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Research article

Estimating of monthly global Solar Radiation by Angstrom-Prescott (A-P) method for Ahvaz and Abadan cities

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Abstract

Undoubted the main cause of air pollution in the world are fossil fuels and better way for reduction it is using of renewable energy. The main aim of this article is calculation of Statistical analysis of solar radiation by Angstrom-Prescott (A-P) method for Abadan and Ahvaz cities. In this paper at first the data of solar radiation were received from the Meteorological organization. Then by the Angstrom-Prescott (A-P) method, solar radiation for two cities calculated also the amount of radiation per month, the maximum amount of possible radiation monthly, constant equation coefficients, solar radiation on a flat surface and for a specified area and radiating out from the Sun's atmosphere measured. In this research, the average amount of solar radiation annually was obtained 8.42 hours a day

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for the Abadan city and 8.28 hour Ahvaz city. Moreover, constant equation coefficients were obtained as 0.30 and 0.49 for Abadan also 0.31 and 0.47 for Ahvaz city obtained. This paper shown that south of Iran especially Khuzestan province has a good potential in solar radiation and suitable for investment in solar fields.

Keywords: renewable energy, solar energy, estimate, sun radiation**,** Khuzestan province.

Introduction

Energy is an essential factor for development and economic growth in each country [1].The growth of the using of fossil fuels and global warming is main cause of trends towards the sustainable energy by the way the researchers decided use of sustainable energy resources [2, 3]. Renewable energy sources are clean, many environmental and economical benefits in contrast to conventional energy sources by the way in recent year study and using of renewable energy has more in the world and day to day increasingly.[4,5]. Today investigation on the renewable energy is a program policy of different countries and increasing [6-8]. The fig 1 shows EPIA scenarios for global annual new installed PV capacity, 2000 To 2015, as it obvious during 2000s and 2009s there are a slow increase while between 2010s to 2015s trends of global annual new installed PV capacity there are rapid growth and it shows importance of renewable energy.

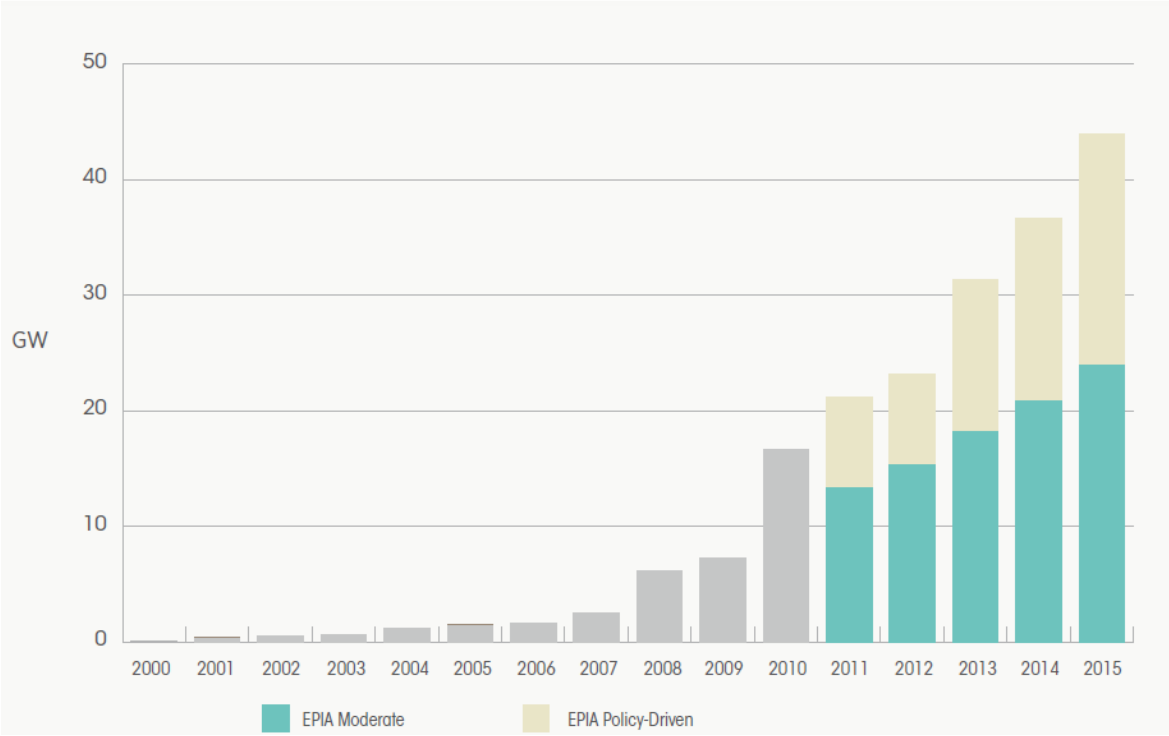


Fig 1: EPIA scenarios for global annual new installed PV capacity, 2000 To 2015[9].

Nowadays Concentrate of Solar Power technology and using it is growing fast in all of the world [10]. The fig 1. Shows the schematic example of a solar Photovoltaic system [11].

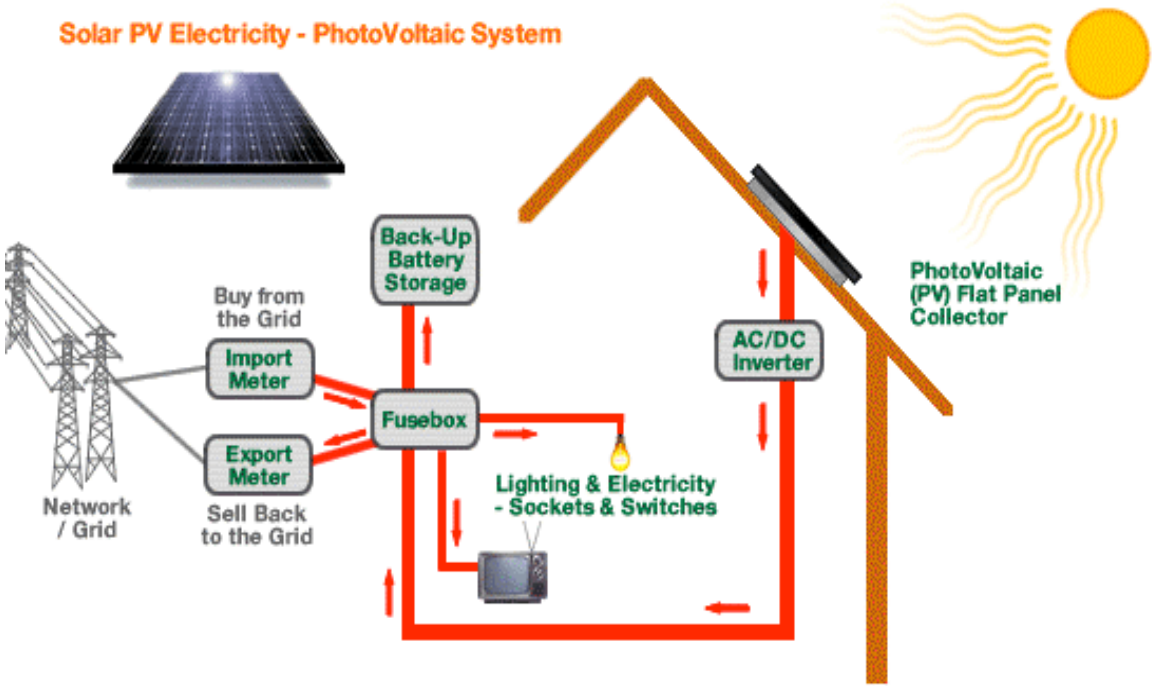
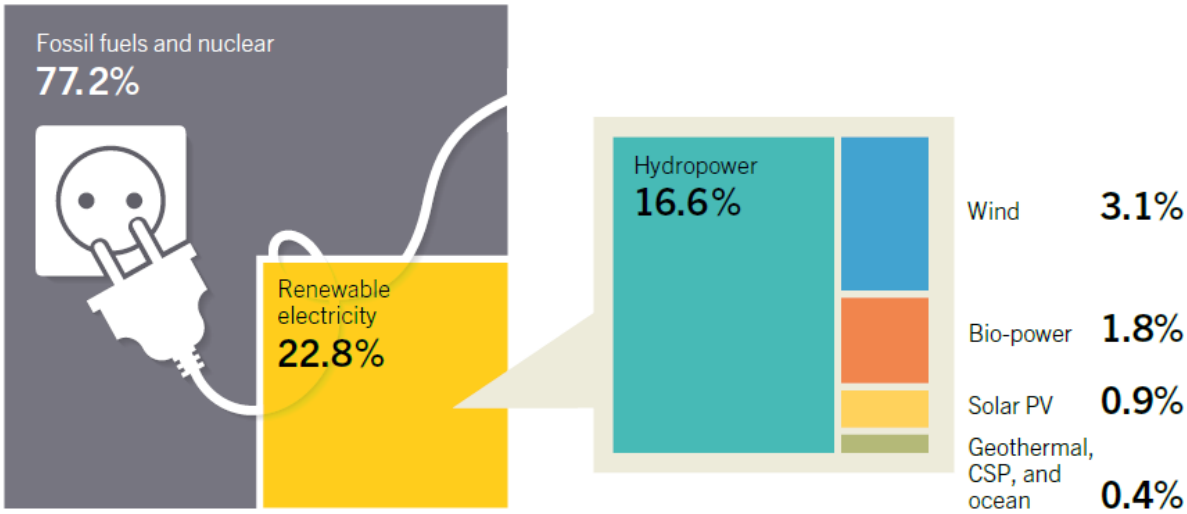


Fig 1. Schematic example of a solar Photovoltaic system [11]

In the recent year, using of the solar energy in increasing in the world [11]. Research work on the solar energy such as estimation of solar energy and hybrid by different researcher before done [13-16]. Photovoltaic power generation is one of the best and suitable sources for producing renewable energy. Fig 2 Shows the estimated renewable energy share of global electricity production, end-2014 as it clear in fig 2 the share of fossil fuels and nuclear energy is 77.2% for electric production while share of renewable energy in order to electric production is very low than mentioned energies also among the renewable energy that generate electricity, share of PV system for electric generation is 0.9% that is trivial [17].

Fig. 2. Estimated Renewable Energy Share of



Global Electricity Production, End-2014 [17]

Solar energy is a very large, inexhaustible source of energy, and well known among other kind of important renewable energy source for the future in many countries [18, 19]. At present performance of the Solar photovoltaic (PV) in the world has proved and this technology can provide a part of energy generation [20]. From the point of research in Iran country ali sabziparvar (et al) analysis and estimated global solar radiation in central arid deserts of Iran done that shows importance of solar energy [21].

Geography of the study area:

Abadan is a one of the cities in Khuzestan Province, Latitude 30 22 N degrees longitude 48 15 E degrees latitude and at an altitude of 6.6 meters above sea level. This city is considered as one of the known Oil and Gas spots in Iran moreover is famous Port in Iran .Abadan have a warm climate The population of Abadan is 217,988 (2011 census). Ahvaz is one of the biggest city in Iran and capital of Khuzestan province also one of Iran's metropolises. This city is located in the central region of Ahvaz County, with Latitude 31 20 N degrees longitude 48 40 E degrees latitude and at an altitude of 22.5 meters above sea. 51% of oil produced by National Iranian South Oil Company is currently produced in this city and it also houses some of largest Iranian companies .The population of Ahvaz is 1,112,021(2011 census) [22, 23]. The fig 3 shows the position of the Khuzestan province on the map of Iran. As it is clear the Abadan and Ahvaz cities are in the south of Iran.

Fig. 3**.** Iran map the Abadan and Ahvaz cities is the site studied in the current study [24]

Results and Discussion

Solar analysis:

For obtain the amount of solar radiation there is a given methods that it called Angstrom- Prescott (1940) according this equation we have [25, 26]:

$$\frac{H}{H0} = a+b\left(\frac{n}{N0}\right) \quad (1)$$

In above formula H is the monthly average daily global solar radiation on a horizontal surface at a given location , $H0$ is the monthly mean daily extraterrestrial radiation on a horizontal surface in the absence of the atmosphere, n is the monthly mean daily number of hours of observed sunshine, N is the monthly mean value of the day length at a given location, also two coefficient ‘a’ and ‘b’ are remarkable that for evaluate of them we can Using of the below equation [27-29]:

a=-0.110 + 0.235 cos ϕ + 0.323 ($n/N0$) (2)

b = 1.449 - 0.553 cos ϕ - 0.694 ($n/N0$) (3)

a and *b* are the regression coefficient also *H0* can be obtained: [30,31]

$$H0 = \frac{24*3600*GSC}{\pi}[1+0.033\cos\frac{360n}{365})](\cos(\phi)\cos(\delta)\sin(\omega) + \frac{2\pi\omega S}{360}\sin(\phi)\sin(\delta)) \quad (4)$$

The above equation can be used to calculate H0 that is the extraterrestrial radiation for the location, also in above equation GSC is the solar constant and it is equal 1367 W m^{-2}, , δ the solar declination, ωS is the mean sunrise hour angle for the given month:[32] The solar declination (δ) and the mean sunrise hour angle (ωS) can be calculated by the following equations (22) and (24):

To calculate the amount δ there is a formula: [33]

$$\delta = 23.45sin(360\frac{284+n}{365}) \quad (5)$$

$$\omega S = cos^{-1}(-tan\emptyset tan\ \delta) \quad (6)$$

For obtain the monthly average of the maximum possible daily can be used of following formula: [34]

$$No = \frac{2}{15}cos^{-1}(-tan\emptyset tan\ \delta) \quad (7)$$

Table 1 shows the values of the constant coefficients, the sun radiation on a flat surface and in a certain area, the radiating out from the atmosphere, the average daily solar radiation, and the daily highest possible radiation.

Table 1. Calculated monthly mean of global solar radiation and input parameters of monthly mean average of global solar radiation for Abadan and Ahvaz

Month	Cities	ωS	δ	average solar radiation in month	Isc(Solar Constant in J/s-m2)
Jan	Abadan	77.13	-20.91	200.1	1367
	Ahvaz	76.61	-20.91	188	1367
Feb	Abadan	82.29	-12.95	178.3	1367
	Ahvaz	82.42	-12.95	173.6	1367
Mar	Abadan	88.59	-2.41	248	1367
	Ahvaz	88.53	-2.41	238.2	1367

Apr	Abadan	95.54	9.41	231.1	1367
	Ahvaz	95.76	9.41	235.7	1367
May	Abadan	101.43	18.79	272.8	1367
	Ahvaz	101.89	18.79	271.7	1367
Jun	Abadan	104.37	23.08	316.6	1367
	Ahvaz	104.95	23.08	322.2	1367
Jul	Abadan	103.04	21.18	314.4	1367
	Ahvaz	103.57	21.18	320.3	1367
Aug	Abadan	98.01	13.45	323.1	1367
	Ahvaz	98.33	13.45	326.1	1367
Sep	Abadan	91.29	2.21	299.4	1367
	Ahvaz	91.34	2.21	305.5	1367
Oct	Abadan	84.34	-9.59	266.7	1367
	Ahvaz	84.12	-9.59	265.3	1367
Nov	Abadan	78.48	-18.91	226.8	1367
	Ahvaz	78.02	-18.91	222.3	1367
Dec	Abadan	75.65	-23.04	212.2	1367
	Ahvaz	75.06	-23.04	195.7	1367

Table 2 shows amounts obtained from the regression coefficient, sun's radiation on a flat surface, Extraterrestrial radiation daily on a horizontal surface, average of daily sun's radiation and maximum probably Daily sun's radiation for Abadan and Ahvaz city.

Table 2. Monthly sun solar and a and b coefficient regression, monthly average solar radiation, monthly average daily radiation on a horizontal surface, extraterrestrial radiation for the location of Abadan and Ahvaz.

Month	Cities	*a*	*b*	*Ho* *(KJ/m2-day)*	*Hg* *(KJ/m2-day*	*Hg/Ho*	*n*	*No*	*n / No*
Jan	Abadan	0.29	0.52	21.16	10.96	0.51	6.67	10.28	0.64
	Ahvaz	0.28	0.55	20.58	10.41	0.50	6.26	10.21	0.61
Feb	Abadan	0.26	0.59	26.11	11.98	0.45	5.94	10.97	0.54
	Ahvaz	0.25	0.61	25.60	11.44	0.44	5.78	10.93	0.52
Mar	Abadan	0.31	0.49	32.24	17.79	0.55	8.26	11.81	0.69
	Ahvaz	0.30	0.51	31.86	17.29	0.54	7.94	11.80	0.67
Apr	Abadan	0.28	0.56	38.28	18.65	0.48	7.45	12.73	0.58
	Ahvaz	0.28	0.56	38.10	18.88	0.49	7.60	12.76	0.59
May	Abadan	0.30	0.51	42.28	22.26	0.52	8.80	13.52	0.65
	Ahvaz	0.29	0.53	42.29	22.19	0.52	8.76	13.58	0.64
Jun	Abadan	0.32	0.46	43.86	24.97	0.56	10.21	13.91	0.73
	Ahvaz	0.33	0.46	43.97	25.70	0.58	10.39	13.99	0.74
Jul	Abadan	0.32	0.46	43.18	24.58	0.56	10.14	13.73	0.73
	Ahvaz	0.33	0.46	43.25	25.28	0.58	10.33	13.80	0.74
Aug	Abadan	0.34	0.42	40.09	24.07	0.60	10.42	13.06	0.79
	Ahvaz	0.34	0.41	39.99	23.99	0.59	10.51	13.11	0.80
Sep	Abadan	0.34	0.42	34.72	20.88	0.60	9.65	12.17	0.79
	Ahvaz	0.34	0.41	34.42	20.65	0.59	9.85	12.17	0.80
Oct	Abadan	0.34	0.42	28.12	16.88	0.60	8.89	11.24	0.79
	Ahvaz	0.33	0.44	27.65	16.18	0.58	8.56	11.21	0.76

Nov	Abadan	0.32	0.47	22.42	12.75	0.56	7.56	10.46	0.72
	Ahvaz	0.31	0.50	21.86	12.04	0.55	7.17	10.40	0.68
Dec	Abadan	0.31	0.48	19.81	10.95	0.55	7.07	10.08	0.70
	Ahvaz	0.29	0.53	19.21	9.92	0.51	6.31	10.00	0.63

Fig 4 shows the average Sun's monthly radiation, as the fig clearly depicts, the largest amount of radiation was obtained in August and the least amount of radiation in February for two cities.

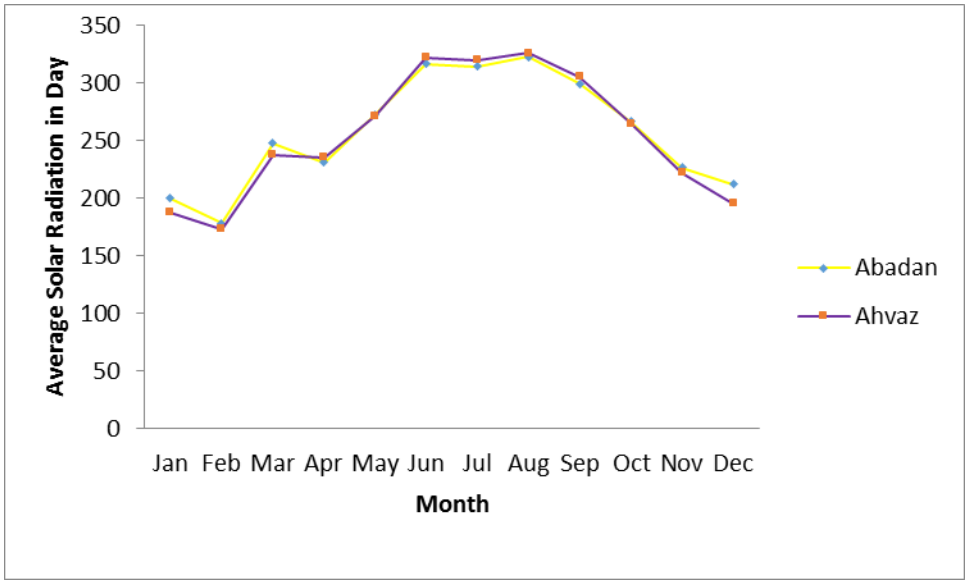


Fig. 4. Average Solar Radiation of Abadan and Ahvaz

Fig 5 shows Extraterrestrial Radiation for two cities on a flat surface the maximum occurred in June with value 43.86 and minimum occurred in December with value 19.81 for Abadan city also the maximum occurred in June with value 43.97 and minimum occurred in December with value 19.21for Ahvaz city.

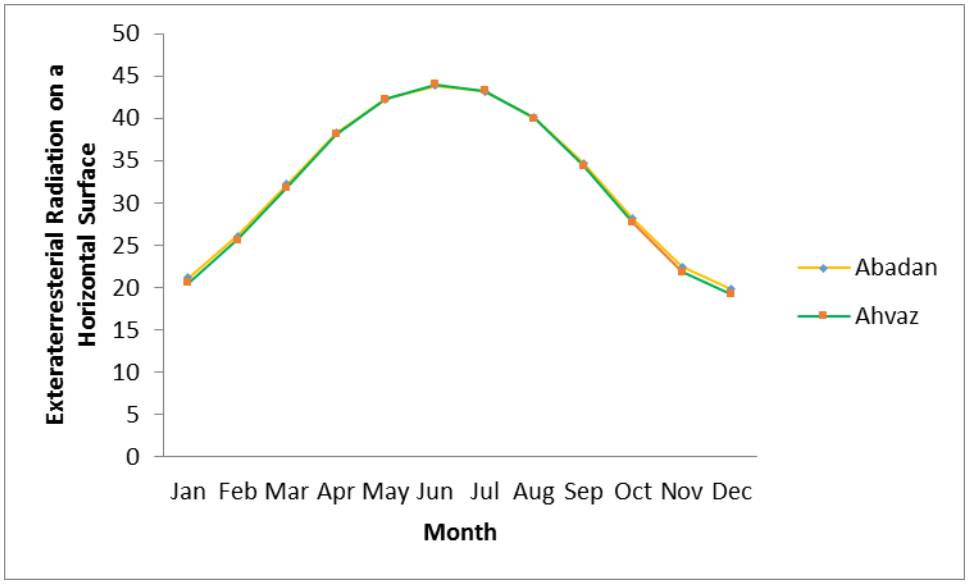


Fig 5. Extraterrestrial Radiation on a horizontal surface of Abadan and Ahvaz.

Fig 6 shows sun radiation on a flat surface that for radiation on a flat surface the maximum occurred in June with value 24.97 and minimum occurred in December with value 10.95 for Abadan city also the maximum occurred in June with value 25.7 and minimum occurred in December with value 9.92for Ahvaz city.

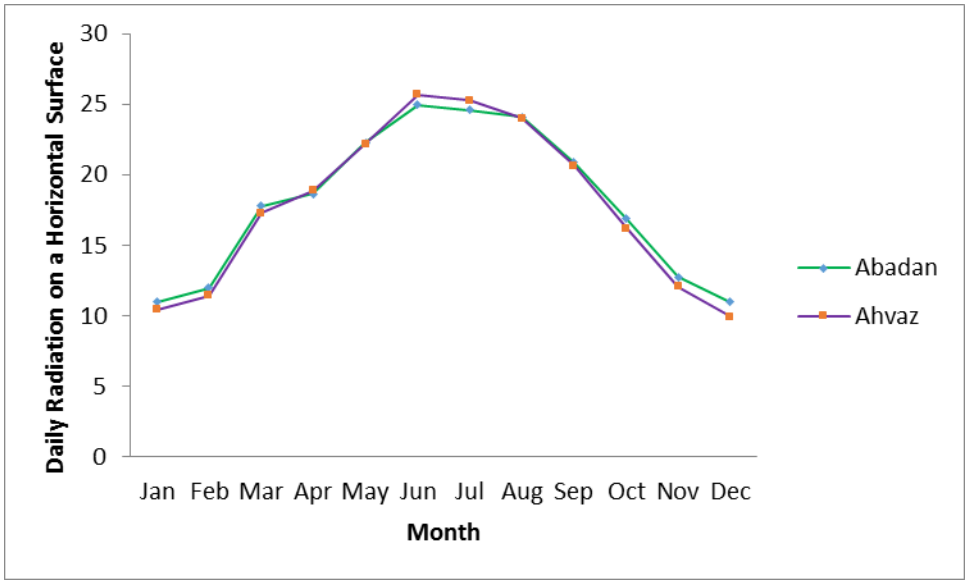


Fig 6. Daily radiation on a horizontal surface of Abadan and Ahvaz.

Fig 7 shows Monthly Solar Radiation of Abadan and Ahvaz cities that the minimum solar radiation with value 178.3occurred in February and the maximum occurred in August With value 323.1and the minimum solar radiation with value 173.6 occurred in February and the maximum occurred in August With value 326.1.

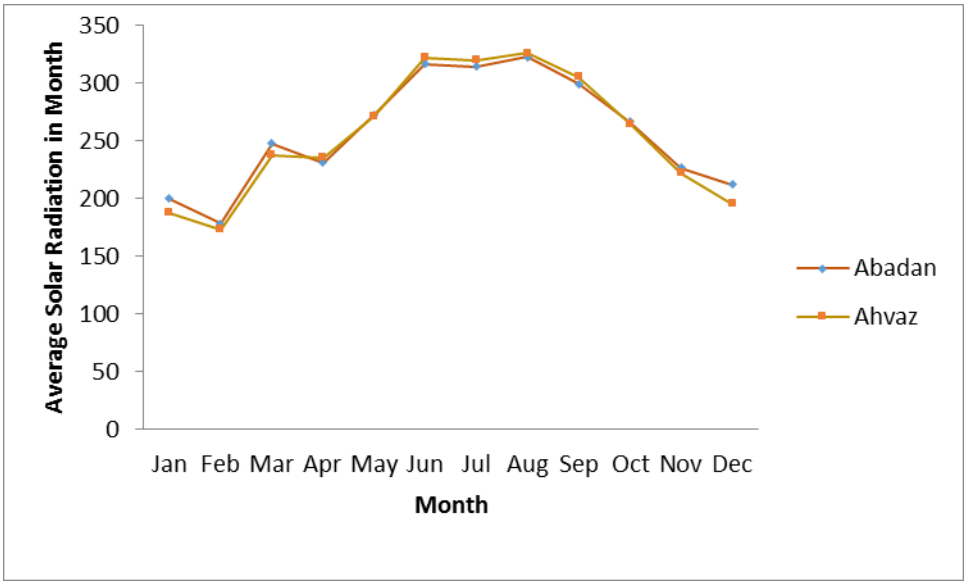


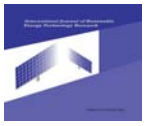
Fig 7. Monthly Solar Radiation of Abadan and Ahvaz

Conclusion

The rapid depletion of fossil fuel resources, environment problems, population of world and energy consumption, are vital factors to consider utilization clean energy. This article Present a Statistical analysis of solar radiation by Angstrom-Prescott (A-P) method for Abadan and Ahvaz cities, in this research first of all the data on solar radiation from the cities of Abadan and Ahvaz were collected from the Meteorological organization. Then the Angstrom-Prescott (A-P) method, in order to calculate solar radiation, used. The amount of radiation per month, the maximum amount of possible radiation monthly, constant equation coefficients, solar radiation on a flat surface and for a specified area and radiating out from the Sun's atmosphere was determined. In this way, the average amount of solar radiation annually was obtained 8.42 hours a day for the Abadan city and 8.28 hour Ahvaz city. Moreover, constant equation coefficients were obtained as 0.30 and 0.49 for Abadan also 0.31 and 0.47 for Ahvaz city obtained. Also monthly average daily radiation on a horizontal surface Ho = 31.02 and extraterrestrial radiation for the location Hg 17.03 (KJ/m2-day) for Abadan city and monthly average daily radiation on a horizontal surface Ho = 30.72 and extraterrestrial radiation for the location Hg 16.53 (KJ/m2-day) for Ahvaz city calculated. The results indicate that the studied area have high potential in terms of solar radiation as well as their ability to produce energy.

References

[1] Kasra Mohammadi, Shahaboddin Shamshirband , Por Lip Yee , Dalibor Petkovi, Mazdak Zamani, Sudheer Ch , Predicting the wind power density based upon extreme learning machineEnergy 86 (2015) 232-239.



[2] Kasra Mohammadi ,Shahaboddin Shamshirband , Mohammad Hossein Anisi , Khubaib Amjad Alam , Dalibor Petkovic, Support vector regression based prediction of global solar radiation on a horizontal surface, Energy Conversion and Management 91 (2015) 433–441.

[3] Ali Mostafaeipour , Ahmad Sedaghat, Morteza Ghalishooyan,Evaluation of wind energy potential as a power generation source for electricity production in Binalood, Iran, Renewable Energy 52 (2013) 222-229.

[4] Application and economic viability of wind turbine installation in Lutak, Iran Kasra Mohammadi, Ali Mostafaeipour, Ahmad Sedaghat, Shahaboddin Shamshirband, Dalibor Petković , Environmental Earth Sciences, 2016;75: 1-6.

[5] B. Ould Bilal, M. Ndongo , C.M.F. Kebe, V. Sambou, P.A. Ndiaye, Feasibility study of wind energy potential for electricity generation in the northwestern coast of Senegal, Energy Procedia 36 (2013) 1119 – 1129.

[6] H. Khorasanizadeh , K. Mohammadi , A. Mostafaeipour, Establishing a diffuse solar radiation model for determining the optimum tilt angle of solar surfaces in Tabass, IranEnergy Conversion and Management 78 (2014) 805–814.

[7] Cristina L. Archer 1, and Ken Caldeira, Global Assessment of High-Altitude Wind Power, Energies 2009, 2, 307-319; doi:10.3390/en20200307.

[8] Maryam Sadeghi, Bahram Gholizadeh, Economic analysis of using of wind energy, Case study:Baladeh city, North of Iran, International Journal of Agriculture and Crop Sciences, IJACS/2012/4-11/666-673.

[9] Renewable energy technologies: cost analysis series Solar Photovoltaic's 2012.

[10] Ramadan Abdiwe, Markus Haider, Investigations on Heat Loss in Solar Tower Receivers with Wind Speed Variation, Vol4 (4): pp, 159-165, 2015.

[11] Enda Flood, K. McDonnell, F. Murphy and G. Devlin, A Feasibility Analysis of Photovoltaic Solar Power for Small Communities in Ireland, The Open Renewable Energy Journal, 2011, 4, 78-92.

[12] T.Srinivas a,n, B.V.Reddy Hybrid solar–biomass power plant without energy storage, Case StudiesinThermalEngineering2(2014)75–81.

[13] Enda Flood, K. McDonnell, F. Murphy and G. Devlin A Feasibility Analysis of Photovoltaic Solar Power for Small Communities in Ireland, the Open Renewable Energy Journal, 2011, 4, 78-92.

[14] M. Jamil Ahmad, G.N. Tiwari Optimization of Tilt Angle for Solar Collector to Receive Maximum Radiation, the Open Renewable Energy Journal, 2009, 2, 19-24.

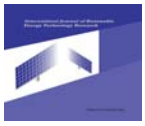
[15] Souvik Ganguli, Jasvir Singh, Estimating the Solar Photovoltaic generation potential and possible plant capacity in Patiala, international of applied engineering research, dindigul , Volume 1, No 2, 2010.

[16] M. Muralikrishna and V. Lakshminarayana, hybrid (solar and wind) energy systems for rural electrification, ARPN Journal of Engineering and Applied Sciences, vol. 3, 2008, No. 5.

[17] "Renewable 2015 Global Status Report".

[18] Ibrahim, A., Othman, M.Y., Ruslan, M.H., Mat, S., Sopian, K.: Recent advances in flat plate photovoltaic/thermal (PV/T) solar collectors. Renew. Sustain. Ener. Rev. 15(1), 352–365 (2011).

[19] M. Jamil Ahmad, G.N. Tiwari, Optimization of Tilt Angle for Solar Collector to Receive Maximum Radiation, the Open Renewable Energy Journal, 2009, 2, 19-24.



[20] Pragya Sharma,and Tirumalachetty Harinarayana, Solar energy generation potential along national highways, International Journal of Energy and Environmental Engineering 2013, 4:16.

[21] Ali A. Sabziparvar A simple formula for estimating global solar radiation in central arid Deserts of Iran, Renewable Energy 33 (2008) 1002–1010.

[22] http://www.wikepidia.com.

[23] www.iranchamber.com/provinces/25_khozestan/.php.

[24] www.map of world.com/Iran.

[25] Altin Maraj, Andonaq Londo, Coskun Firat ,Rexhep Karapici, Solar Radiation Models for the City of Tirana, Albania,international journal of renewable energy research ,2014 ,vol4No 2.

[26] Emmanuel A. Sarsah, Felix A. Uba, Monthly-Specific Daily Global Solar Radiation Estimates Based On Sunshine Hours In Wa, Ghana, international journal of scientific & technology research , 2013,volume 2 issue 8,Energy.

[27] N. N. Gana and D.O. Akpootu, Angstrom Type Empirical Correlation for Estimating Global Solar Radiation in North-Eastern Nigeria, International Journal Of Engineering And Science (IJES) Volume 2, 2013, Issue 11, pp58-78.

[28] Ashok Kumar Rajput, Rajesh Kumar Tewari and Atul Sharma Utility Base Estimated Solar Radiation at Destination Pune, Maharashtra, India, *Int. J. Pure Appl. Sci. Technol.*, 13(1) (2012), pp. 19-26.

[29] Sidra Afzal Shaikh, M. Akhlaque Ahmed, M. Wasim Akhtar, Total, Beam and Diffuse Solar Radiation Studies for Rohri, Sindh, isesco journal of Science and Technology, Vo l9 - N umber 16, 2013, pp 43-52.

[30] A.A. El-Sebaii, F.S. Al-Hazmi, A.A. Al-Ghamdi, S.J. Yaghmour,Global, direct and diffuse solar radiation on horizontal and tilted surfaces in Jeddah, Saudi Arabia, Applied energy 87 ,2010,568–576.

[31] M. H. Saffaripour , M. A. Mehrabian , H. Bazargan, Predicting solar radiation fluxes for solar energy system applications, Int. J. Environ. Sci. Technol,2013 10:761–768.

[32] inci turk togrol, estimation of solar radiation from angstroms coefficient by using geographical and meteorological data in Bishkek, Kyrgyzstan, Journal of Thermal Science and Technology©2009 TIBTD Printed in Turkey, Isı Bilimi ve Teknigi Dergisi, 29, 2, , 2009,pp 99-108.

[33] Huashan Li , Yongwang Lian ,Xianlong Wang, Weibin Ma, Liang Zhao, Solar constant values for estimating solar radiation , Energy 2011,pp 1-5.

[34] Godfrey Nnaegbo Okonkwo , Anthony Osita Chibuike Nwokoye, Relationship between global solar radiation and sunshine hour duration for Bida in Nigeria, international Journal of Renewable and Sustainable Energy 2014; 3(2): 43-46.