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Evaluating the potential of solar energy and its role in supporting the infrastructure services at Trebil border complex in Anbar Governorate

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ABSTRACT

The study area has a large abundance of renewable energy sources, especially solar radiation, so it must be invested in supporting the anchor structures services in the Trebil Border Complex, and for this reason, the analytical - quantitative approach was used as well as meteorological data for solar radiation, wind and rain, and the research found that a complex Trebil boundary needs electrical energy up to (1215464) watts / hour / day equivalent to (1215.464) kilowatt hours. To meet this need, the research suggested a solar system because the stations in the study area have a very large solar flood, and the capacity of that system has reached (1225) A kilowatt / hour by (3500) solar panels with an area of (8000-10000) square meters and a cost of (1225000) dollars at a cost of (1) dollars per watt, with internal street lighting And surveillance cameras, solar heaters, desalination plants, and more than the complex needs, through which the areas near it are fed, especially the Rutba district.

Introduction

Man has become accustomed to using renewable energy on a daily basis in order to meet his needs of electric energy, and these needs are not limited to the pioneers and residents of cities only, but also extend to reach remote areas, especially at border outlet complexes that are located in remote areas far from residential areas, so he took care Research using renewable energy sources in the study area, especially (solar radiation), and employing them in the service of the pioneers and residents of the Trebil border complex.

Research problem

The research problem is summarized as follows: Does the potential of renewable energy have a role in supporting the infrastructure services of the Trebil border complex in Anbar province, and are there actual renewable energy projects that supply this complex.

Research hypothesis

The research hypothesis is summarized as follows: The potential of renewable energy has a great role in supporting the infrastructure services of the Trebil border complex in Anbar province, if it is invested in actual projects that supply this complex.

Research objective:

The research seeks to achieve the following
1.Knowing the role of solar energy potentials in the study area and the importance of developing it.
2- Knowing the role and importance of renewable energy sources in supporting the anchor services for border crossing complexes in Anbar Governorate.

Research Methodology

We have been relying on the analytical - quantitative approach through the use of statistical and quantitative methods and programs as needed in order to determine the best places to establish solar energy systems within the Trebil Border Complex, through a survey based on the Iraqi weather records for the period (1989-2019). The study area was spatially delineated in the Trebil border complex and the surrounding areas. The study area was spatially defined in the Trebil complex, as the complex is located between two latitudes (30 44 32 - 30 45 32) and two longitudes (30 00 39 - 30 01 39) degrees. As for the study time limits, the climatic characteristics of the study area were studied for the period between two years (1990-2020) for a period of thirty years to show the potentials of the study area from solar radiation, the study relied on data from Al-Rutba Station, Al-Nukhaib Station and Al-Qaim Station As shown by the data in Table (1).

Table 1. The stations of the study area in terms of location, height above sea level, and global Anotropic number

Station name	Anotropic number	Altitude (M)	Location in relation to latitude (N)		Location in relation to longitude
Humid	40642	630	2¯	33°	17¯ 40 °
Based	40627	177	8¯	34°	41¯ 41 °
Al-Nukeeb	40658	305	2¯	32°	15¯ 42 °

Reference : The researcher's work based on: The Ministry of Transport and Communications, the Iraqi General Authority for Meteorology and Seismic Monitoring, Iraq Climate Atlas, unpublished data, Baghdad, 2000.

Characteristics of solar radiation in the study area

Solar radiation is very important among the other elements of the climate because it is responsible for all the processes that occur in the atmosphere, such as clouds, rain, air turbulence, thunderstorms and other elements.[1] And the main source of energy on the surface of the earth, through which electrical energy can be generated even in remote areas. Which is urgently needed, as is the case in the study area because it is located in the depth of the desert and far from residential areas, and thus the sun controls the climate and life on the surface of the earth and plays a major role in the development and progress of human life.[2] In order to know the radiation characteristics in the stations of the study area, it is necessary to identify the monthly and annual rates of the amount of solar radiation arriving at those stations and the monthly distributions and annual rates for them during the period (1989-2019).

Map (1) of the location of the study area

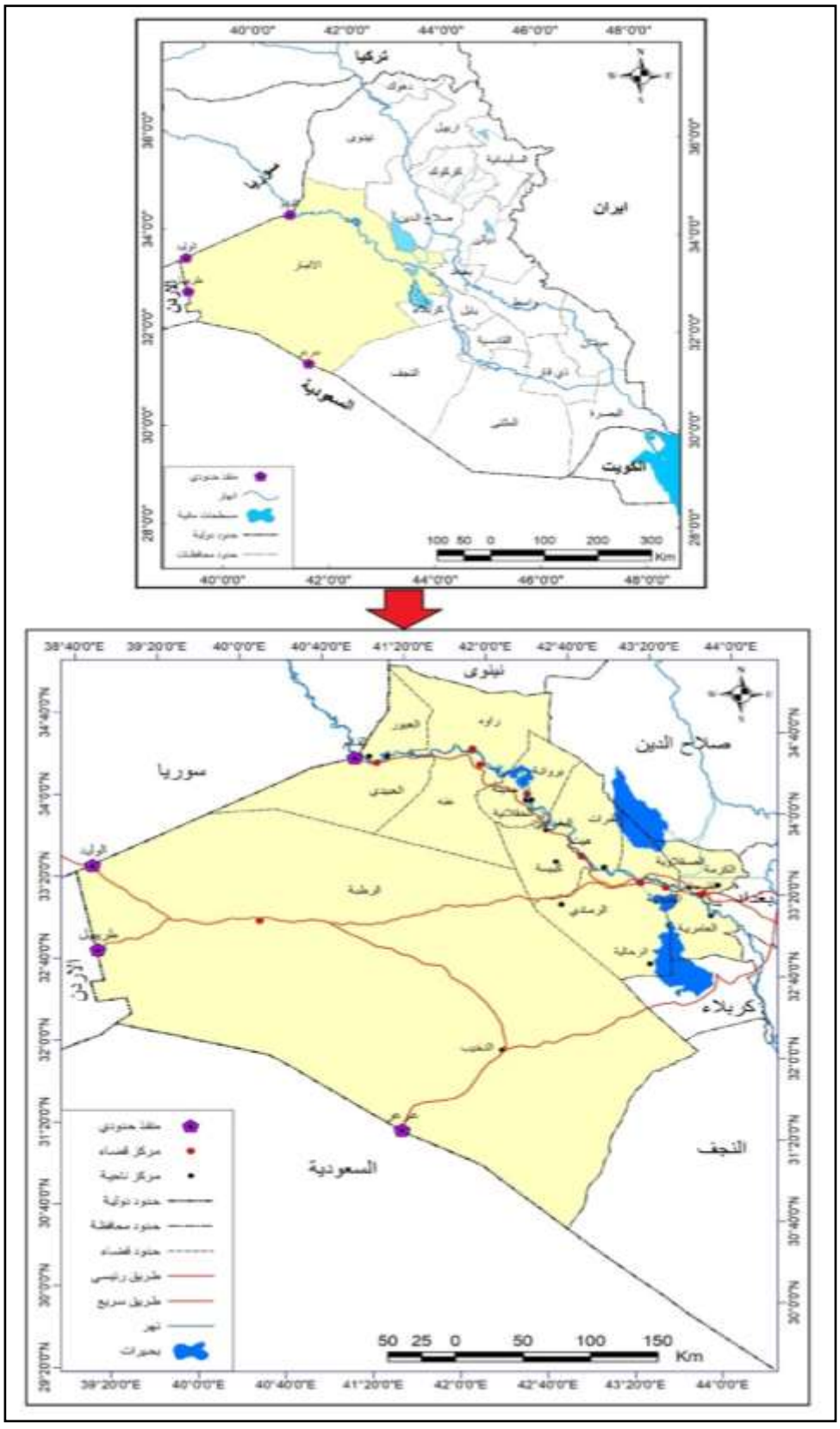
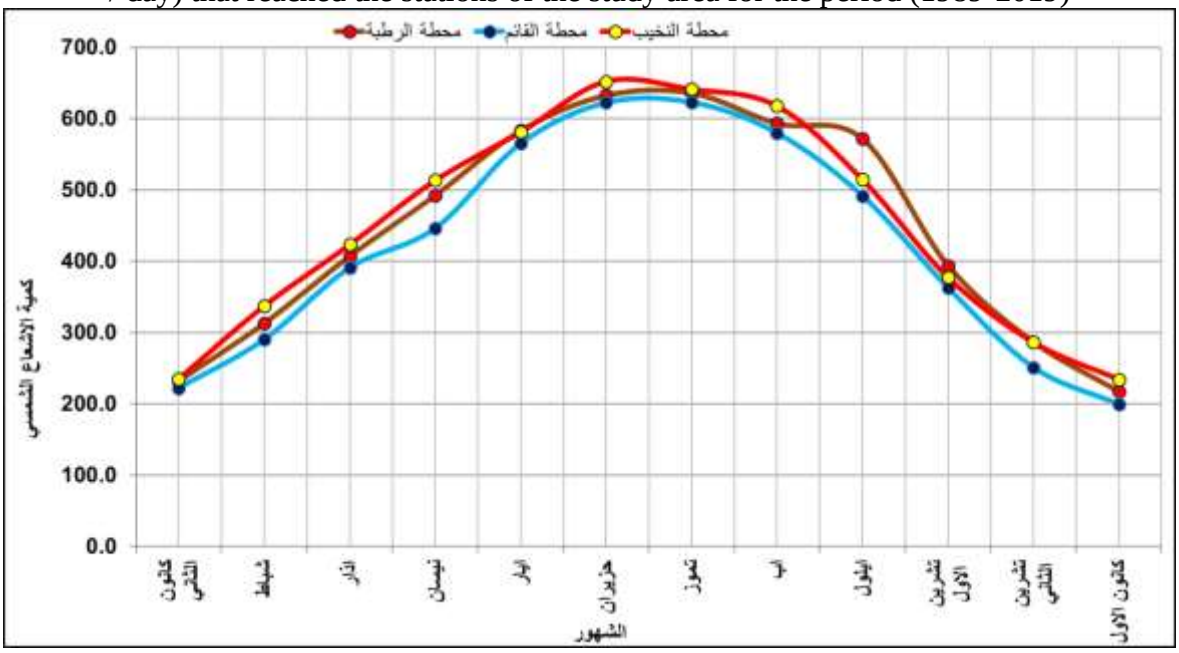


Table 2. The monthly and annual rates of the total amount of solar radiation (calories / cm2 / day) that reached the stations of the study area for the period (1989-2019)

Months	**The station**		
January	Al-Rutba station	Al-Qaim station	Al-Nukhaib Station
February	232.1	222.1	235.3
March	312.8	290.3	337.6
April	407.1	390.7	423.4
Mays	492.3	446.1	513.4
June	583.2	565	581.2
July	632.7	622.3	652.2
Father	636.2	622.8	641.3
September	593.5	579.7	617.7
October	571.9	491.5	514.7
November	394.1	362.8	377.5
December	286.9	251.1	286.7
annual rate	217.1	199.2	234.5

Reference Ministry of Transport and Communications, General Authority for Meteorology and Seismic Monitoring, Agricultural Climate Division, Baghdad, unpublished data, 2020.

Figure 1. The monthly and annual averages of the total amount of solar radiation (calories / cm2 / day) that reached the stations of the study area for the period (1989-2019)



Reference - From the researcher's work, depending on the data of Table No. (2)

It is evident from the data of Table No. (2) and Fig. No. (1) that the study area has a very large sun flood that varies during the seasons of the year between stations (Al-Rutba, Al-Qaim and Al-Nukhayb), whose rates range between (217.1-636.2) calories / cm2 / day for the station Al-Rutba and (199.2-622.8) its price / cm2 / day and finally Al-Nukhayb station, whose monthly rates range between (234.5-652.2) price / cm2 / day. Its annual rate is (451.3) its price / cm2 / day, followed by the Al-Rutba station, the annual rate of which is (446.7), its price / cm2 / day, and finally it is followed by the Al-Qaim station, which is considered to be the least receiving solar radiation among the stations in the study area, as its annual rate is (420.3) Its price is / cm2 / day.

Solar radiation energy in the study area

1. The annual average of the amount of solar energy in the study area

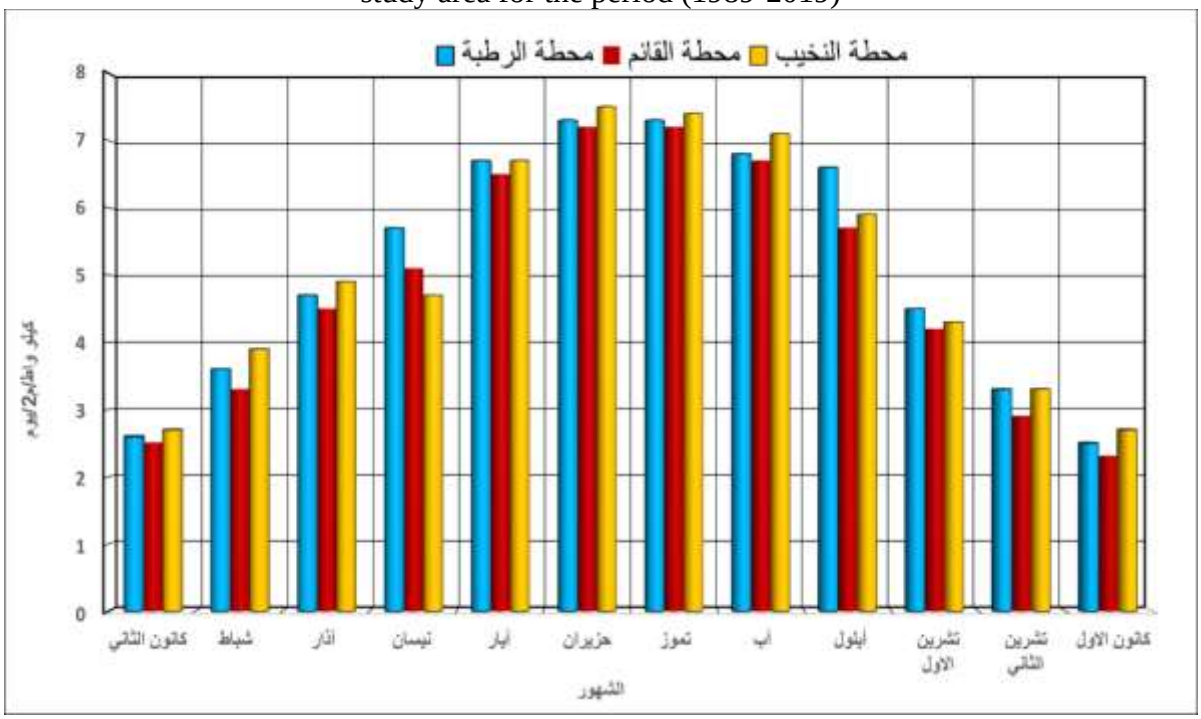
The study area enjoys a large abundance of solar energy as it has high rates compared to other parts of the Iraqi country. Many studies have been conducted to estimate the amount of solar energy arriving to the governorate in general, but the study that we are about will depend on converting the total amount of solar radiation arriving to the district stations The study within Anbar Governorate to solar energy using the following equation

Table 3. Annual average of the amount of solar energy (kilowatt / m2 / day) stations in the study area for the period (1989-2019)

Months	**The station**		
January	Al-Rutba station	Al-Qaim station	Al-Nukhaib Station
February	2.6	2.5	2.7
March	3.6	3.3	3.9
April	4.7	4.5	4.9
Mays	5.7	5.1	4.7
June	6.7	6.5	6.7
July	7.3	7.2	7.5
Father	7.3	7.2	7.4
September	6.8	6.7	7.1
October	6.6	5.7	5.9
November	4.5	4.2	4.3
December	3.3	2.9	3.3
annual rate	2.5	2.3	2.7

Reference : The above rates were extracted depending on the application of the following equation: m = k x w, where: - m = amount of solar energy k = total solar radiation w = constant and equal to 0.0116

Figure 2 . Annual average of the amount of solar energy (kilowatt / m2 / day) stations in the study area for the period (1989-2019)



Reference - From the researcher's work based on the data of Table No. (3)

The study area enjoys an enormous amount of solar energy, as the annual average amount of solar energy reaching all its stations is about (5.0) kilowatt / m2 / day, and this is equivalent to (1800). Kilowatt / m2 / year for all parts of the study area, and from Table (3) and Fig. (2), the following shows

1.The amount of solar energy delivered to the study area ranges between (4.8-5.2) kilowatt / .square meters / day

2.The amount of the incoming solar energy did not fall below (4.8) kilowatt / square meters / day in all stations in the study area, as the lowest value was recorded in the Al-Qaim station, which amounted to (4.8) kilowatt / square meters / day and this is equivalent to (1728) kilowatt / .square meters /Year

3- The Al-Nukhayb plant acquires the largest amount of solar energy connected to it, as the annual average in it is (5.2) kilowatt / square meters / day, and this is equivalent to (1872) kilowatt / square meters / year.

2- The seasonal average of the amount of solar energy delivered to the study area

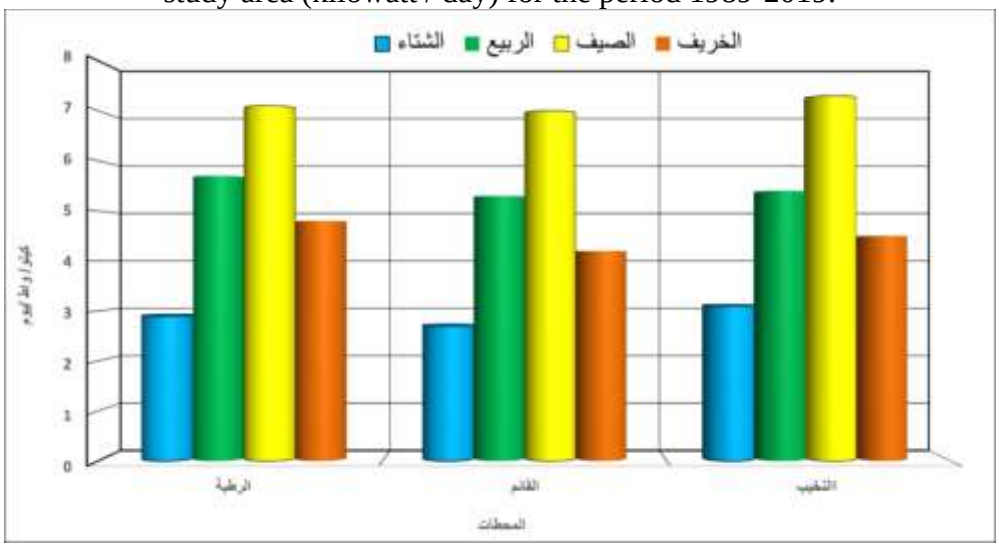
Through the data of Table No. (4) and Fig. No. (3), it is clear that the amount of solar energy rises in the direction from the winter season towards the summer and then decreases again in the direction towards the autumn season. M 2 / day and increased, as it rose in the spring to (5.7) kW / m 2 / day, and in the summer it reached (7.1) kW / m 2 / day, but in the fall season it decreased to (4.8) kW / m2 / day. As for the Al-Qaim station, the average amount of solar energy in the winter season reached (2.7) kilowatt / square meters / day, while in the spring it reached (5.3) kilowatt / square meters / day, while in the summer it increased to (7.0) kilowatt / square meters / day. Then it decreased to (4.2) kilowatt / square meters / day in the fall season, and in the Al-Nukhayb station the average amount of solar energy was (3.1) kilowatt / square meters / day in the winter season, and in the spring it increased to (5.7) kilowatt / square meters / day. It continued to rise in the summer to (7.3) kW / m2 / day, then it decreased in the autumn to (4.5) kW / m2 / day. The spatial variation in the same separation between the stations of the study area plays a fundamental role, as this spatial difference shows that the quantities of solar energy rise as we go from north to south within Anbar Governorate and as shown in Table No. (4) and Figure No. (3), where we find that the amount The energy in the Al-Rutba station in the winter season reaches (2.9) kilowatt / square meters / day, while in the Al-Nukhayb station for the same season it reached (3.1) kilowatt / square meters / day, and in the Al-Qaim station it reached (2.7) kilowatt / square meters / day. In the spring season, this rate in Al-Rutba station reached (5.7) kW / m2 / day, and in Al-Qaim station (5.3) kW / m2 / day, while in Al-Nukhaib station it reached (5.4) kW / m2 / day, and this same applies to the rest of the chapters. the year.

Table 4. The seasonal average amount of solar energy supplied to the stations in the study area (kilowatt / day) for the period 1989-2019.

The station	winter	the spring	the summer	The autumn
AlRutiba	2.9	5.7	7.1	4.8
AlQayim	2.7	5.3	7.0	4.2
AlNakhib	3.1	5.4	7.33	4.5

Reference : based on the data of Table No. (3).

Figure 3. The seasonal average of the amount of solar energy supplied to the stations in the study area (kilowatt / day) for the period 1989-2019.



Reference : From the researcher's work based on Table No. (4)

3- The monthly average of the amount of solar energy delivered to the study area

The monthly rates of the amount of solar energy arriving in the study area are characterized by its variation from month to month and from one climate station to another, but it is characterized by a set of general characteristics, namely The amount of solar energy increases in the direction from the north of the study area to its south in the different months of the year, and this becomes clear if we compare the amount of energy in these stations and in any month of the year. M 2 / day, and in Al-Qaim station, the rate for the same month was (2.3) kilowatt / square meters / day, while in Al-Nukhayb station it reached (2.7) kilowatt / square meters / day In the month of March, the amount of solar energy in the Al-Rutba station reached (4.7) kilowatt / square meters / day, and in the Al-Qaim station it reached (4.5) kilowatt / square meters / day, while in the Al-Nukhayb station it reached (4.9) kilowatt / square meters / day. As shown in Table (3) that The summer months in all stations in the study area record the highest rates of the amount of solar energy, so the general average for the months (June, July, and August) was about (7.3, 7.3, 6.8) kilowatt / m2 / day, and despite this, the stations of the study area are characterized by their homogeneity The amount of solar energy supplied to it, as shown in Table (3). The winter months record the lowest rates of solar energy reaching the study area. The general average for the months of January, December and February is about (2.6, 2.5, 3.6) kilowatt / m 2 / day. Through the data of Table No. (3), it becomes clear that there are two directions for the difference in the amounts of solar energy reaching the different parts of the study area, the first is spatial and the second is temporal. Al-Rutbah (2.6) kW / m2 / day, and in Al-Qaim station (2.5) kW / m2 / day, while in Al-Nukhayb station it reached (2.7) kW / m2 / day. As for the temporal variation, it can be clarified by studying each station separately in order to give an honest picture of the quantities of solar energy in the year as follows: - The movement of receiving solar energy quantities in the Rutba station for all months of the year starting from January amounted to (2.6) kilowatt / square meters / day, and this rate increased to reach (5.7) kilowatt / square meters / day in the month of April, and after that the rate starts to rise in a way represented No. (2) until the amount of solar energy reaches its highest point in the month of June to reach (7.3) kilowatt / square meters / day, then it decreases again in the month of September to reach (6.6) kilowatt / square meters / day, until it reaches its lowest levels in a month December by (2.5) kW / m2 / day. As for the Al-Qaim station, it recorded a marked

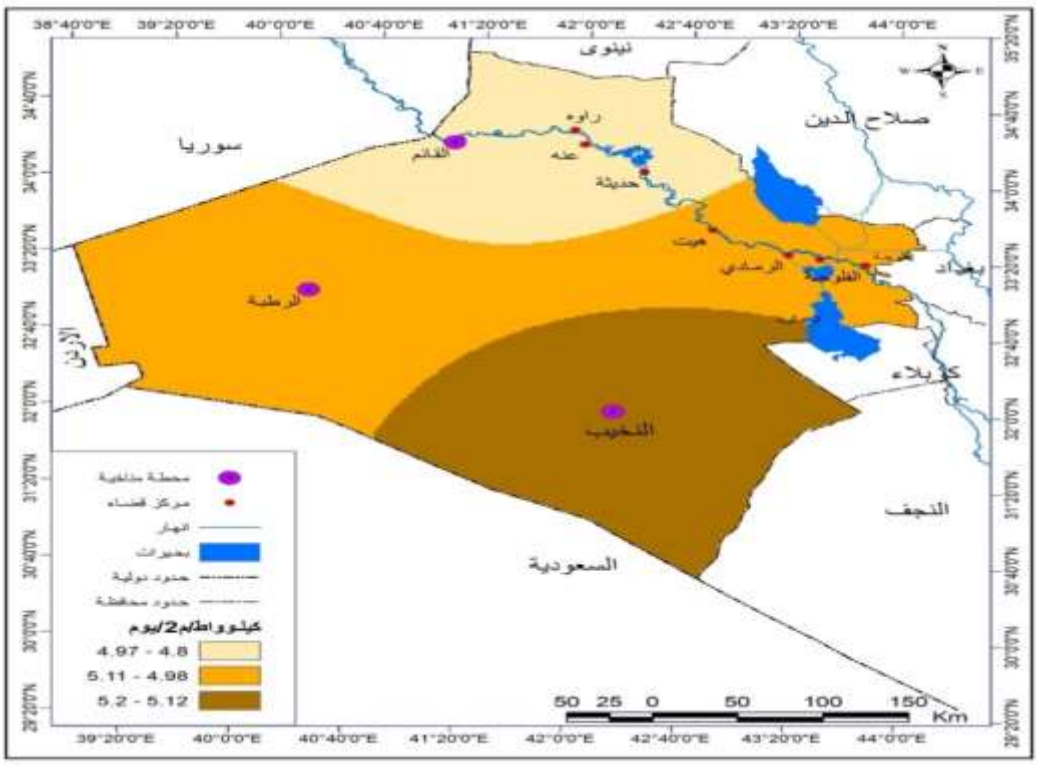
variation from month to month, as the average amount of solar energy reaching it ranges between (2.3 - 7.2) kilowatt / square meters / day, as it recorded an average amount of solar energy in the month of January (2.5) kilowatt / square meters / day. The rate increased to (5.1) kilowatt / square meters / day in April, then the rate continued to rise with the advancement of summer, reaching its highest amount during the month of June by (7.2) kilowatt / square meters / day, then it gradually decreased until it reached its lowest rates in The month of December to reach (2.3) kilowatt / m 2 / day, and through the analytical budget of the figures and tables of the monthly rates of the stations of the study area, the Al-Qaim station comes in the last place in terms of the monthly rates of the amount of solar energy reaching it. Whereas, the amount of solar energy that arrived at Al-Nukhayb station in January reached (2.7) kilowatt / square meters / day, while in March it reached (4.9) kilowatt / square meters / day, then this rate increased to reach its highest value in the month of June by (7.5 kW / m 2 / day, then soon until the amount of solar energy begins to gradually decrease, registering in the month of October a rate of (4.3) kilowatt / m2 / day, and then continuing to decrease to reach its lowest rate in the month of December, reaching (2.7)) Kilowatt / m 2 / day, and through the foregoing it became clear that the Al-Nukhayib station ranks first among the stations in the study area in terms of receiving the quantities of solar energy reaching it, through the data of Table No. (3) we can divide the study area into three geographical regions according to You receive it from the amount of solar energy and these regions, as shown in Map No. (2), are: -

1- The first region: It is distinguished as the highest regions in terms of the amount of solar energy received by it. This region represents Al-Nukhayb station, as the average amount of solar energy reaching it is about (5.2) kilowatt / square meters / day and this is equivalent to (1972) kilowatt / square meters / year And this rise in the rate of solar energy is due to the high rate of the amount of solar radiation in it, which reaches (451.3) its price / cm2 / day.

2- The Gethsemane region: This region is characterized by moderate rates of solar energy reaching it, as the average amount of solar energy reaching it reached (5.1) kilowatt / square meters / day and this is equivalent to (1836) kilowatts / square meters / year and this region includes the Rutba station as the equilibrium The amount of solar energy within this region is related to the average rate of total solar radiation in it, which amounted to about (446.7) calories / cm2 / day.

3- The Third Region: This region is characterized by low rates of solar energy reaching it, as the rate of solar energy in it is about (4.8) kilowatt / square meters / day, and this is equivalent to (1728) kilowatt / square meters / year, which includes the Al-Qaim plant and the reason for the decrease in the average amount of energy The solar system is due to the low average amount of total solar radiation in it, which reached (420.3) calories / cm2 / day.

Map (2) of the solar radiation regions in the study area



References : based on the data of Table No. (18

Evaluating the renewable energy sources in the two border complexes of Al-Walid and Trebil and their role in supporting the anchor services

Solar energy potential at Trebil border complex

The study area has a large flood of solar radiation through which it can generate abundant amounts of electrical energy through solar cells, as the annual rate of the amount of solar radiation for the Al-Rutba station reached (446.7) calories / cm2 / day with a period of (30) years, and this is evident in Table No. (15), As for the amount of energy that can be generated in the Rutba plant, its annual average is about (5.1) kilowatt / square meters / day, and this is evident from the data of Table No. (18) The study also found that the Trebil border complex consumes electrical energy estimated at (1215464) watts / hour / day, which is equivalent to (1215.464) kilowatt hours. The other ancillary services he needs, because the electric power is the basis on which the rest of the anchor infrastructure services in the complex are based. Thus, the study suggested the solar complex with energy production quantities that reached (1225) kilowatt / hour, and thus the number of solar panels needed by the project reached (3500) panels with a production rate of (350) watts per panel. As for the location, direction and size of the project and its economic cost, its location and direction must be in a direction through which the largest possible amount of solar radiation can be received. For solar rays during daylight hours, as shown in Map No. (3), while the area of land needed by the solar project is between (8000-10000) m ^{2} As for the economic cost of the project, the study concluded that the cost of producing one watt of photovoltaic cells amounted to $ 1 with the cost of installation and providing all the services needed by the project. The electrical energy from the Jordanian side or provided by generators (diesel), and that costs gradually decrease in the event that other renewable energy sources are invested in the complex. The photovoltaic project contributes to supporting all the anchor services in the Trebil border complex, as the provision of electric power is the cornerstone of providing other services as the provision of desalinated water, its pumping and disposal of wastewater thrown by the complex, as well as the provision of communication services and street lighting, all depend on electric energy. Thus, the provision of all these services is a major factor in attracting the population to the compound area and then it becomes a growing pole that contributes to realizing spatial development.

The economic feasibility of investing solar energy in the Trebil Border Complex

The Trebil complex represents a commercial importance that exceeds all the complexes of the study area, especially after the events of 2013, as it is the only highly effective commercial complex in the study area, so the complex must be supported with all the anchor services, and thus it is necessary to identify the administrative structures of the complex , From the observation of Table No. (5), it became clear that the number of springs in the Trebil complex amounted to (237) which were separated by (2 - 2.5) tons, and the number of refrigerators reached (170), while the number of lighting points in all urban structures of the complex reached (2106) in addition to the number The air fans in the complex are (332) fans, in addition to the number of electronic computers and printers, which reached (102) calculators and (99) printers, and they require continuous electrical energy, so it must be provided by relying on renewable energy sources because the study area abounds in it.

Table (5) the electrical devices in the Trebil border complex

Directorates	Sepals.	Refrigerators	Lamps	Fans	laptops	Printers
Trebil Port Directorate	16	8	125	32	12	12
Civil Customs Center	26	16	150	40	30	30
Military Customs Center	7	4	52	14	5	5
Police station	8	4	82	7	2	2
Intelligence	2	2	45	4	3	2
Passports and residency	10	5	120	16	10	10
Civil Defense	2	1	52	3	1	1
Mechanisms Division	1	1	46	2	1	1
Access control	1	-	45	1	1	1
General Supervisor Department	8	3	40	12	8	8
Check-out control	1	-	28	1	1	1
Warehouse	5	-	32	12	1	1
National Security	2	1	22	3	1	1
Electric Circuit	2	1	24	3	1	1
Water circle	2	1	8	3	1	1
The bank	2	1	32	4	3	3
Telecommunications	1	1	22	2	1	1
Plant quarantine	1	1	20	3	1	1
Veterinary quarantine	2	1	25	4	1	1
the hotel	120	110	950	125	4	2
Tax	2	1	26	3	2	2
Road transport	2	1	35	3	2	2
International transport	2	1	26	3	2	2
Directorate of old enforcement	8	4	54	16	8	8
All inclusive	4	2	45	16	-	-
Health Center	6	3	52	12	1	1
Total	237	170	2106	332	102	99

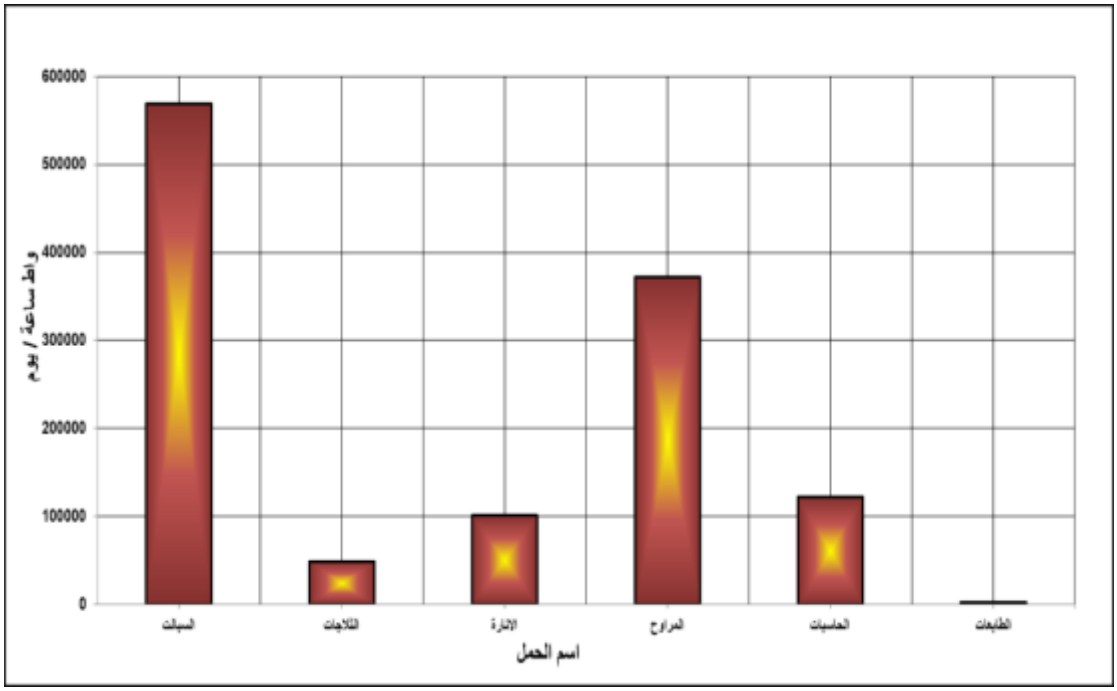
References : From the researcher's work based on data from Trebil Border Complex, General Supervisor Department (unpublished data)

Table (6) Load capacity and operating hours at Trebil Border Complex

types	Load capacity in watts	Operating hours / day	Load power in watt hours / day	The number of loads	The total power of the loads is in watt hours / day
Sepals	1500	16	24,000	237	568800
Refrigerators	240	12	2880	170	48 960
Luminescent	40	12	480	2106	101088
Fans	70	16	1120	332	371840
Calculators	120	10	1200	102	122400
Printers	120	2	240	99	2376
Total	2090	80	29920	3046	1215464

Reference : From the researcher's work based on Table (5)

Figure 4. Load capacity and operating hours at Trebil Border Complex



Reference : From the researcher's work based on Table (6)

From the observation of Table No. (6) and Fig. No. (4), it became clear that the total power of the loads for all the devices of the Trebil Border Complex reached (1215464) watt-hours / day by operating hours amounting to (80) hours, as the load capacity of the devices reached (568800) Watt-hour / day at an operating rate of (16) hours, while the total load of refrigerators devices reached approximately (48960) watt-hour / day with an operating rate of (12) hours, while the total loads of lighting amounted to (101088) watt / day / hour at a rate of (12) operating hours, and the total loads of the air fans in Trebil complex reached (371840) watt-hour

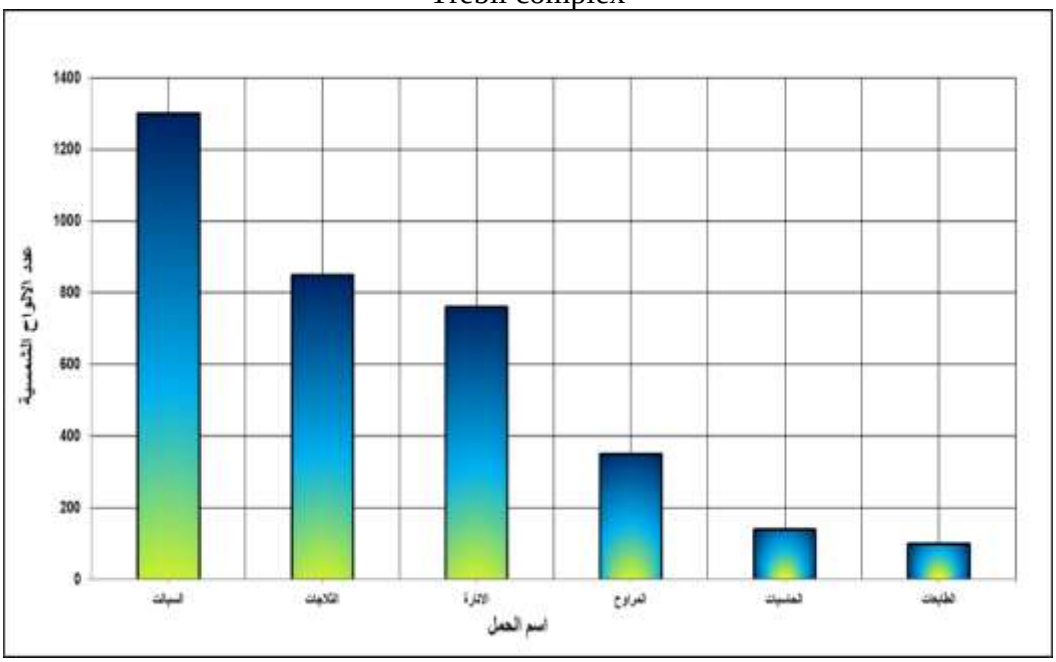
/ day, while the total loads of computers and printers were respectively (122400 and 2376) by operating hours amounting to (10 and 2) respectively, so the power reached The total loads and for all the devices of the Trebil Border Complex are about (1215464) watt-hours / day, equivalent to (1215.464) kilowatt-hours.

Table 7. The number of solar panels and batteries needed by the solar energy system in the Trebil complex

Load name	Number of solar panels
Sepals	1300
Refrigerators	850
Luminescent	760
Fans	three hundred fifty
Calculators	140
Printers	100
Total	3500

Reference : From the researcher's work based on Table (6)

Figure 5. The number of solar panels and batteries needed by the solar energy system in the Trebil complex



Reference : From the researcher's work based on Table (8)

Therefore, the Trebil border complex needs a solar project that covers the total energy of the loads in the complex, which reached (1215,464), and by noting Table No. (8) and Fig. No. (28), it became clear that the number of solar panels needed by the solar project in the complex reached (3500) panels Solar by an output of 350 watts per one panel, so the capacity of the solar system is The Trebil border complex has reached (1216.464) kilowatt hours, i.e. (3500 x 350/1000), so the Trebil border complex needs a solar system with a capacity of (1225) kilowatt

hours with internal street lighting, surveillance cameras, solar heaters, desalination stations, and more than the complex needs are done. Through it, feeding the areas close to it, especially the Rutba district. By observing Table No. (9), which represents a comparison of the costs of generating electric power with conventional fuels (kerosene) and solar energy, it became clear that the total cost of the project amounted to (1225,000) dollars at a rate of (1) dollars per watt. With an area of (8000-10000) square meters, and in the event that there are other sources of electrical energy such as hydropower or wind energy, the size and cost of the solar system in the Trebil complex will gradually decrease, and thus it is necessary to propose a solar system for the complex as shown in the map.

Table 9. Comparison of the cost of generating electricity by solar energy with conventional fuels (gasoline)

Type of generator	Generator price	The cost of operating the generator by (5) ampere						The total cost of the generator price along with the annual cost of operating the generator	System Service Life (Generator)		The costs that are paid daily; the cost to operate, together with the generator price / 2
		Gasoline				Gasoline with oil					
		Daily		Weekly		monthly	annually		the year	day	
Fuel-powered generator	$ 100	9 dollars	3469.6	$ 2.7		280.8 dollars	3369.6		1	360	9.6 $
system Solar powered	18,000 thousand dollars	-	-	-	-	-	-	-18,000 thousand dollars	25$	9000$	9000$

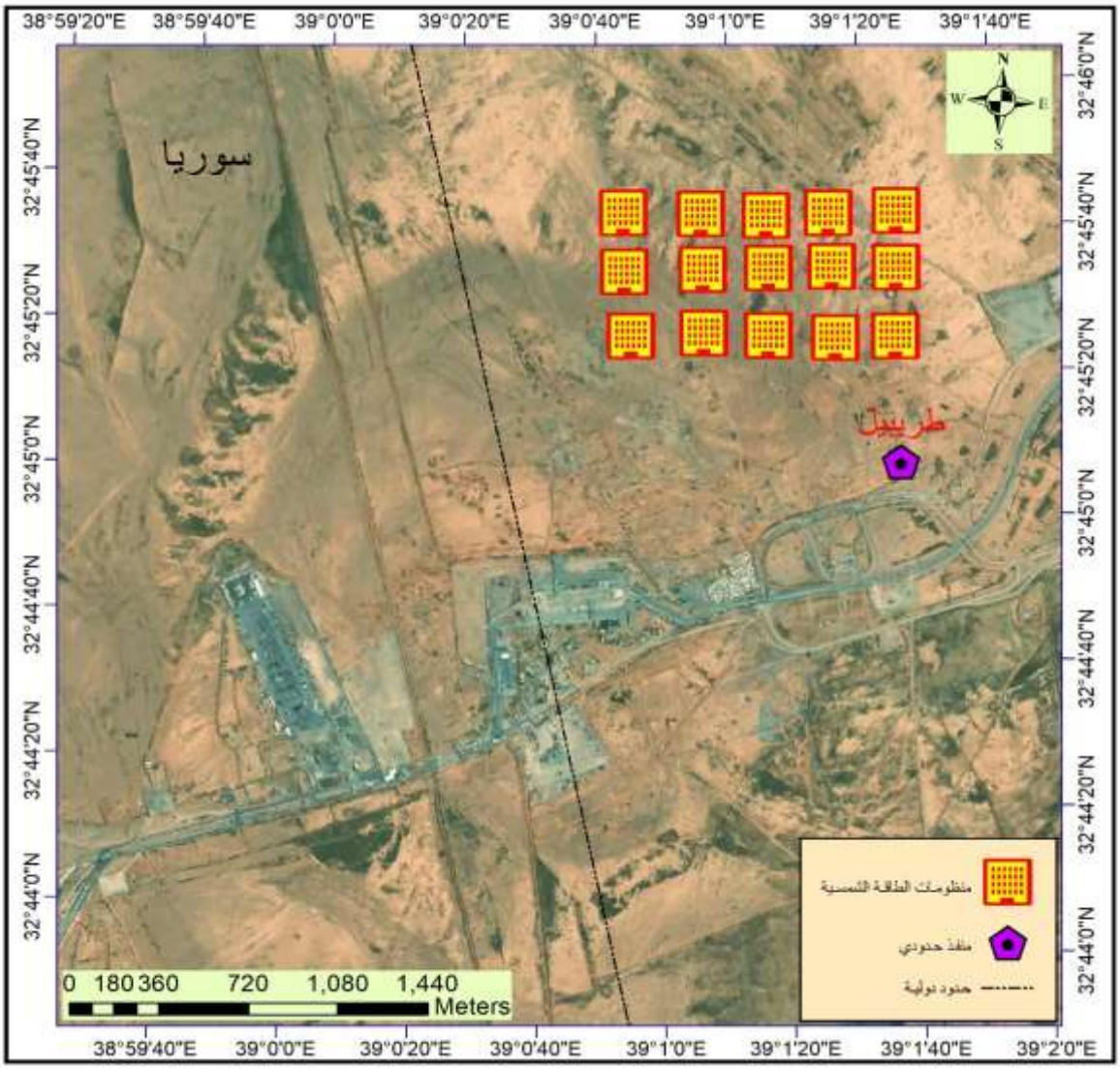
Reference : Siham Kamel Muhammad and Imad Hamdi Jassim, calculation of the costs of establishing a .solar farm in remote areas, Damascus University Journal of Agricultural Sciences, Volume 28, Issue 2, 2012, p. 421

The generator spends 1 liter per hour of fuel at the official price (450) Iraqi dinars, equivalent to () (0.37 dollars), * meaning

.We need 24 (liters) of petrol (24 hours) per day, at a cost of 9 = 0.37 x 24 dollars

**** The price of a liter of engine oil () (3240 dinars, equivalent to () (2.7 dollars per week).**

Map No. (3) of the solar energy system in the Trebil border complex



References - The researcher's work relying on the USGS site, LANDSAT, with multi-spectral sensor (MSS), using SAS PLANET and .Arc map v: 10.8

Conclusions

1.The climate of the study area is characterized by a large flood of solar radiation, as the region's stations receive abundant amounts of radiation during daylight hours, at the forefront of which is the al-Nukhayb station, which receives approximately (451.3) calories / cm2 / day. As for the al-Qa'im station, the total of what it receives annually reached (420.3) Calories / cm2 / day, while the same rate in Al-Rutba station was (446.7) calories / cm2 / day.

2- The study found that the Trebil border complex needs electrical energy with a capacity of (1215464) watt-hours, which is equivalent to (1215.464) kilowatt-hours. Thus, the study suggested a solar system through which the deficit of the complex can be filled with central services.

3- By employing renewable energy sources in the study area, especially (solar radiation), depending on what the stations in the study area receive, so the annual rate of the amount of solar energy in the Al-Rutba station reached (5.1) kilowatts / m2 / day and in the Al-Qaim station it reached (4.8) (KWh / m2 / day), while it reached (5.2) kW / m2 / day at Al-Nukhaib station, which occupies the forefront among those stations.

Recommendations

1.Paying attention to the provision of infrastructure services such as electric energy, drinking water, transportation methods, sanitation networks, and communications in both parts of all border crossing complexes, because they are located in remote areas far from urban centers, so it must be transformed into an attraction and stability factor for the population instead of being a factor of expulsion.

2.Investing all the renewable natural geographic potentials of the study area, especially solar radiation, in generating electric power and supplying border crossing complexes with all anchor services.

3- Paying attention to the proposed renewable energies projects in each complex because they are vital projects that do not require large economic costs, as well as they are clean projects that do not produce any pollutants that harm the environment.

References

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4. . Personal interview with Engineer Omar Hussein Raja, Head of Wind Energy Department, Renewable Energy Department, Ministry of Science and Technology, Baghdad, on January 27, 2020, Wednesday.
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