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Optimal Planning of an Off-grid Electricity Generation with Renewable Energy Resources using the HOMER Software

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ABSTRACT

In recent years, several factors such as environmental pollution which is caused by fossil fuels and various diseases caused by them from one hand and concerns about the dwindling fossil fuels and price fluctuation of the products and resulting effects of these fluctuations in the economy from other hand has led most countries to seek alternative energy sources for fossil fuel supplies. Such a way that in 2006, about 18% of the consumed energy of the world is obtained through renewable energies. Iran is among the countries that are geographically located in hot and dry areas and has the most sun exposure in different months of the year. Except in the coasts of Caspian Sea, the percentage of sunny days throughout the year is between 63 to 98 percent in Iran. On the other hand, there are dispersed and remote areas and loads far from national grid which is impossible to provide electrical energy for them through transmission from national grid, therefore, for such cases the renewable energy technologies could be used to solve the problem and provide the energy. In this paper, technical and economic feasibility for the use of renewable energies for independent systems of the grid for a dispersed load in the area on the outskirts of Isfahan (Sepahan) with the maximum energy consumption of 3Kwh in a day is studied and presented. In addition, the HOMER simulation software is used as the optimization tool.

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1. INTRODUCTION

With the world’s industrial development and the growing demand for energy and on the other hand limited fossil fuels and the necessity of preserving resources for future generations and also preventing environmental damage caused by burning them, there is no other way left but to use renewable energies.

Absence of national grid in remote areas, high cost of construction of a new transmission lines due to the long distances and geographical complications, made the administrators and designers of the electricity grid to think about looking for alternative solutions to supply energy in such areas. On the other hand, the increasing rate of electrical energy and large number of dispersed consumers has become one of the biggest problems for power companies. This factor made the power companies to think of using renewable energy as a solution to provide power for the independent loads of the grid.

One of the most important renewable energies is solar energy which is as a free and inexhaustible energy source, has the potential to transform into other forms of energy and in the form of photovoltaic systems can be used as a cost effective source of electrical energy to provide electrical energy for the consumers that have no access to the national transmission grid due to geographical and climatic conditions.

Using diesel generators for many years was considered as the best solution for power supplying dispersed loads which are far from grid. But nowadays, due to the advancements in renewable energies’ technology and environmental concerns, energy production by renewable energy sources is expanded more and more.

Today, hybrid systems have become one of the most effective solutions to meet the electrical energy needs of different regions. Having in mind the discontinuation of produced energy by the renewable sources, in practice it has been proven that the use of hybrid systems can be an appropriate solution and using a proper combination of these resources, an affordable, clean and reliable production system is attainable.

Iran that its latitude is 25 to 45 degree is one of the ideal areas in terms of solar radiation. The minimum annual average of solar radiation on the horizon is approximately 3.6 $\frac{Kwh}{m^2 day}$ for Rasht and the maximum of it is about 5.9 $\frac{Kwh}{m^2 day}$ for Bam. In the sloped surface (with 45 degree), the average amount of the solar radiation is 6.5 $\frac{Kwh}{m^2 day}$. In Iran, except the Caspian Sea coasts, the percentage of sunny days throughout the year is between 63 to 98 percent. That means more than 300 days of the year is sunny. Considering this amount of solar radiation, it can be said that most provinces are located in proper solar radiation area [1].

The purpose of this study is the optimization and technical and economic analysis of the hybrid systems for a load far from grid in an area on the outskirts of Isfahan (Sepahanshahr). Studies had done using solar radiation data in the area and the cost of diesel fuel and the output parameters are expressed as functions of these variables.

In this study HOMER software is used for simulation. Homer has been produced and extended by the International Organization of Renewable Energies. This software could be used for sizing hybrid systems which is based on the net present costs. In addition, this software is able to perform sensitivity analysis on variables with non-deterministic values. In fact, HOMER makes it possible for the user to check the effect of changing a variable over the entire system. This software requires data on energy sources such as: type of system components, number of components, costs, efficiency, longevity, economic constraints, and control methods for the analysis [2].

In this paper, at first the conditions and properties of the site is expressed and then structure of the proposed hybrid system for providing load energy in case study in Sepahanshahr is studied in detail and this proposed system is modeled in HOMER. Then, more detailed information on the various components of the system such as load, resources etc. are presented. Finally, the results of the HOMER software simulation are presented.

2. EVALUATION OF CONDITIONS OF STUDY SITE

Isfahan is located in 435 kilometers south of Tehran in the central plateau of Iran. General level of Isfahan is about 1570m above sea level. Isfahan with the longitude of 51 degrees 39 minutes 40 seconds east and latitude of 32 degrees 38 minutes 30 seconds north have the average annual solar radiation of about 4.6 $\frac{Kwh}{m^2 day}$ which indicates the considerable potential of solar energy in Isfahan. In this study, technical and economic evaluation of feasibility of installing and designing a hybrid system for providing electrical energy for a building with cultural and entertainment use on the district on the outskirts of Isfahan (Sepahanshahr) has been addressed. The building has two floors with beneficial underpin of 1350 square meters and total area of 1100 square meters. The extent and characteristics of the building's electrical load requirements will be provided in the next sections. Figure 1 depicts the exact location of the building and site which is marked on aerial photograph [3].

Figure 1. Location of the studied building marked on the aerial photograph

3. HYBRID SYSTEM

A hybrid system is consisted of two or more sources of power generation which is used to obtain higher efficiency than systems which include only one source of power and exploitation in the best work point. Since the operation of a hybrid power generation system strongly depends on the environmental conditions of its usage, so it seems necessary to firstly choose the renewable energy sources which are appropriate to the potential of the area of exploitation of this hybrid system. The problem of discontinuity using renewable sources in hybrid systems could be eliminated by using energy storage elements. Figure 2 shows the overall schematic of the energy production system independent of grid which is considered in this study [4].

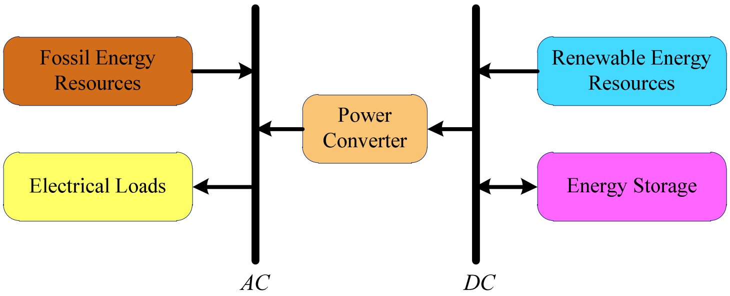

Figure 2. Overall schematic of the energy production system independent of grid in this study

The overall schematic shown in Figure 2 is modeled in HOMER software like Figure 3. Details on the various components of the system such as load, sources etc. are provided in the next sections.

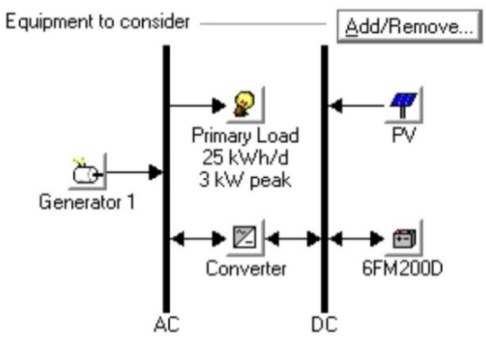

Figure 3. Implementation of production system independent of grid in the HOMER software

4. THE PARAMETERS AND CONDITIONS OF THE STUDY SITE

4.1. Electrical Load

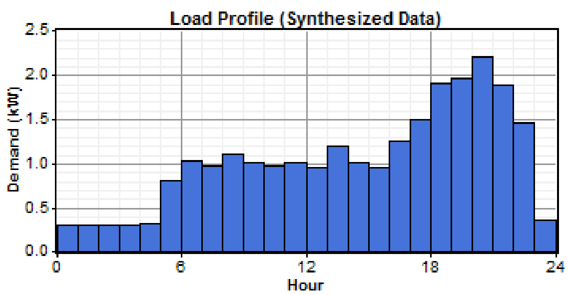

Figure 4. Daily load profile of the studied complex in a particular day

According to the calculations which were made, in the studied cultural and entertainment complex in Sepahanshahr area which is considered as an independent load, the amount of the consumed electrical energy is 25Kwh/d and the maximum demand is 3kw. According to calculations and measurements which were made on a particular day, the maximum peak load in the building was 2.33kw and the maximum peak load in this complex was between the hours of 17 to 22. Figure 4 depicts the daily load profile of this cultural and entertainment complex in a particular day [5].

4.2. Solar Power

As stated the study site is located in Sepahanshahr area in suburbs of Isfahan. With annual average of solar radiation of about 4.6 $\frac{Kwh}{m^2 day}$, Isfahan has an appropriate potential to use solar energy. Table 1 shows the average values of radiation received in a horizontal surface of the earth in different months of the year.

By entering Average values of radiation received in a horizontal surface of the earth in HOMER and considering the height of the studied site, an index introduced calling clearness index. Figure 5 shows the output related to the solar radiation in different months in Isfahan [6].

Table 1. Average Values of Radiation Received in a Horizontal Surface of the Earth in Different Months of the Year in Isfahan

Month	Average radiation $\frac{Kwh}{m^2 day}$
January	2.694
February	3.444
March	4.083
April	4.972
May	5.889
June	6.638
July	6.305
August	5.833
September	5.223
October	4.027
November	2.944
December	2.583
Average	4.552

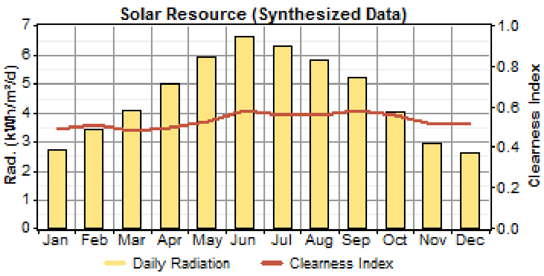

Figure 5. Amount of the radiation in Isfahan ($\frac{Kwh}{m^2 day}$)

5. THE PARAMETERS AND CONDITIONS OF THE STUDY SITE

In this section we review the components of the hybrid system which is used in this case study and we will try to provide proposed technical and economic models. Components of the hybrid system used in this case study are: 1) Diesel Generator, 2) Photovoltaic, 3) Battery, and 4) Converter. In the following we describe the technical specifications and proposed model along with the price, hours of operation and characteristic of each unit.

5.1. Diesel Generator

One of the most important parts of designing hybrid systems for providing electrical energy is the proper selection of a diesel generator, because if it is not selected properly, irreparable damages could occur. The most significant parameters to consider when selecting a diesel generator are: 1) Whether diesel generators are used to supply emergency power or it is going to be used permanently. 2) Type of the load that diesel generator is used to provide. 3) KW and KVA of the diesel generator.

Unfortunately most of the people believe that low power diesel generator is more suitable for emergency power usage, because these types of diesel generators are used in case of power failures on part-time. This misunderstood of the consumers often results in damages to diesel generator and the devices which are connected to it. Hence one should consider the load amount in case of power failures and thenselect the needed diesel generator [7].

Cost of the commercial diesel generators on the market varies depends on the size of the unit and their power capacity. For this study, the purchase price (based on the prices offered by Tabriz Motorsazan Company) varies between 124 to 140 dollars per kilowatts. Therefore in this analysis the cost of purchasing and installing is considered 160 dollars per kilowatt and the cost of replacement and maintenance are considered 143 and 0.08 dollars per kilowatt accordingly. In figure 6 the curve of capacity and its costs are shown [8].

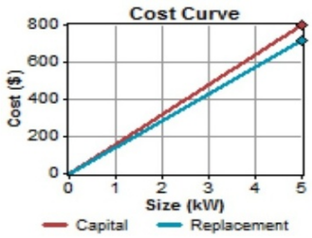

Figure 6. Curve of costs of installation and replacement of diesel generator in HOMER

5.2. Photovoltaic System

Solar panels selected for this study are solar panel 250W with crystal menu of LG Company (LG250s1c), that the technical specifications of the panel are presented in Table 2 and 3.

Table 2. Electrical Characteristics at Standard Test Conditions(STC)

Maximum Power at Standard Test Conditions (P_{max})	250
Voltage at the Maximum Power Point(V_{mpp})	29.9
Current at the Maximum Power Point(I_{mpp})	8.37
Open Circuit Voltage (V_{oc})	37.1
Short Circuit Current (I_{sc})	8.76
Module Efficiency (%)	15.5
Operation Temperature (°C)	-40 °C ~ +90 °C
Maximum System Voltage (V)	1000
Maximum Series Fuse Rating (A)	15
Power Tolerance	0 ~ +3 %

**Standard Test Conditions (STC): Radiation Rate 1000 W/m^2, Temperature 25˚C, Time 1.5AM.*

Table 3. Electrical Characteristics of Normal Operation Conditions and Temperature(NOCT)

Maximum power (*W*)	176
Maximum power voltage (*V*)	27.35
Maximum power current (*A*)	6.42
Open circuit voltage (V_{oc})	34.54
Short circuit current(I_{sc})	6.77
Efficiency reduction (from 1000 W/m^2 to 200 W/m^2)	< 4.5 %

**Normal Operation Conditions and Temperatures : Radiation Rate 800 W/m2, Temperature 20˚C, Wind Speed 1m/s.*

The purchase cost of solar panels (LG250s1c) is about 1.6 dollars per watt. Hence in this study, the purchase and installing cost of solar panels is considered 2000 dollars per kilowatt and the replacement cost of these panels is considered 1700 dollars. Figure 7 shows the curve of capacity and costs of solar panels [9].

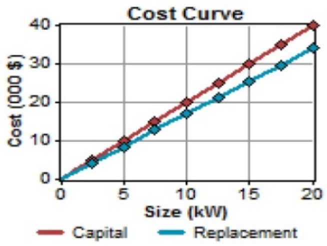

Figure 7. Curve of the costs of installation and replacement of solar panels in HOMER

In this study, photovoltaic system in sizes of 0, 2.5, 5, 7.5, 10, 12.5, 15 kW is used. Intended lifespan for this solar system is 20 years.

5.3. Battery

Different models of batteries are available in the market for this purpose. The selected battery for this study is 6FM200D (Ah 200, V12) from Vision Company, that its technical specifications is given in Table 4 and the discharge curve is presented in Figure 8.

Table 4. Technical Specification of Battery (6FM200D)

Nominal Voltage (V)	12
Number of Cells	6
Designed Lifetime (year)	10
Nominal Operational Temperature(°*C*)	25 °C
Internal Resistance of the Battery at Full Charge(*mOhms*)	3.5
Efficiency of Module (%)	15.5
Storage Temprature(°*C*)	-20 °C ~ +60 °C
The Maximum Discharge Current at 25 °C (A)	1000 A (*5s*)
Short Circuit Current (A)	3300
Maximum Charge Current(A)	60

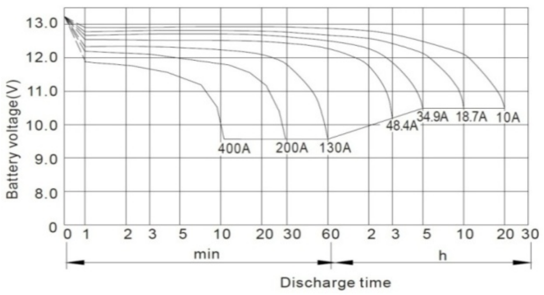

Figure 8. Battery discharge curve (6FM200D)

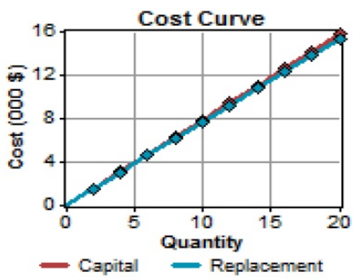

Figure 9. Curve of costs of installing and replacing batteries in HOMER

The purchase cost of this model of battery (6FM200D) is about 755 dollars for each battery. So in this study the cost of purchasing and installing each battery is considered 790 dollars and replacement cost is considered 770 dollars for each battery. Figure 9 shows the curve of number and cost of batteries [10].

In this study, the number of batteries in system is used as 0, 4, 8, 12, 16, 20, 24, 30. Intended lifetime for each battery is 10 years.

5.3. Converters

Purchase cost of a DC to AC converter (based on the prices offered by Sunrous Company) is about 180 dollars per kilowatt. So in this study, the purchase and installation cost of converter is considered 200 dollars per kilowatt and replacement cost is considered about 180 dollars. In this study, converters with the size of 0, 2, 4, 6, 8 kilowatt are used in system. Lifetime of the unit is 10 years and its efficiency is 98%. In figure 10 curves of capacity and its cost is displayed [11], [12].

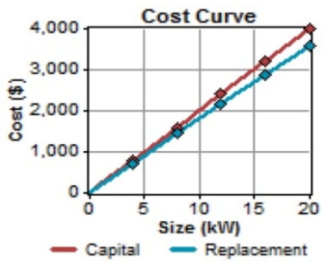

Figure 10. Curve of the costs of installation and replacement of converter in HOMER

6. RESULTS OF THE SIMULATION PERFORMED IN HOMER SOFTWARE

In HOMER software for calculation of system lifetime, Net Price Calculation (NPC) equation is used, in which the costs include installation, replacement, fuel, etc. all costs and revenues are assessed with a fixed interest rate during the year. In order to considering impact of inflation in the calculations, Equation (1) is used.

$$i = \frac{i' - f}{1+f} \tag{1}$$

In this,

i: Real interest rate,

i' : Nominal interest rate,

f : The inflation rate.

The main output of the economic calculations in this software is Net Price Calculator (NPC) which is calculated from the Equation (2):

$$C_{NPC} = \frac{C_{\text{annual, total}}}{CRF\left(i, R_{\text{Project}}\right)} \tag{2}$$

In it,

$C_{annual,\ total}$: Total annual cost,

$R_{Project}$: Lifetime of the project,

i : real interest rate.

To calculate the return on capital over the N years, Equation (3) is used:

$$CRF\left(i, N\right) = \frac{i\left(1+i\right)^N}{\left(1+i\right)^N - 1} \tag{3}$$

In which$CRF\ (I,N)$is the return on capital factor during N years.

In the optimization which is done in HOMER, all of the possible states have been simulated and the best combination with the minimum (*NPC*) is introduced as the optimum arrangement [13]. This best combination provides the all predetermined constraints set by the operator with the lowest net cost. In this paper, in addition to the constraints about fuel, cost, etc. the constraint of minimum penetration of renewable sources is added too. The result of optimization by HOMER is shown in Figure 11. In the most optimized condition that is considered, photovoltaic system and storage have the capability of supplying all of the required electrical power for the load and the diesel generator will play the role of a resource in the system.

Sensitivity Results | Optimization Results

Double click on a system below for simulation results.

	PV (kW)	Gen1 (kW)	6FM200D	Conv. (kW)	Initial Capital	Operating Cost ($/yr)	Total NPC	COE ($/kWh)	Ren. Frac.	Capacity Shortage	Diesel (L)	Gen1 (hrs)
	12.5		20	4	$ 41,600	4,973	$ 98,642	0.961	1.00	0.02		

Figure 11. Results of the Optimization Problems in HOMER

Details of the various costs of the components of the studied hybrid system in 20-year lifetime of the project are shown in Figure 12. As it can be seen in Figure 12, the maximum initial cost in the project is about purchasing photovoltaic system but the maximum replacement cost during 20 year is for battery which has a great role in the overall cost of the project.

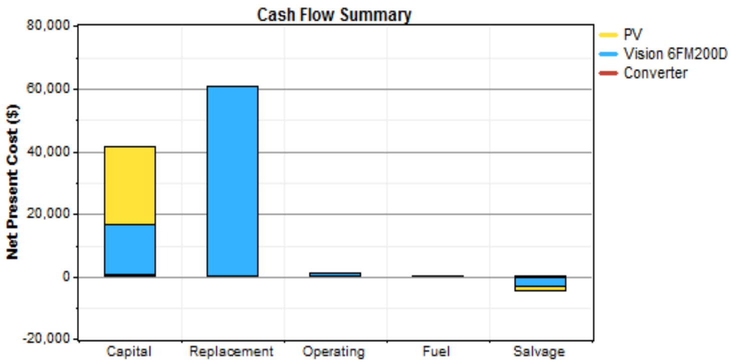

Figure 12. Cost of different components of the studied hybrid system

Accordingly, the average power produced by the solar cells is 20.335 (kWh/yr), but this rate varies in different months of the year. The maximum power produces by the solar cells is in June and the minimum of it is for December. In Figure 13 the average power produced by the solar cells for different months of the year are shown.

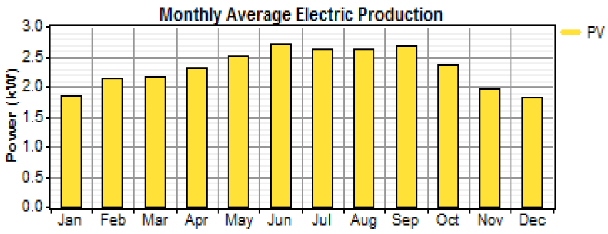

Figure 13. The average power produced by the solar cells for different months of the year

Accordingly the output power of the solar system in different hours of the day based on the capacity and produced power for different months of the year is displayed in Figure 14.

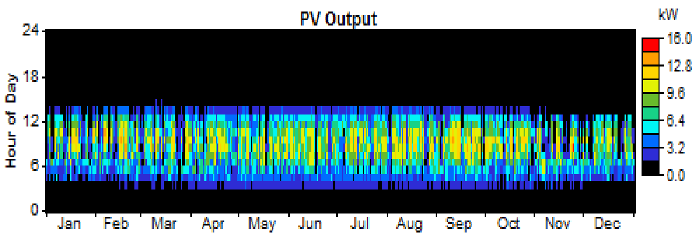

Figure 14. The electric power output of the solar system in different hours of the day

Excess electrical power generated by the solar system is stored in the considered storage system, batteries. The rate of the stored electrical power in the batteries is shown for different hours of day based on the capacity and produced power for different months of the year in Figure 15.

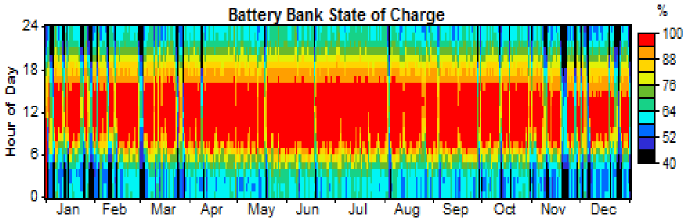

Figure 15. The amount of power stored in the batteries for different hours of day

To further explore the behavior of the designed hybrid system in providing the required electrical energy for the load, the generated electric power by solar cells, stored and discharged energy by the batteries for a week is selected and depicted in Figure 16. As it can be seen in the figure, the considered solar system and the storage for this study can jointly provide the required electrical load of the system entirely. In this system, in the hours that the generated energy by the solar cells is greater than the required electrical power, this excess is stored in the intended batteries and in the hours as the night that solar cells cannot provide electrical power, batteries go into the circuit and provides the required electrical energy of the load. Thus in the designed hybrid system the all required electrical power for the load is provided by the photovoltaic and storage system [14], [15].

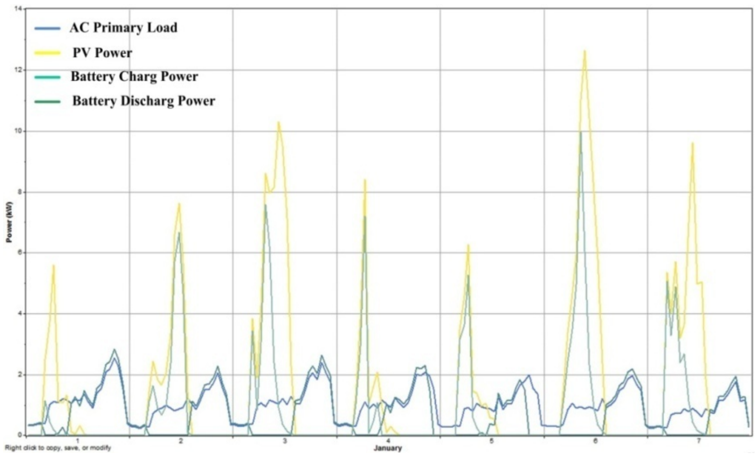

Figure 16. Evaluation of the studied hybrid system in a week

7. CONCLUSION

With industrial development of the world and the increasing demand of energy in one hand and limited resources of fossil fuels and the need to conserve these resources for the next generations and also preventing environmental damage caused by burning them on the other hand, there is no other solution than using renewable energies such as solar. Furthermore, around the world one of the major concerns about remote areas and areas far from the grid is providing electrical power for these areas. Connecting these areas to the grid is costly and in some cases is physically impossible. In such case using Distributed Generation (DG) resources id the best option for providing required electrical energy for this category of consumers. In the coming years with reduction in initial investment cost as well as increasing the efficiency of solar panels, the importance and necessity of using these panels to provide clean energy appears more than even before. In addition, with producing energy near the consumption centers eliminates the need to establish voltage transmission lines near towns and villages. Since the hybrid systems are fed from two or more sources of energy, they have higher reliability in compare with systems that have only a source for energy generation. In this paper, a hybrid system was proposed to provide the electrical energy for the studied load. Using the HOMER software optimizations of the system was performed and the optimal mode was selected. In this case 100% of the required energy is supplied by the intended photovoltaic and storage system and the diesel generator is a backup source.

REFERENCES

[1] Bahrami, Mohsen, Payam Abbaszadeh. An overview of renewable energies in Iran. *Renewable and Sustainable Energy Reviews*. 2013; 24: 198-208.

[2] Fulzele JB, SubrotoDutt. Optimium planning of hybrid renewable energy system using HOMER. *International Journal of Electrical and Computer Engineering (IJECE).* 2011; 2(1): 68-74.

[3] Alamdari, Pouria, Omid Nematollahi, Ali Akbar Alemrajabi. Solar energy potentials in Iran: A review. *Renewable and Sustainable Energy Reviews.* 2013; 21: 778-788.

[4] Shaahid SM, LM Al-Hadhrami, MK Rahman. Review of economic assessment of hybrid photovoltaic-diesel-battery power systems for residential loads for different provinces of Saudi Arabia. *Renewable and Sustainable Energy Reviews*. 2014; 31: 174-181.

[5] Asrari, Arash, Abolfazl Ghasemi, Mohammad Hossein Javidi. Economic evaluation of hybrid renewable energy systems for rural electrification in Iran—A case study. *Renewable and Sustainable Energy Reviews.* 2012; 16(5): 3123-3130.

[6] Mohajer, Alireza, Omid Nematollahi, Mahmood Mastani Joybari, Seyed Ahmad Hashemi, Mohammad Reza Assari. Experimental investigation of a Hybrid Solar Drier and Water Heater System. *Energy Conversion and Management*. 2013; 76: 935-944.

[7] Shiroudi, Abolfazl, Seyed Reza Hosseini Taklimi, Seyed Ahmad Mousavifar, Peyman Taghipour. Stand-alone PV-hydrogen energy system in Taleghan-Iran using HOMER software: optimization and techno-economic analysis. *Environment, development and sustainability*. 2013; 15(5): 1389-1402.

[8] Khatib, Tamer, A Mohamed, K Sopian, M Mahmoud. Optimal sizing of building integrated hybrid PV/diesel generator system for zero load rejection for Malaysia. *Energy and Buildings* 2011; 43(12): 3430-3435.

[9] Diaf, Said, Djamila Diaf, Mayouf Belhamel, Mourad Haddadi, Alain Louche. A methodology for optimal sizing of autonomous hybrid PV/wind system. *Energy Policy*. 2007; 35(11): 5708-5718.

[10] Fulzele JB, Subroto Dutt. Optimium planning of hybrid renewable energy system using HOMER. *International Journal of Electrical and Computer Engineering (IJECE).* 2011; 2(1): 68-74.

[11] Shahinzadeh, Hossein, Mohammad Moien Najaf Abadi, Mohammad Hajahmadi, Ali Paknejad. Design and Economic Study for Use the Photovoltaic Systems for Electricity Supply in Isfahan Museum Park. *International Journal of Power Electronics and Drive Systems (IJPEDS)*. 2013; 3(1): 83-94.

[12] Kaabeche, Abdelhamid, RachidIbtiouen. Techno-economic optimization of hybrid photovoltaic/wind/diesel/battery generation in a stand-alone power system. *Solar Energy*. 2014; 103: 171-182.

[13] Al-Karaghouli Ali, LL Kazmerski. Optimization and life-cycle cost of health clinic PV system for a rural area in southern Iraq using HOMER software. *Solar Energy.* 2010; 84(4): 710-714.

[14] Eltamaly, Ali M, et al. Economic Modeling of Hybrid Renewable Energy System: A Case Study in Saudi Arabia. *Arabian Journal for Science and Engineering*. 2014; 1-13.

[15] Sen, Rohit, Subhes C Bhattacharyya. Off-grid electricity generation with renewable energy technologies in India: An application of HOMER. *Renewable Energy*. 2014; 62: 388-398.

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