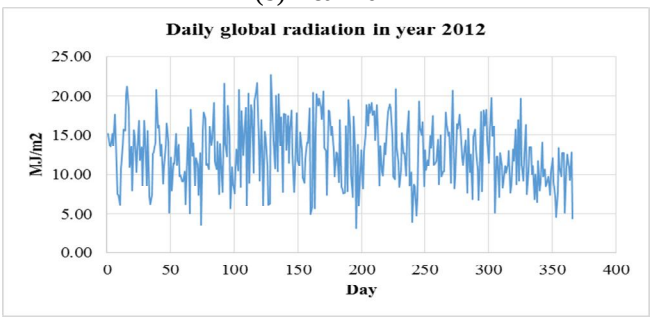
Generally, from the data analysis of global solar radiation it is clear that there is no single day the observation station does not receive solar radiation. Figure 2 describes the daily global solar radiation and Table 1 list the monthly average daily global solar radiation from the year 2010 until 2015. The analysis of the graphs indicate that the daily maximum global solar radiation values was recorded on September 2010 (day of 250) and May 2012 (day of 129) with values of global solar radiation at 22.97 MJ/m2/day and 22.67 MJ/m2/day respectively. The daily minimum global solar radiation values were recorded on January 2011 (day of 30) at 0.64 MJ/m2/day and December 2014 (day of 353) at 1.66 MJ/m2/day. The result analysis is accordance with Malaysia seasons where daily maximum global solar radiation are recorded during Southeast Monsoon that usually start on half of May and ends on September. During this monsoon, the weather is relatively dry and sometimes there is occurrence of drought. On the other hand, the daily minimum global solar radiation is recorded during Northeast Monsoon that usually commences on November and ends in March. At this time, the season is wet and sometimes may cause flooding.



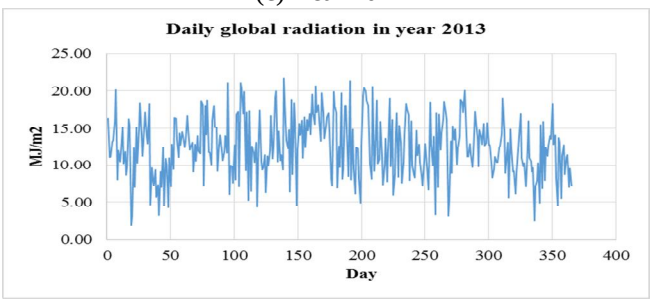
(a) Year 2010



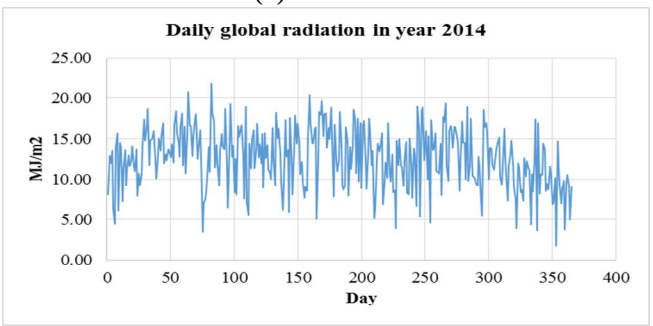
(b) Year 2011



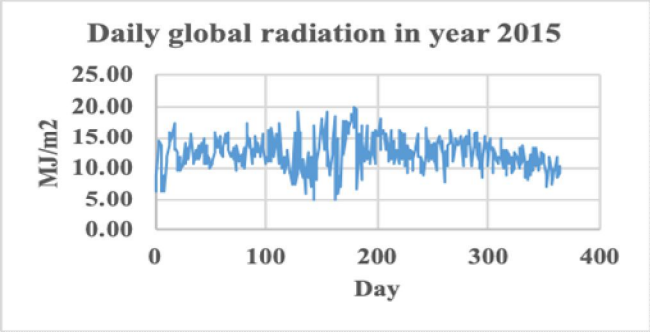
(c) Year 2012



(d) Year 2013



(e) Year 2014



(f) Year 2015

Figure 2: Daily global solar radiation for (a) Year 2010, (b) Year 2011, (c) Year 2012, (d) Year 2013, (e) Year 2014, and (f) Year 2015.

According to Table 1, the data obtained shows that the quantity of solar radiation emitted by the sun is not constant due to weather condition [10]. This is proved when the data of solar radiation variation computed is relatively high with variance, s^2=2.06.

Figure 3 and Table 2 show the annually minimum, maximum and average daily global solar radiation from year 2010-2015. The highest average of global solar radiation was recorded in year 2010 with 13.31 MJ/m2/day whilst the lowest average of global solar radiation was 12.48 MJ/m2/day in year 2013. The 24 hours maximum of global solar radiation was recorded in September 2010 with 22.97 MJ/m2/day.

Table 1: Monthly average daily global solar radiation for the year 2010 to 2015.

	Average Global Solar Radiation (MJ/m^2/day)											
Month Year	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
2010	14.20	13.95	13.38	14.07	14.27	11.42	12.85	13.50	13.81	13.53	12.44	12.30
2011	10.05	13.95	12.35	13.97	13.70	12.22	16.61	12.63	13.02	12.07	11.41	10.40
2012	13.44	11.92	12.04	14.24	13.71	13.86	13.36	12.10	13.32	13.43	11.53	9.61
2013	10.14	10.14	10.14	10.14	10.14	10.14	13.40	12.15	11.77	13.53	11.34	10.38
2014	11.69	14.42	13.58	13.20	12.96	14.11	12.91	11.36	13.96	12.76	10.87	9.66
2015	11.90	12.89	12.98	12.89	11.67	13.86	13.64	12.35	13.18	13.06	11.52	10.47

This maximum value was recorded during the Southeast Monsoon where the weather was dry. The 24 hours minimum of global solar radiation was recorded in late of January in year 2011. This situation clearly shows that the season was wet during Northeast Monsoon where the solar radiation values is low.

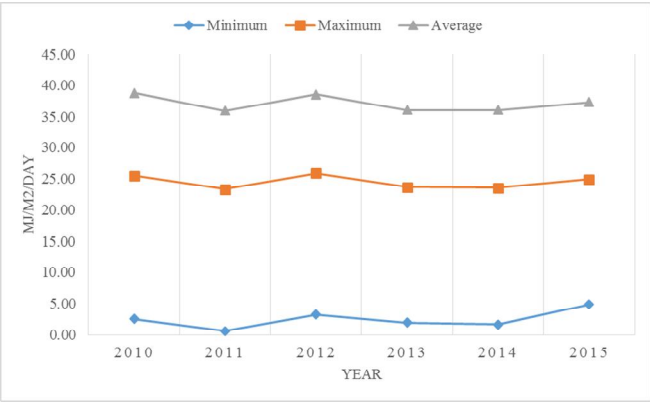


Figure 3: Annual minimum, maximum and average global solar radiation (2010-2015).

Table 2: Annual average, maximum, and minimum global solar radiation for the year 2010 to 2015.

Year	**Global Solar Radiation (MJ/m^2/day)**		
	Average	**Maximum**	**Minimum**
2010	13.31	22.97	2.49
2011	12.70	22.65	0.64
2012	12.71	22.67	3.18
2013	12.48	21.70	1.92
2014	12.60	21.84	1.66
2015	12.53	20.04	4.81

4. SOLAR ENERGY AS FUTURE ENERGY SOURCE

The country anxiety towards increasing of GHGs emission in the atmosphere had insisted the energy sector to adopt technology that environmental friendly in generation of electricity. There are several technologies available, however energy source switching (fuel switching) with implementation of solar energy is able to give short to medium term effects in reduction of GHGs emission [11].

According to the analysis of global solar radiation data at Hospital Johor Bahru, it is clearly present that the potential to adopt solar energy as future energy source is very high. This can be clearly seen when the data obtained shows that there is no single day with completely no sunshine. This situation also attributed by the Malaysia location that near to the equator makes Malaysia is blessed with sunshine most of the time.

Figure 4 shows the annual average global solar radiation data in kWh/m2/day. Referring to the graph the solar radiation variations are relatively small, however the variation can still be determined clearly. According to the data, it was estimated that the maximum solar radiation captured can reach until 694 kWh/day if the average annually sun intensity is 3.70

kWh/m2/day with solar panel efficiency at 25% and solar panel area at 750m2. The minimum solar radiation captured can be at 651 kWh/day if the average annually sun intensity is 3.47 kWh/m2/day with solar panel efficiency at 25% and solar panel area at 750m2 [12].

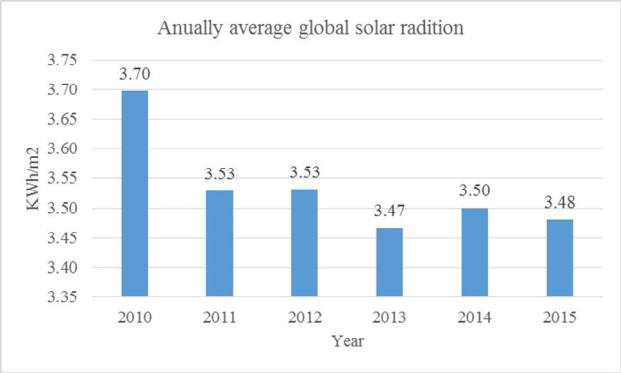


Figure 4: Annual average global solar radiation (2010-2015).

5. CONCLUSION

In this study, analysis towards global solar radiation data is aiming to get a clear view regarding solar radiation in Southern Region of Peninsular Malaysia specifically at IM Region. The results obtained indicate that the annual average of global solar radiation is higher in year 2010 with value of 13.31 MJ/m2/day whilst the lowest value of global solar radiation is recorded in year 2013 at 12.48 MJ/m2/day. The daily maximum global solar radiation values was recorded on month of May and September where the weather at this time is relatively dry or known as Southeast Monsoon. The daily minimum global solar radiation values were recorded on January and December where during these months Malaysia is experiencing Southeast Monsoon. In analyzing data of monthly average daily global solar radiation, a high variance value is obtained with s2=2.06 where it shows that the data are spread out from one another. This clearly indicates that the solar radiation received is not constant and the changes of monsoon influenced the solar radiation emitted by the sun. The analysis of the results also indicates that the potential to adopt solar energy as future energy source is very encouraging for energy sector. The maximum solar radiation captured can reach up to 694 kWh/day whilst the minimum solar radiation captured can be at 651 kWh/day. The results achieved in this study show that solar energy is being recognized as one of main energy source for energy sector in order to ensure electricity generation security and environment sustainability.

REFERENCES

1. Li, Z. and Zhao, J., "**Environmental effects of carbon taxes: a review and case study**," *World Journal of Social Science*., vol. 4 (2), 2017, pp. 7-11. https://doi.org/10.5430/wjss.v4n2p7
2. Delsole, T., Yan, X. and Dirmeyer, P. A., "**Changes in seasonal predictability due to global warming**," *Journal of Climate*., vol. 27, 2013, pp. 300-311. https://doi.org/10.1175/JCLI-D-13-00026.1
3. Yatim, B., Abdullah, M. and Surif, S., "**Banjir Besar Johor**," *UKM Press*, 2012.
4. IMPAK, "**Current environmental concerns**. Issue 4," *Quarterly Publication of the Department of Environment*, Ministry of Natural Resources and Environment, 2007.
5. Lee, M. Y. and Hashim, H., "**Modelling and optimization of CO2 abatement strategies**," *Journal of Cleaner Production*., vol. 71, 2014, pp. 40-47. https://doi.org/10.1016/j.jclepro.2014.01.005
6. Muzathik, A. M., "**Potential of global solar radiation in Terengganu, Malaysia**," *International Journal of Energy Engineering (IJEE)*, vol. 3 (4), 2013, pp. 130 – 136.
7. Pusat Iklim Nasional Jabatan Meteorologi Malaysia, Jalan Sultan 46667 Petaling Jaya, Selangor, 2016.
8. MMD, Malaysia Meteorological Department, 2017. Available: http://www.met.gov.my
9. Google Map, 2017. Available: https://www.google.com/earth/
10. MMD, Malaysia Meteorological Department. Climate change scenarios for Malaysia 2001-2009. Malaysia: Numerical Weather Prediction Development Section, Technical Development Division, Malaysian Meteorological Department, Ministry of Science, Technology and Innovation; 2009. Scientific Report, 2010.
11. Shahida S, Minhans A., and Che P. O., "**Assessment of greenhouse gas emission reduction measures in transportation sector of Malaysia**," *Jurnal Teknologi*., vol. 70 (4), 2014, pp. 1-8. https://doi.org/10.11113/jt.v70.3481
12. Solar Panel Calculator, 2017. Available: https://barani.biz/apps/solar/