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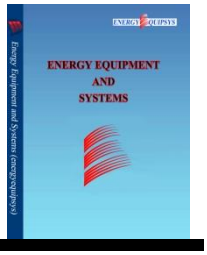

Possibility of supplying energy to border villages by solar energy sources

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ABSTRACT

Solar Energy is considered the cleanest and the most accessible energy source in the world. Its application is also one of the best electrification and energy transmission methods than other energy transmission models for outlying villages in terms of costs, transportation, maintenance, and similar factors. Accordingly, one of the critical studies on the context of exploitation of this energy is the possibility of establishing and identifying susceptive areas. In this study, the amount of solar energy entering the earth's surface and the number of cloudiness days were studied based on the studied area's meteorological data. Also, we designed and simulated solar photovoltaic power plants through the Meteorological Data on Virtual model. The solar analyzer function in the ArcGIS commercial closed environment was used to estimate the entering radiation to the earth's surface in the studied area. To study the number of cloudiness days has been used from the mentioned area's weather station data. The results showed that the solar analyzer function showed four months of the year available for full exploitation of these systems. The highest amount of radiation occurred after July. Optimal radiation conditions continue until November. In some days of the remaining months, this energy has been confronted with limitations. Nine villages were identified with the highest solar power utilization in the present study. Villages include the following: Kuran, Hurseen, Bavan, Barduk, Betic, Mareush, Jolfan, Sin Abad and Gudel.

Keywords: Solar Energy, Villages, Photovoltaic Power Plants, ArcGIS, Solar Analyzer Function.

1. Introduction

People's daily lives depend on energy production and consumption; therefore, energy supply and demand in human societies increase. On the other hand, in recent years, the limited availability of oil and other fossil fuels has exposed the whole world to future energy. Meanwhile, the replacement of renewable energy fossil fuels, such as wind and solar energy, has become especially important in reducing energy consumption, saving energy, controlling supply and demand of energy, and reducing pollutant emissions [1]. Many countries try to maximize solar energy use by replacing this energy to generate heat and electricity and reduce the losses due to fossil fuels. Replacing renewable energy fossil fuels, especially solar energy, is one of the most important coping strategies for energy crises and environmental problems caused by various energy sources in the present century [2]. Considering Iran's geographic location and its location on the world's solar belt, this country is one of the most critical countries in having solar

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radiation with the desirable potential and power [3]. Considering to spatial and geographical distribution of rural parts of Urmia and also due to distance from the national electrical power source, impossible and occasionally long-distance and lower applicant from transmission power; decision making to perform electrical power project was always countered with hesitating and showed the necessity of using solar radiation to supply current. Using solar radiation is one of the best ways to electrify and power generation than other energy transport models to the village and out-of-reach places considering cost, transportation, and maintenance. Benefit from solar radiation between the most critical parameters in system output, location, and condition of the system's panel installation [4]. To find the feasibility of using solar power, the main studied factors were solar energy submitted to earth and the number of cloudy days [5]. Submitted radiation is the main parameter in energy balance models. Despite this parameter importance, it is measured limited. Devices to measure this parameter and being expensive should be calibrated because of its high sensitivity, so most meteorological stations do not have it. Therefore, station measurements do not apply to the vast area due to spotty [6]. The importance of energy and different sources to supply is currently the fundamental approach of global governments. Fossil fuels assign most of the energy requirement sources [7]. The primary source of greenhouse gasses diffusion is the energy part, and supplying energy from fossil fuels generated a crisis for the environment and sublimate million tons of greenhouse gasses to the atmosphere [8]. Most world industries designed their energy supply infrastructures with fossil fuel sources (e.g., coal, oil, and natural gas). However, fossil fuels are considered non-renewable resources; humans should be looking for a substitution source to respond to energy demand [9]. In comparison, the energy intensity indicator[1] in Iran reaches 100 to 300 from 1984 to 2004. The means of energy intensity in the world is 0.4, which is more than 0.6 in our country [10]. Solar Energy, as one of the primary renewable energy sources, is suggested in two sorts of thermal and electrical power. European countries arrange to supply more than 50% of the low-pressure thermal requirement by solar heat sources until 2030 [11]. However, photovoltaic technology with high potential will be responsible for 5% and 11% of Europe's electrical demands for 2030 and 2050 [12]. Multi-objective optimization is used to maximize the production of power and water was used. The results showed that the total power generation values and freshwater production corresponding to the most optimal point are 719 kW and $14\frac{kg}{s}$, respectively. this method can be used for the development of local desalination plants [13]. These methods lead to the development of solar based integrated system with thermoelectric generators and reduce the cost of solar systems [14].

Today harms and restriction of fossil fuels and rising energy consumption increased the tendency to using renewable energy sources, especially solar radiation[15]. In contrast, from 2000 to 2011, per capita world energy production increased to 10.3 [16]. It is predicted that in 2050, this increment reaches more than 60% of 2020 consumption [17]. Supplying renewable energy considering Iran's potential, solar energy resulted in more maintaining natural resources and land revitalization due to zero CO_2 and other waste component production, reducing power transmission lines, increasing local independence in energy supply, and higher powering speed rural areas and lower costs [18]. Measurements also revealed that the number of sunny hours per year in Iran reduced from southeast to North West and increased from west to east [19]. Several methods suggested investigating solar radiation submitted to earth included: Satellite Images, Linear interpolation, Neural-artificial network, physical transport process [20]. An empirical relationship is available by meteorological data [21]. Energy/exergy / exergoeconomic (3E) parameters can affect the general competitiveness of energy systems use. These values even affect the construction of energy

1 . Energy Intensity: Energy Consumption Defined Base on Ton, Equivalent Crude Oil Per 1000 Dollar of Gross National Product

projects [22]. Generally, remote sensing technics due to accuracy and high speed and satellite images because of their time series preparation to investigate radiation can be a proper substitution for empirical and traditional procedures [23]. Most terrestrial phenomena such as radiation reached the ground cannot be directly determined by satellite images and should be investigated by satellite data input [24].

Most research has suggested the use of an independent electricity distribution network in rural and remote areas. The use of data stations is experimental and traditional and needs to be updated. In the reviewed research, cloudy days were not included in the calculations. Evaluating input radiation to the earth's surface in a given area is performed by the analytical instrument of solar radiation in ArcGIS software. Therefore, in this study, we investigated the number of cloudy days and the amount of solar radiation submitted to earth in the studied area and compared this amount to the photovoltaic system's requirement to assess installation feasibility and use those rural areas boundary parts of West Azerbaijan province in Iran.

2. Research background

Minor investigations were performed related to the feasibility of solar radiation application for energy production, some of the most related references presented in Table (1).

The high dependence and growing demand of the world on energy sources is the fundamental factor in developing economic activity. Limited fuel resources and other fossil fuels faced the world with the complicated issue of supply energy. Due to the natural span of renewable energy, especially solar radiation, and their availability in a given situation, this kind of energy is preferable. Considering the decline in investment in the new energy sector, setting environmental rules due to contamination and ecological changes in the earth, increasing energy usage, and sharing renewable energy in the economic development of disadvantaged areas, it is inevitable to replace solar energy with fossil fuels. Solar Energy is the unique renewable energy source of the

world and the primary source of other existing energy on the earth. It is also considered the best and cost-beneficial Energy in Iran that responds to most environmental concerns and as an inexhaustible source regarding Iran's geographical, environmental, and climate conditions, which can be exploited in Iran. Iran, located between 25 to 40 degrees of northern latitude, is one of the world's best countries to receive solar radiation energy [31].

Table 1. Research background

Subject Reviewed	Description	References
The potential of constructing a solar power plant by evaluating climatic parameters using GIS	This article studied the potential of solar power plant construction by evaluating climatic parameters by GIS. Finally, the Potentiometric plan was assessed for Khuzestan province and classified into seven categories.	[25]
Fuzzy logic application to FTOPSIS power plant location using GIS	This study evaluated to find a location for a solar power station by Fuzzy TOPSIS and finally find nine places as the best location to construct the solar station	[26]
Possibility of using solar energy to support lighting systems with satellite image processing in GIS space.	In this study, authors set and compared SEBAL and Solar Analyst models and concluded that the Solar Analyst function in comparison with the SEBAL algorithm is more appropriate and accurate numerically, and validation	[27,28]
Evaluating potential Evapotranspiration in Iran	Author to find Evapotranspiration by Stamper method in the Azerbaijan area, calculated submitted radiation to earth using DEM SRTM images with the help of the Solar Analyst function in the ArcGIS software environment	[29,30]

Solar radiation availability on the earth's surface is one of the leading causes of using solar systems worldwide. Solar radiation is defined as the energy amount received to the earth's surface at a particular time by WH/m2. Phenomena, which produces electric power influenced by solar radiation without a stimulator, nominated photovoltaic circumstance and system which used this called photovoltaic system, which is the most common use of new energy sources [32]. Photovoltaic cells have had the satisfying potential to supply energy for independent network applications and can be used to produce sustainable energy. The advantages of using this system can be numbered as preventing environmental pollution, no need for extensive transmission and distribution lines, and ease of maintenance and operation. Considering the 20 to 25 years long life of photovoltaic cells, this technology regards as a principal and applicable device to use new energy to respond to electrical energy supply out of public networks and complex access
areas [33].

The solar radiation analysis instrument between the spatial analysis devices can measure solar radiation's influence on different parts of the earth at a particular time and depict and analyze it. Applying this instrument, we can calculate atmospheric effects, longitude, the location altitude, slope, direction, daily and seasonal changes in the sun angle, and the effect of height shadow on received radiation to earth. The function above is advisable to calculate Surface radiation on a local scale. The inputs of the function included the digital Elevation Model, central part latitude, and given time. This uses the algorithm presented by Girija et al. (2019). The base of its function is combining sight orientation and a source of possible radiations[34]. This function calculates every entry cell's sight direction situation by an Input Digital Elevation Model (DEM) and then transferred to the supposed earth surface by special functions. In the next step, direct solar radiation in a different direction of the sky is made by a sun map on the hypothetical earth's surface. Sun map showed the sun's situation on special circuits at different times. Then the amount of radiation subject to diffusion is computed by Skymap. Finally, to measure direct solar radiation, sun map and sky map layers overlapped with sight direction in the given area [35,36].

3.Materials and Methods

The current study performed a descriptive-analytical approach in the aspect of entity and methodology that is practical. Managers can benefit from its results in planning and policymaking for producing and transporting new energy sources. This research concern is to eliminate one of the human needs and improvement and optimization tools, objects, and patterns to develop welfare and comfort and promote human life. Hence, it is practical (developmental) by the aim. Because its results are directly applied to solve problems and possess local and positional properties, and usually do not have generalizability properties in other locations except for similar areas, so it is scientific research.

3.1. Studied area

Urmia city as a center of west Azerbaijan province with 5312 km2 vastness, located in the northwest of Iran by 44^{o} and 24' to 45^{o} and 25' of eastern longitude and 37^{o} and 7' to 38^{o} and 10' of northern latitude. According to the 2020 census, the population was 3.081 million people, where the population of the rural part was calculated as 283510 [37]. The location of Urmia city in Azerbaijan province was presented in figure 1. This research also evaluated 150 villages of Urmia city located on a 15 km distance from the Iran-Turkey border.

3.2. Procedure

Figure 2 represented the overall steps and research procedures to the feasibility of using solar energy in border villages.

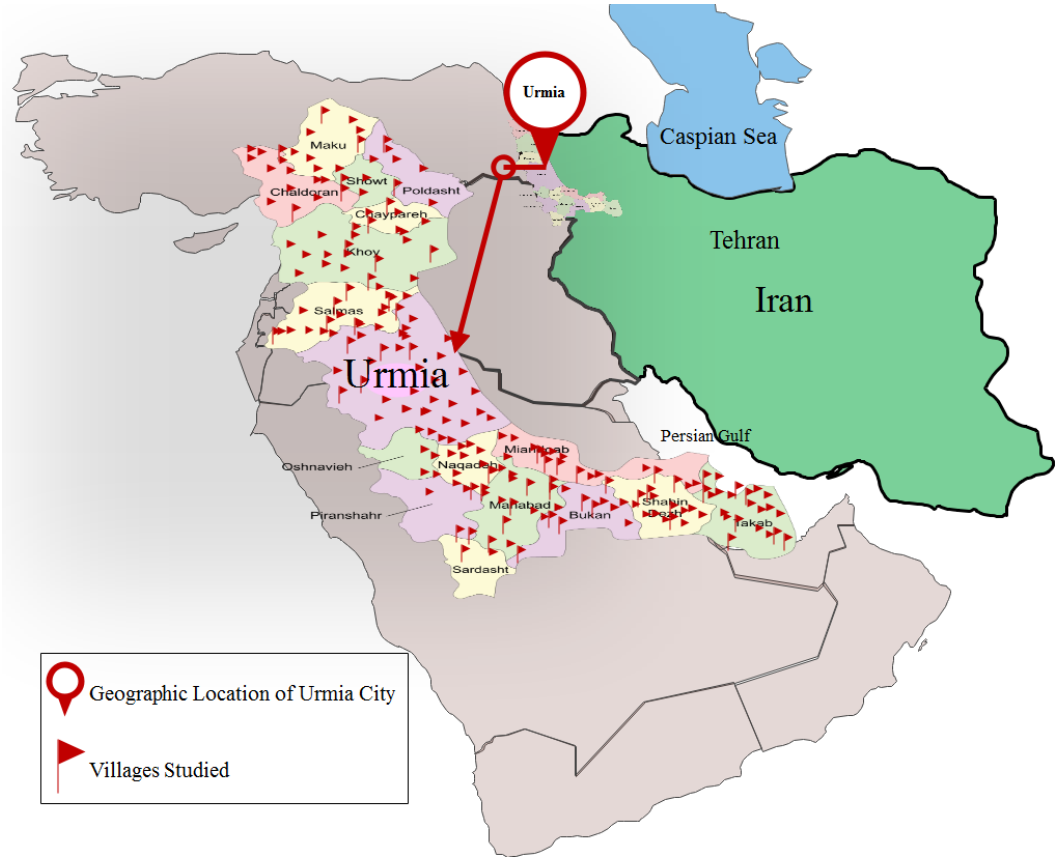


Fig.1. The geographic location of Urmia city and studied area situation

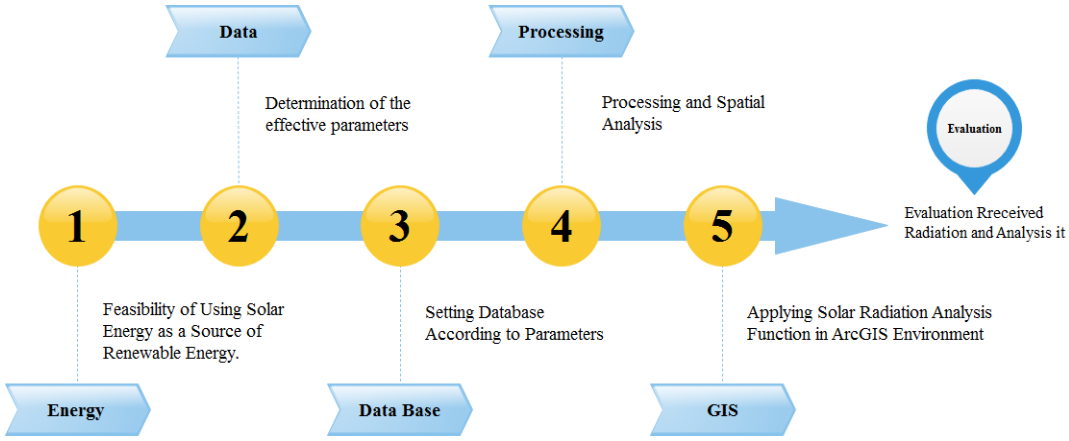


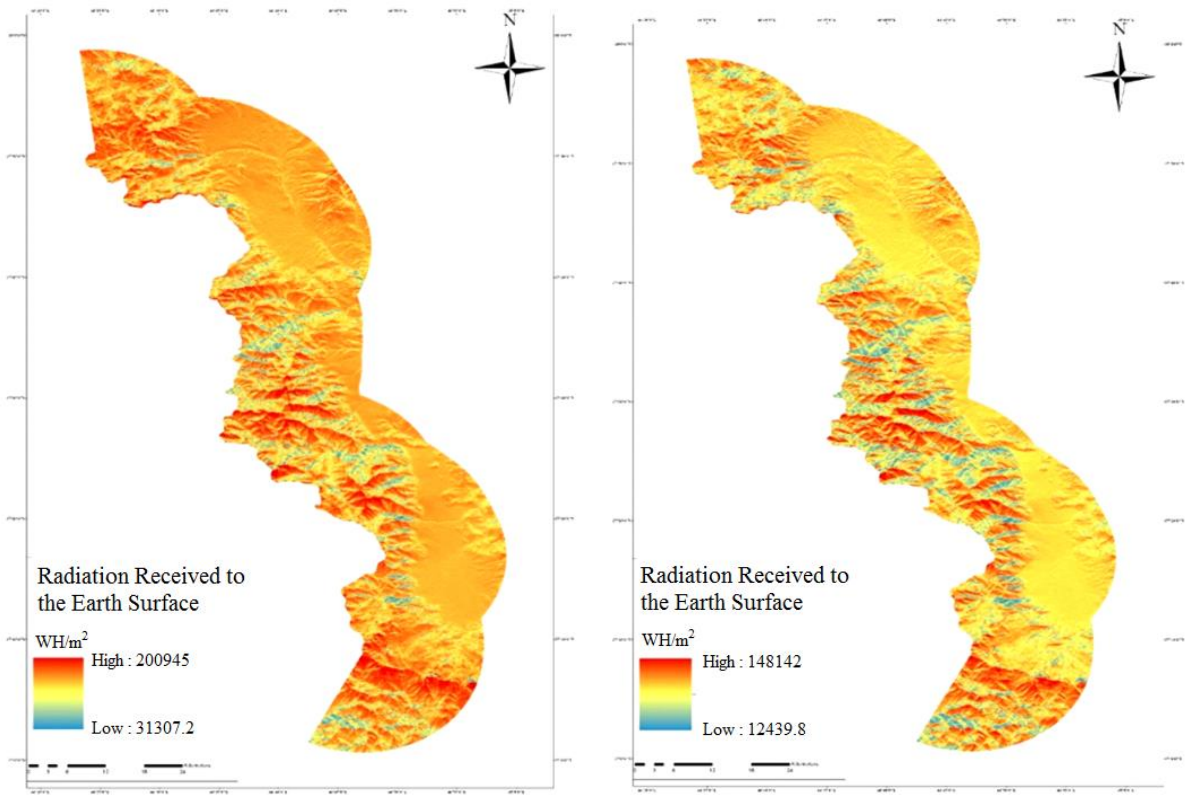
Fig.2: The overall procedure of research

3.3. Used data

- Digital terrain model related to ASTER Sensor (ASTER GDEM)
- Topographic maps 1/2500 studied area
- Meteorological data related to cloudy days for the studied area (Urmia station)
- During this experiment, we used ArcGIS 10.2 and Excel 2013 software.
- For analyzing energy data, Minitab software was used.

4.Results

In the current study, solar function analysis was used to investigate intake radiation to the earth's surface amongst spatial analysis instruments. This model input is Land Digital Model, so the Land digital model of the ASTER sensor was used with 28 m resolution. Due to extracting the location village in the studied boundary, a 1/2500 topographical map was used. Also, the primary input of the solar analysis function is Digital Elevation Model (DEM), so we isolated border villages from DEM, and by executing the solar analysis function, the means of submitted radiation to earth (by WH/m^2) were calculated in all days and then total radiation received to the earth was calculated for 12 months. Obtained values for both April and September were presented in Fig.3. The next step, received each village extracted radiation, and its amount for 28 villages among 150 was evaluated as defined in Fig.4. Radiation levels in different villages were studied in 12 months and divided into 32 categories. The top 10 shows the high radiation levels in the average range of 4500 WH/m^2 and the bottom 10 sets the lowest average of 2500 WH/m^2. The highest amount of radiation occurred after July. Optimal radiation conditions continue until November. Most of the radiation occurred in October. Kafshan region, with an average of 2916 WH/m^2 has the lowest radiation level, and the Kuran region with 4540 WH/m^2 has the highest radiation level.



a **b**

Fig.3. The obtained radiation. a: April, b: September.

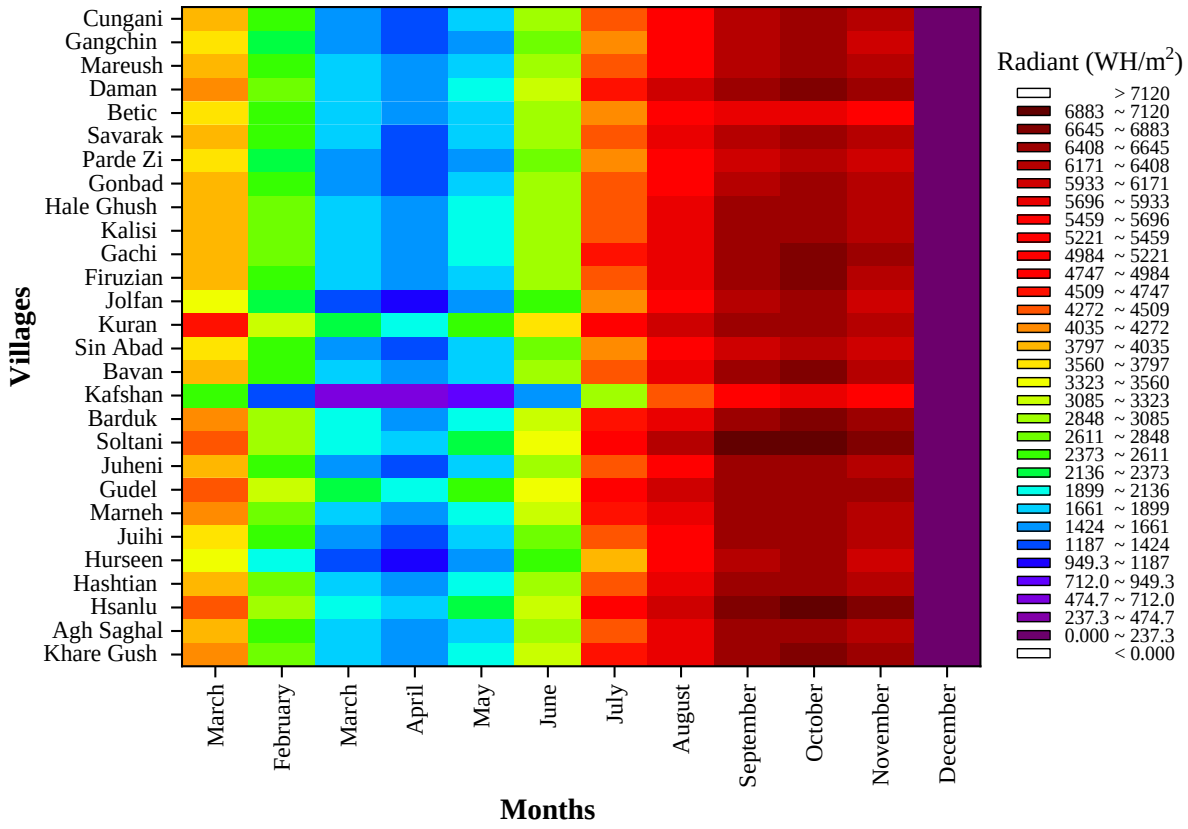


Fig.4: Average values for radiant received monthly for some villages

5.Discussion and Conclusion

The number of cloudy days and the amount of solar radiation submitted to earth in the studied area and compared this amount to the photovoltaic system's requirement to assess installation feasibility and use those rural areas boundary parts of West Azerbaijan province in Iran were investigated. Evaluating input radiation to the earth's surface in a given area was performed by the analytical instrument of solar radiation in ArcGIS software. To study the feasibility of using photovoltaic systems in border villages of Urmia, the area's technical and economic potential should be measured for power production. Solar radiation's technical potential means utilizing solar radiation employing currently available technology with specific efficiency without considering economic remarks and proximity to the consumer markets. Regarding the aim of the research, we only evaluate the technical potential of the area. Technical potential included the amount of received energy to the earth's surface and the number of cloudy days in the area. Photovoltaic systems require 1000 $Wh.m^2$ radiation in standard conditions to produce power. Results showed that mean daily radiation for all studied villages located in the range of 211 to 3556 $Wh.m^2$. Another criterion to measure the area's technical potential is the number of cloudy days, so using 60 years statistics (1951-2010), the number of cloudy days and averaging of values, the number of cloudy days separated by different months of the year were calculated. So the conditions of the study area considering receiving energy to the earth's surface and the number of cloudy days to use solar energy sources in the other months were presented in Table 2. Cloudy days were not found in July, August, September, and June, and the conditions for using solar systems are desired. The worst-case scenario is January, December, March, and April, which requires caution in the energy storage source of hybrid systems.

Table 2. Results obtained by evaluating the given area.

Months	Number of Cloudy Days	Number of Suitable Villages	Number of unsuitable villages
March	9	150	0
April	9	150	0
May	4	150	0
June	0	150	0
July	0	150	0
August	0	150	0
September	0	150	0
October	4	150	0
November	6	146	4
December	10	143	7
January	11	145	5
February	9	150	0

Results revealed that the study area in most of the villages had the lowest energy required to use in photovoltaic systems, and just cloudy days are considered as an obstacle to using solar energy. While and regarding the number of cloudy days in 4 months of the year, it is entirely possible to use solar energy, but there will be a restriction in another month for some days. Considering the received radiation to the earth's surface, ten villages had the most energy acquisition, so they were the best location to install and establish a solar system was indicated in figure 5. Nine out of 28 villages were introduced for the use of optimal solar systems. Villages include the following: Kuran, Hurseen, Havan, Barduk, Betic, Mareush, Jolfan, Sin Abad, and Gudel.

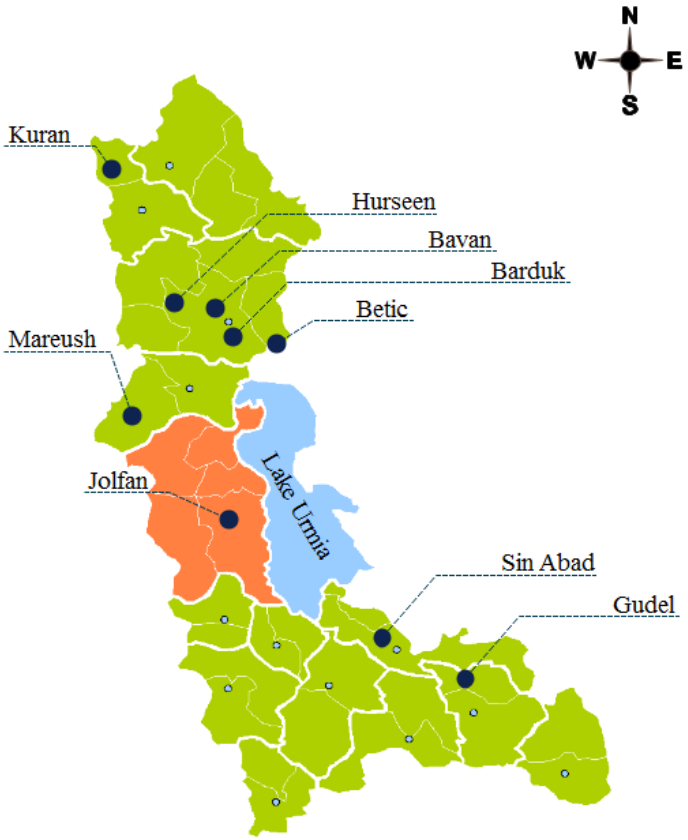


Fig.5. Villages with the most solar radiation received to the earth's surface

6.Conclusion

This study attempted to shift energy strategists from using traditional energy sources to renewable energy sources, taking into account the economic constraints of rural and border areas in Iran. To this end, the amount of solar energy reaching the earth's surface and the number of cloudy days were studied using local meteorological data. Used ArcGIS' commercial indoor solar analyzer to estimate radiation entering the study area. The year-long study took place in northwestern Iran's border and rural areas. Many energy strategists are unwilling to use renewable and sustainable energy because they do not see the long-term benefits. The average daily radiation of the villages studied ranges from 211 to 3556 $Wh.m^{-2}$. Although solar energy can be used to reduce the number of cloudy days in a month, there are some restrictions. The 10 cities with the highest electricity consumption are also the best places to install and build solar power plants.

References

[1] Y. Yu, Z. Xin Jin, J. Zu Li, L. Jia, Low-carbon development path research on China's power industry based on synergistic emission reduction between CO2 and air pollutants, J. Clean. Prod. 275 (2020) 123097. doi:10.1016/j.jclepro.2020.123097.

[2] F. Ghasemzadeh, M. Esmaeilzadeh, M. Esmaeili Shayan, Photovoltaic Temperature Challenges and Bismuthene Monolayer Properties, Int. J. Smart Grid. 4 (2020) 190–195. https://www.ijsmartgrid.org/index.php/ijsmartgridnew/article/view/131/pdf.

[3] J. Polo, C. Fernández-Peruchena, V. Salamalikis, L. Mazorra-Aguiar, M. Turpin, L. Martín-Pomares, A. Kazantzidis, P. Blanc, J. Remund, Benchmarking on improvement and site-adaptation techniques for modeled solar radiation datasets, Sol. Energy. 201 (2020) 469–479. doi:10.1016/j.solener.2020.03.040.

[4] M. Esmaeili Shayan, Solar Energy and Its Purpose in Net-Zero Energy Building, A. Pérez-Fargallo, I. Oropeza-Perez (Eds.), Zero-Energy Build. New Approaches Technol., IntechOpen, 2020. doi:10.5772/intechopen.93500.

[5] M. Azadbakht, E. Esmaeilzadeh, M. Esmaeili-Shayan, Energy consumption during impact cutting of canola stalk as a function of moisture content and cutting height, J. Saudi Soc. Agric. Sci. 14 (2015) 147–152. doi:10.1016/j.jssas.2013.10.002.

[6] G. Franzese, V. Della Rocca, F. Esposito, Resolution of the size/distance degeneracy of the dust devils signals observed with a stationary meteorological station, Aeolian Res. 44 (2020) 100594. doi:10.1016/j.aeolia.2020.100594.

[7] M.S. Esmaeili, G. Najafi, Energy-Economic Optimization of Thin Layer Photovoltaic on Domes and Cylindrical Towers, Int. J. Smart Grid - IjSmartGrid. 3 (2019) 84–91. https://www.ijsmartgrid.ijrer.org/index.php/ijsmartgridnew/article/view/61 (accessed July 8, 2019).

[8] M. Esmaeili Shayan, F. Ghasemzadeh, Nuclear Power Plant or Solar Power Plant, N. Awwad (Ed.), Nucl. Power Plants - Process. from Cradle to the Grave, IntechOpen, Landon, 2020. doi:10.5772/intechopen.92547.

[9] M. Esmaeili-Shayan, H. Shamsabadi, H. Azadi, Design and construction of a dynamic site to receive electricity from the river's flow studied by fishery and utilization workshops, Fourth Clean Energy Annu. Conf., Graduate School of Industrial and Advanced Technology, 2014.

[10] M. Esmaeili Shayan, Solar Energy and Nuclear Power. Economic Requirements and Hindrances, GRIN Verlag, 2020. https://books.google.com/books?id=KkL8DwAAQBAJ.

[11] B. Koçak, A.I. Fernandez, H. Paksoy, Review on sensible thermal energy storage for industrial solar applications and sustainability aspects, Sol. Energy. 209 (2020) 135–169. doi:10.1016/j.solener.2020.08.081.

[12] I. Boie, C. Kost, S. Bohn, M. Agsten, P. Bretschneider, O. Snigovyi, M. Pudlik, M. Ragwitz, T. Schlegl, D. Westermann, Opportunities and challenges of high renewable energy deployment and electricity exchange for North Africa and

Europe - Scenarios for power sector and transmission infrastructure in 2030 and 2050, Renew. Energy. 87 (2016) 130–144. doi:10.1016/j.renene.2015.10.008.

[13] A. Azad, E. Aghaei, A. Jalali, P. Ahmadi, Multi-objective optimization of a solar chimney for power generation and water desalination using neural network, Energy Convers. Manag. 238 (2021) 114152. doi:10.1016/j.enconman.2021.114152.

[14] A. Behzadi, A. Habibollahzade, P. Ahmadi, E. Gholamian, E. Houshfar, Multi-objective design optimization of a solar based system for electricity, cooling, and hydrogen production, Energy. 169 (2019) 696–709. doi:10.1016/j.energy.2018.12.047.

[15] A.R. Gupta, V.K. Rathod, Solar radiation as a renewable energy source for the biodiesel production by esterification of palm fatty acid distillate, Energy. 182 (2019) 795–801. doi:10.1016/j.energy.2019.05.189.

[16] I. V. Provornaya, I. V. Filimonova, L. V. Eder, V.Y. Nemov, E.A. Zemnukhova, Formation of energy policy in Europe, taking into account trends in the global market, in: Energy Reports, Elsevier Ltd, 2020: pp. 599–603. doi:10.1016/j.egyr.2019.09.032.

[17] A. Andreou, J. Barrett, P.G. Taylor, P.E. Brockway, Z. Wadud, Decomposing the drivers of residential space cooling energy consumption in EU-28 countries using a panel data approach, Energy Built Environ. 1 (2020) 432–442. doi:10.1016/j.enbenv.2020.03.005.

[18] L. Joshi, D. Choudhary, P. Kumar, J. Venkateswaran, C.S. Solanki, Does involvement of local community ensure sustained energy access? A critical review of a solar PV technology intervention in rural India, World Dev. 122 (2019) 272–281. doi:10.1016/j.worlddev.2019.05.028.

[19] M. Esmaeili Shayan, G. Najafi, A. Ahmad Banakar, Power Quality in Flexible Photovoltaic System on Curved Surfaces, J. Energy Plan. Policy Res. 3 (2017) 105–136. http://epprjournal.ir/browse.php?a_id=230&sid=1&slc_lang=en (accessed February 10, 2019).

[20] D. Guijo-Rubio, A.M. Gómez-Orellana, P.A. Gutiérrez, C. Hervás-Martínez, Short- and long-term energy flux prediction using Multi-Task Evolutionary Artificial Neural Networks, Ocean Eng. (2020) 108089. doi:10.1016/j.oceaneng.2020.108089.

[21] Q. Cao, Y. Liu, K. Lyu, Y. Yu, D.H.W. Li, L. Yang, Solar radiation zoning and daily global radiation models for regions with only surface meteorological measurements in China, Energy Convers. Manag. 225 (2020) 113447. doi:10.1016/j.enconman.2020.113447.

[22] A. Habibollahzade, Employing photovoltaic/thermal panels as a solar chimney roof: 3E analyses and multi-objective optimization, Energy. 166 (2019) 118–130. doi:10.1016/j.energy.2018.10.048.

[23] M. Esameili Shayan, G. Najafi, S. Esameili Shayan, Design of an Integrated Photovoltaic Site: Case of Isfahan's Jarghouyeh photovoltaic plant, J. Energy Plan. Policy Res. 6 (2021) 229–250. http://epprjournal.ir/article-1-858-en.html (accessed March 6, 2021).

[24] M. Norouzi, M. Yeganeh, T. Yusaf, Landscape framework for the exploitation of renewable energy resources and potentials in urban scale (case study: Iran), Renew. Energy. 163 (2021) 300–319. doi:10.1016/j.renene.2020.08.051.

[25] H.K. Firozjaei, M.K. Firozjaei, O. Nematollahi, M. Kiavarz, S.K. Alavipanah, On the effect of geographical, topographic and climatic conditions on feed-in tariff optimization for solar photovoltaic electricity generation: A case study in Iran, Renew. Energy. 153 (2020) 430–439. doi:10.1016/j.renene.2020.01.127.

[26] E.T. Asr, R. Kakaie, M. Ataei, M.R. Tavakoli Mohammadi, A review of studies on sustainable development in mining life cycle, J. Clean. Prod. 229 (2019) 213–231. doi:10.1016/j.jclepro.2019.05.029.

[27] M. Rezaei, A. Mostafaeipour, M. Qolipour, R. Tavakkoli-Moghaddam, Investigation of the optimal location design of a hybrid wind-solar plant: A case study, Int. J. Hydrogen Energy. 43 (2018) 100–114. doi:10.1016/j.ijhydene.2017.10.147.

[28] O.M. Roche, R.E. Blanchard, Design of a solar energy center for providing lighting and income-generating activities for off-grid rural communities in Kenya, Renew. Energy. 118 (2018) 685–694. doi:10.1016/j.renene.2017.11.053.

[29] Z. Alijani, F. Hosseinali, A. Biswas, Spatio-temporal evolution of agricultural land use change drivers: A case study from Chalous region, Iran, J. Environ. Manage. 262 (2020) 110326. doi:10.1016/j.jenvman.2020.110326.

[30] F. Shahbazi, A.A. Jafarzadeh, Integrated assessment of rural lands for sustainable development using MicroLEIS DSS in West Azerbaijan, Iran, Geoderma. 157 (2010) 175–184. doi:10.1016/j.geoderma.2010.04.010.

[31] M.K. Firozjaei, O. Nematollahi, N. Mijani, S.N. Shorabeh, H.K. Firozjaei, A. Toomanian, An integrated GIS-based Ordered Weighted Averaging analysis for solar energy evaluation in Iran: Current conditions and future planning, Renew. Energy. 136 (2019) 1130–1146. doi:10.1016/j.renene.2018.09.090.

[32] J. Li, Z. Zhang, B. Shen, Z. Gao, D. Ma, P. Yue, J. Pan, The capacity allocation method of photovoltaic and energy storage hybrid system considering the whole life cycle, J. Clean. Prod. 275 (2020) 122902. doi:10.1016/j.jclepro.2020.122902.

[33] F. Ghasemzadeh, M. Esmaeili Shayan, Nanotechnology in the Service of Solar Energy Systems, Nanotechnol. Environ., IntechOpen, London, 2020. doi:10.5772/intechopen.93014.

[34] S. Girija, A. Joshi, Fast Hybrid PSO-APF Algorithm for Path Planning in Obstacle Rich Environment, IFAC-PapersOnLine, Elsevier B.V., 2019: pp. 25–30. doi:10.1016/j.ifacol.2019.12.616.

[35] P. Bartie, W. Mackaness, O. Lemon, T. Dalmas, S. Janarthanam, R.L. Hill, A. Dickinson, X. Liu, A dialogue based mobile virtual assistant for tourists: The SpaceBook Project, Comput. Environ. Urban Syst. 67 (2018) 110–123. doi:10.1016/j.compenvurbsys.2017.09.010.

[36] K. Matsuo, T. Tanaka, Analysis of spatial and temporal distribution patterns of temperatures in urban and rural areas: Making urban environmental climate maps for supporting urban environmental planning and management in Hiroshima, Sustain. Cities Soc. 47 (2019) 101419. doi:10.1016/j.scs.2019.01.004.

[37] Noname, SCI, (2020). https://www.amar.org.ir/english (accessed September 27, 2020).