Analysis and Study Feasibility of the Photovoltage System for the Some Iraqi Governors by Using Homer

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ABSTRACT

Renewable energy provides a comfortable solution for residents who need electricity where they can take advantage of solar energy resources available locally to meet the need of electricity. The availability of electricity in the darkness of night facilitates increased productivity. In this study, it has been designed photoelectric PV system for each of the selected sites of Iraq. where The following results for the parameters: solar panel, the number of batteries, the number of transformers, initial capital, the final cost, battery life, battery production, the productivity of the solar panel, electricity and excess net cost of the system have been conducted. In addition the comparison between the results and choose the best value has done. The results show the similarity for all location sites.

Keywords: Photovoltaic system, feasibility, HOMER.

1. INTRODUCTION

Solar energy is the origin of almost any energy used by humanity and is convertible into electricity due to the photoelectric effect. The photoelectric effect was first found by Heinrich in 1887 but explained in more detail by Einstein in 1905. The photoelectric effect is used in photovoltaic (PV) cells to convert solar radiation into electricity. The amount of electricity that can be produced is based on intensity and wavelength [1].

Twidell and Weir define renewable energy, as extractable energy from natural flows of energy, which occurs in the immediate environment [2]. These flows of energy include solar, wind, hydro, thermal, ocean and biomass resources. Silicon wafers are the starting product for PV cells. Those wafers can be producedby different methods as monocrystalline, polycrystalline and amorphous cells with differing efficiencies. The cells are assembled into modules and represent one unit. These modules can then be assembled into arrays. Monocrystalline cells can reach high efficiencies in laboratory environments of up to 25.6 %, a high durability, and a very low failure-proneness. Losses in diffuse light conditions are low and the operating reliability is steady, but production of monocrystalline solar modules is currently most expensive. Polycrystalline units have the same characteristics except for lower efficiency of under 21.7 % and also lower costs [3].

Amorphous solar cells are thin-layered cells and can be manufactured flexible ondifferent structures because they absorb solar radiation directly by the silicon. However, their efficiency is approximately 5-8 % and their durability is substantially lower compared to mono- and polycrystalline modules. All three types of PV have their legitimation for different application areas. A solar resource assessment can reveal the most qualified technology and device for a site [4].

Ground measurements can be performed for solar resource assessments. However, these measurements are contingent on accuracy and instrument performance. Datacan contain errors and it is possible that these inconsistencies influence results. Thus, solar irradiance models have been developed. These models use meteorological data to estimate the variability of available solar resources accurately [5].

For this reason, Typical Meteorological Year (TMY) data is used in most solarresource assessments due to its representativeness of a location's long-term climate.TMY consists of Global Horizontal Irradiance (GHI), Diffuse Horizontal IrradianceDHI), and Direct Normal Irradiance (DNI). The relationship between GHI, DHI andDNI can be seen in reference (6). Schnitzer et al. state that TMY is most likely to underpredict long-term solar resource compared to other sources. Nevertheless, TMY data is conservative because it does not overestimate solar potential. It can be considered as a reliable source for an economic analysis [6].

Hierofka and Kanuk (2009) used GHI data in an approach based on a geographicalinformation system (GIS) for the assessment of photovoltaic potential. Thereby, theyestimated the electricity production in kWh for a system [7].

Modeling of hybrid renewable energy systems has been developed by manyauthors. The research documents describe methodologies to model HybridSystems components, Hybrid System designs and its evaluation [8]. Authorsmentioned renewable energy systems modeling, indicating its popularity in termsof meeting specific energy demands. Penetration levels on network basis is thefuture of the hybrid power system in power generation capacity of some countries[9].

Hybrid Wind-PV-Fuel Cells power systems have been designed. In these cases,hydrogen production is performed by an electrolyzer, and a fuel cell stackoperates as a back-up in case of lack of availability of wind or sunlight. Systemperformance is simulated by using special software such as Simulink (MATLAB)and Hybrid Optimization Model for Electrical Renewables (HOMER), which wasdeveloped by the National Renewable Energy Laboratory (NREL). [10].

Hundreds of papers and research projects about specific control/powermanagement techniques [11] for hybrid systems (PV, Wind, Fuel Cells, biomass,etc.) have been published. Results show a variety of philosophies to control thepower flow between AC grid, DC loads and different parts of those systems by using power electronic devices, special power circuits [12], AC or DC gridsynchronization equipment and others. Many institutions [13] around the world have experimented and discovered newmethods to improve the efficiency of solar panels, electrolyzers, and stacks of fuelcells, for many applications in industry, automotive and transportation areas.Those institutions have developed projects to create components and materials forsolar cells, electrical power supplies, chemical energy conversion, and energy storage.

D. Saheb-Koussa, M. Haddadi and M. Belhamel [14] in their study, they deal with the design of the hybrid system. Techno-economic optimization of two renewable sources; photovoltaic and wind, with the diesel and battery storage, has been obtained. Their target was to find the suitable stand-alone hybrid system that will provide the energy autonomy of remote area with minimum COE. This paper has been selected, because of having the same target as the one that I have in my project.

E.M. Nfah and J.M. Ngundam [15] who studied a hybrid which including the Pico-hydro and incorporating a biogas generator. This research has been selected because it uses a hydropower as one renewable energy source.
S.M. Shaahid and I. El-Amin [16] the aim of their study was to examine the solar system in order to evaluate the best techno-economic of hybrid RES composed with PV–diesel–battery to answer to the load required by the selected remote village with the demand of 15,900 MWh.

Several other kinds of literature have used the Homer software for techno-economic optimum sizing of hybrid systems. Homer algorithms help in the evaluation of the techno-economic feasibility of RET options and to see the technology with cost effective. It has also integrated with a product database with different products from a variety of manufactures. Hence this software is widely used for hybrid system optimization.

In this study HOMER, energy software was used to determine the optimum combination of PV array power capacity, battery bank power capacity, converter size and PV electrical production for a wide range of constant daily load profiles (10-100)kWh for the three different Iraqi locations.

2. PHOTOVOLTAIC (PV) SYSTEM AND ITS COMPONENTS

Is a set of solar cells connected to each other in a solar panel or group of panels to a group of cells called the solar board matrix [17]. the properties of installationin the roofs of buildings or the highlands does not need the extra space of the building andnot need any additional structural foundations, so, this leads converting the building to electric generator,the electric power generation is almost the same place will reduce the loss significantly from the transmission and distribution networks,This has led to the spread of solar cell systems significantly.

There are a lot of features for systems of solar cells, which have contributed to the acceptance of users is the most important:

1. the PV systems have fixed and do not produce any work noise and no pollution to the environment.
2. Practical life time more than twenty-five years, and with a light weight.
3. Not need to maintain complex, and can operate in poor weather conditions.[17]

The components of PV systems are a solar panel, Batteries, and Electric converter. The solar panel is the visible part of the solar cell system which is installed on the highlands, away from trees and high buildings, where it consists of a set of linked solar cells with each other in a row or in parallel to produce electric power.

The electric converter is a device that converts the DC power output from the solar panels into AC, which usually adapts energy specifications that you need loads.

3. FEASIBILITY

The study of Feasibility has depended on the calculation of the following parameters:

3.1. Daily Load: study the daily load of the electricity which is required such as lighting, water pumping, information and communication devices and electronic devices.

3.2. Capacity shortage is a shortage that occurs between the operational capabilities required for the actual amount of the operational capability of the system throughout the year.

3.3 autonomy battery: It is the ratio of the battery consumption of the electrical loads.

3.4. Excess electricity: It is the excess electrical energy that must be disposed of because it cannot be used to serve the load or charge the batteries. Excess electricity occurs when there is a surplus of energy that is produced (either by a renewable source or generator when it exceeds the minimum output load), and batteries are not able to absorb it all

3.5. Battery Throughput: Is the number of stored energy in the battery discharging cycles in one year. And productivity change whenever the energy level change as a result of battery discharge.

3.6. Battery Life: Through the productivity of the battery, battery life has measured after the energy stored in the battery and power before unloading them.

3.7. Solar panels (PV) Production: amount of electrical energy from photovoltaic energy during the year.

4. CASH COSTS

4. **1.Total net cost of the system:** Is the value of all costs are paid over a limited period minus the value of all benefits, including revenue, capital costs, replacement costs of fuel and other costs.

4.2. Total Capital Cost: cash value of the system cost.

4.3. Total Annual Cost is the total annual costs for each element of the system and to other annual costs, for example, the operator.

4.4. Energy costs: It is defined as the average cost per kilowatt hour of electricity.

5. RESULTS AND DISCUSSION

After the implementation of the Homer simulation program in selected areas for the best design of PV system in Iraq, The comparison between the results and choose the best value has conducted. The following results for the parameters: solar panel, the number of batteries, the number of transformers, initial capital, the final cost, battery life, battery production, the productivity of the solar panel, electricity and excess net cost of the system.

5.1 Simulation Results of PV system design using Homer for Baghdad

5.1.1 Daily load versus boarded power generation capacity, the number of batteries, the ability to energy conversion and COE for the city of Baghdad.

As shown in Figure 1 below using Homer program, the optimal system for PV system power to the city of Baghdad to the ability of power generation boarded PV panel Place between (1 – 26) kW, the number of batteries ranges (2- 14) and the ability to energy converter be between (1.5until 14.5) kW and the Energy costs (COE) (0.125 - 0.181) kWh compared with the daily load variable between (4 - 96 kW / day).

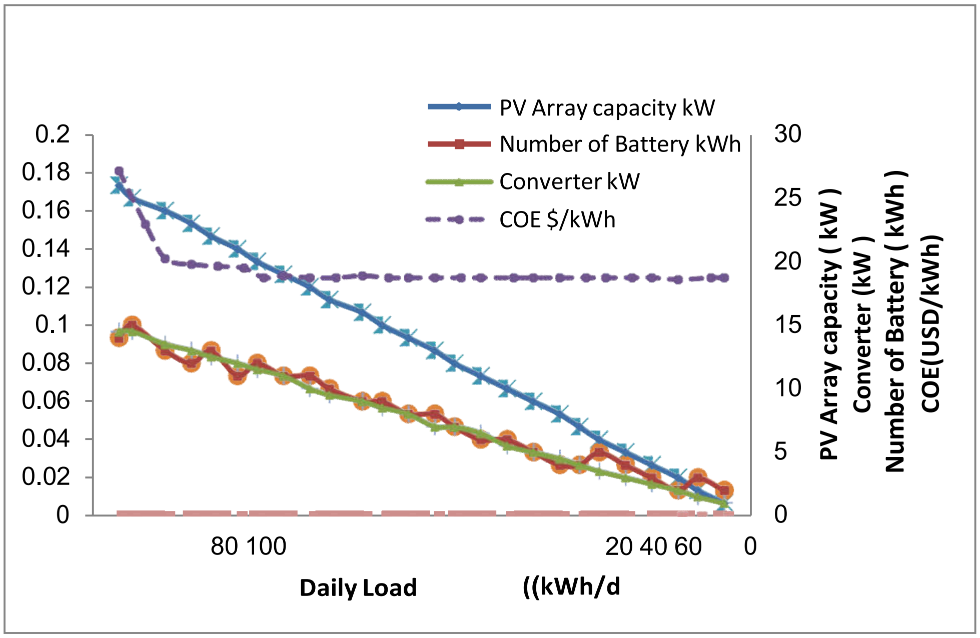

Fig. 1: Illustrates the change in PV Array capacity, boarded the number of batteries, the ability to convert the energy and COE compared to the daily load for the city of Baghdad.

5.1.2 Daily load compared to the extent of PV to produce electricity, the lack of capacity and excess electricity compared to the daily load the city of Baghdad.

In the Figure 2we have get over the PV to produce electricity between (1781 to 46301) kWh / year, and the lack of capacity ranges (from 18 to 1063) kWh / year, as well as, excess electricity will be between (143 to 6708) kWh / year versus variable between Daily Load (4-96) kW / day.

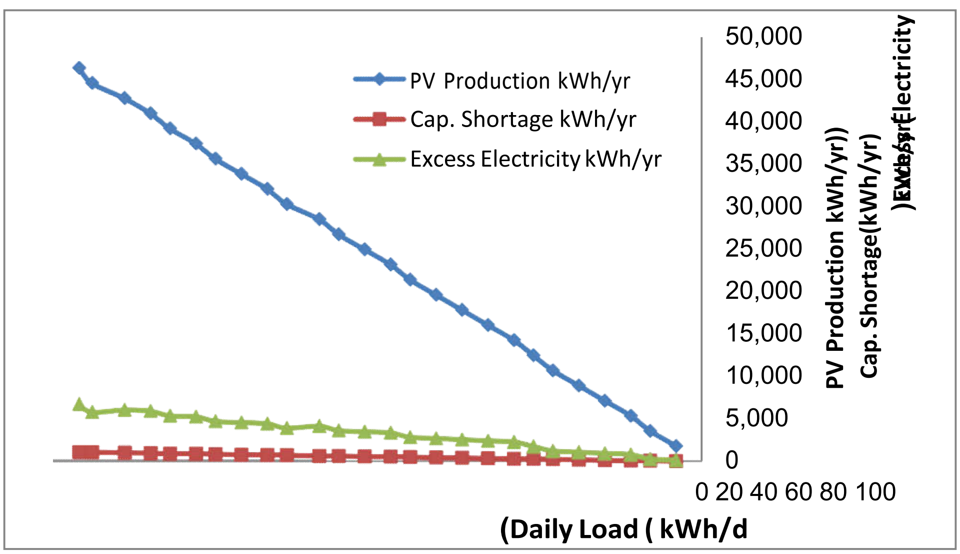

Fig. 2: Over the PV to produce electricity, the lack of capacity and excess electricity, compared to the daily load for the city of Baghdad

5.1.3 Daily load versus over the productivity of the battery, the number of batteries, chargers self-battery, and battery lifetime for the city of Baghdad

The following Figure 3 shows over of the productivity of the battery throughput which is change from (361 to 7367) kWh / year, also the number of batteries between (1 - 13), as well as, self-charging battery autonomy ranges (8.112 – 14.976) hour and the battery life time between (8 - 10) a year, compared with the daily load variable between daily load (4 - 96) kW / day.

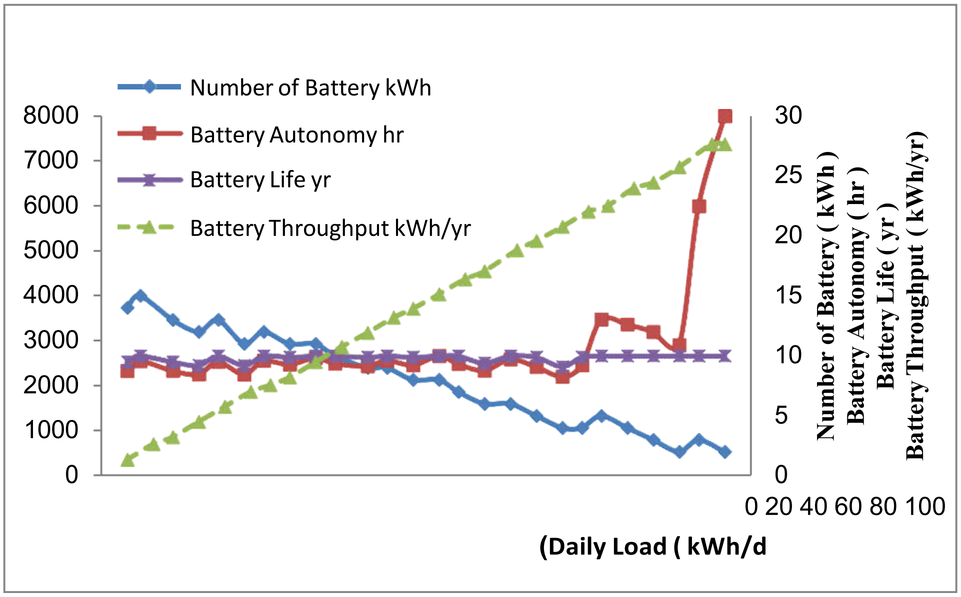

Fig. 3: Over the productivity of the battery, and the number of batteries, chargers self-battery, and the battery life time, compared with the daily load for the city of Baghdad.

5.1.4 Daily load for a set cost of capital and the total net cost of the system and the total annual cost of the city of Baghdad.

As shown in Figure4 which are illustrates group of total capital cost (2620 to 47290) USD, the total net cost of the system (total NPC) (3351 to 54769) USD and the total annual cost (Total Ann. Cost) (262 to 4284) USD versus the daily load (4 - 96) kW / day.

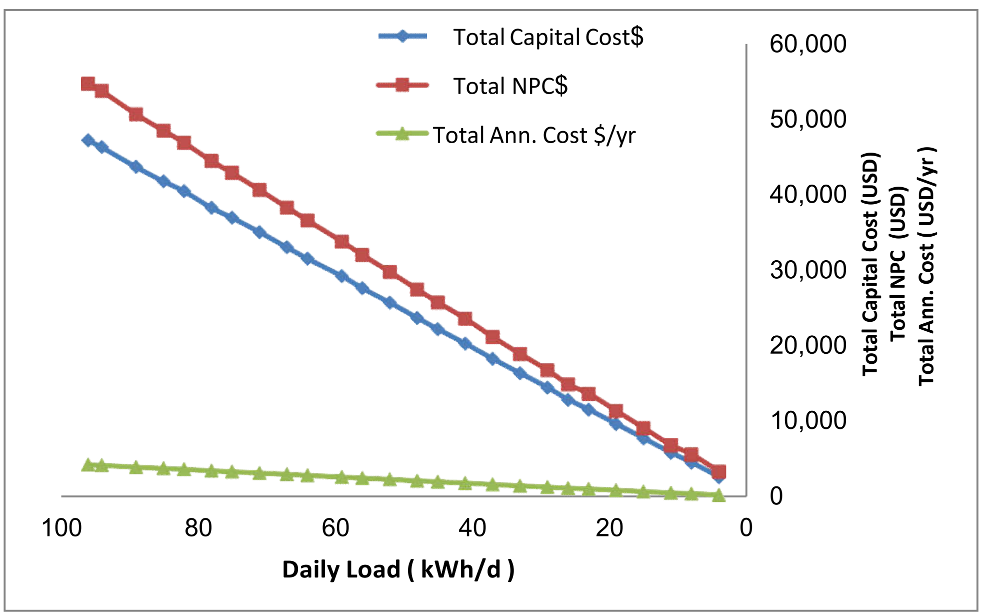

Fig. 4: Set the cost of capital and the total net cost of the system and the total annual cost versus load on the city of Baghdad.

5.2 Simulation Results of PV system design using Homer for Najaf

5.2.1 Daily load versus boarded power generation capacity, the number of batteries, the ability to energy conversion and COE for the city of Najaf.

As shown in Figure 5 below using Homer program, the optimal system for PV system power to the city of Najaf to the ability of power generation boarded PV panel Place between (1 – 26) kW, and the number of batteries ranges (1- 13) and the ability to energy converter be between (1.5until 14.5) kW and the Energy costs (COE) (0.123 -0.154) kWh compared with the daily load variable between (4 - 96 kW / day).

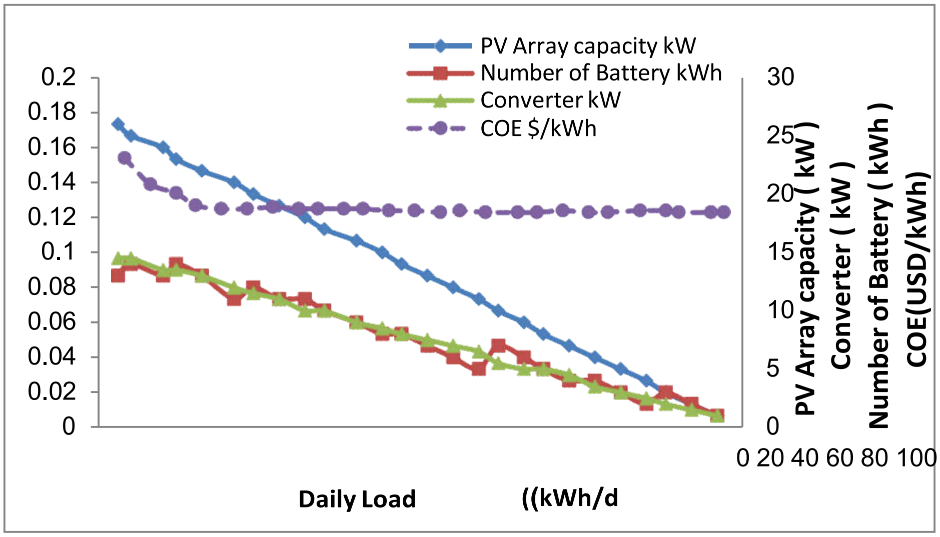

Fig. 5: Illustrates the change in PV Array capacity, boarded the number of batteries, the ability to convert the energy and COE compared to the daily load for the city of Najaf.

5.2.2 Daily load compared to the extent of PV to produce electricity, the lack of capacity and excess electricity compared to the daily load the city of Najaf.

In Figure6we have to get over the PV to produce electricity between (1793 to 46767) kWh / year, and the lack of capacity shortage ranges (from 39 to 1094) kWh / year, as well as, excess electricity will be between (147 to 6613) kWh / year versus variable between Daily Load (4-96) kW / day.

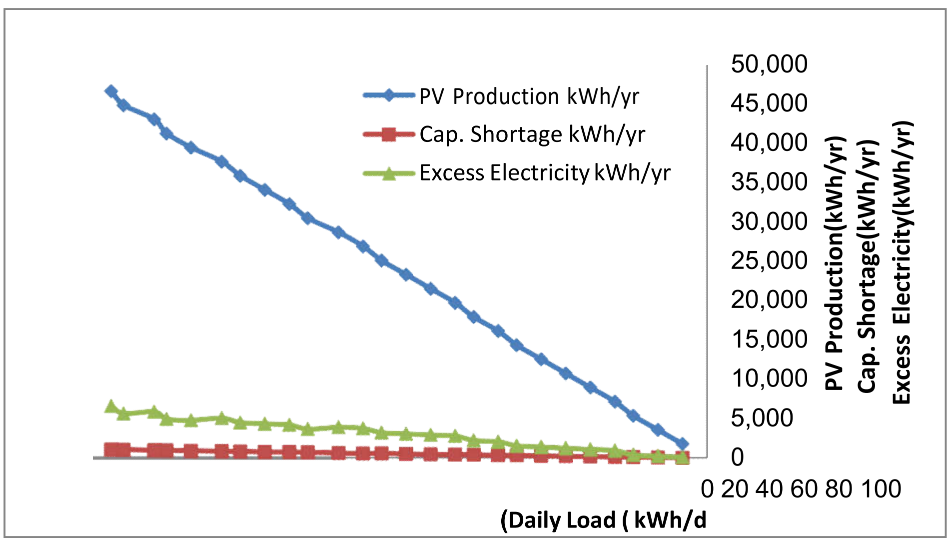

Fig. 6: Over the PV to produce electricity, the lack of capacity and excess electricity, compared to the daily load for the city of Najaf.

5.2.3 Daily load versus over the productivity of the battery, the number of batteries, chargers self-battery, and battery life time for the city of Najaf.

The following Figure 7 shows over of the productivity of the battery throughput which is change from (336 to 7377) kWh / year, also the number of batteries between (1 - 13), as well as, self-charging battery autonomy ranges (8.112 – 14.976) hour and the battery life time between(8 - 10) a year, compared with the daily load variable between daily load (4 - 96) kW / day.

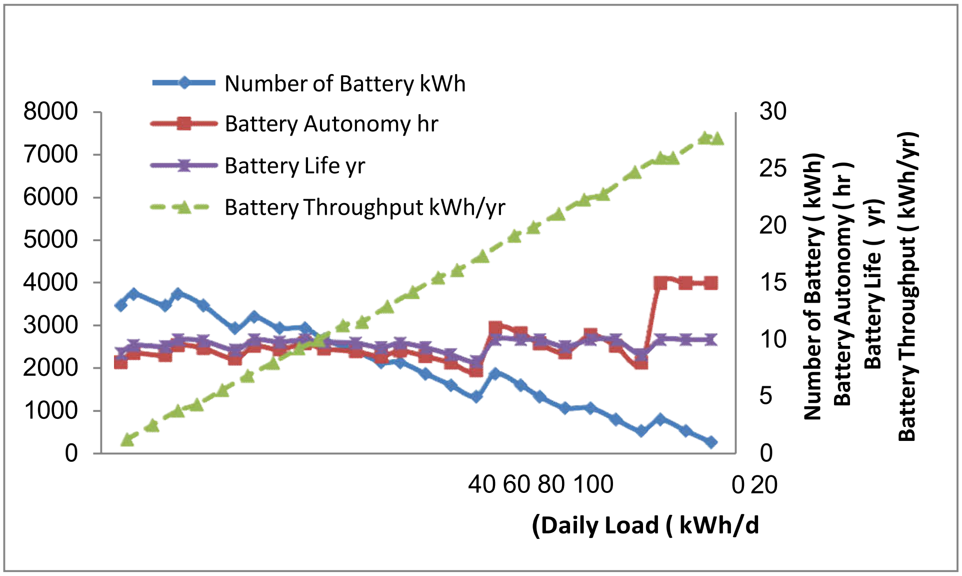

Fig. 7: Over the productivity of the battery, and the number of batteries, chargers self-battery, and the battery life, compared with the daily load for the city of Najaf.

5.2.4 Daily load for a set cost of capital and the total net cost of the system and the total annual cost the city of Najaf.

As shown in Figure 8 which are illustrates group of total capital cost (2620 to 46990) USD, the total net cost of the system (total NPC) (2825 to 54611) USD and the total annual cost (Total Ann. Cost) (221 to 4272) USD versus the daily load (4 - 96) kW / day.

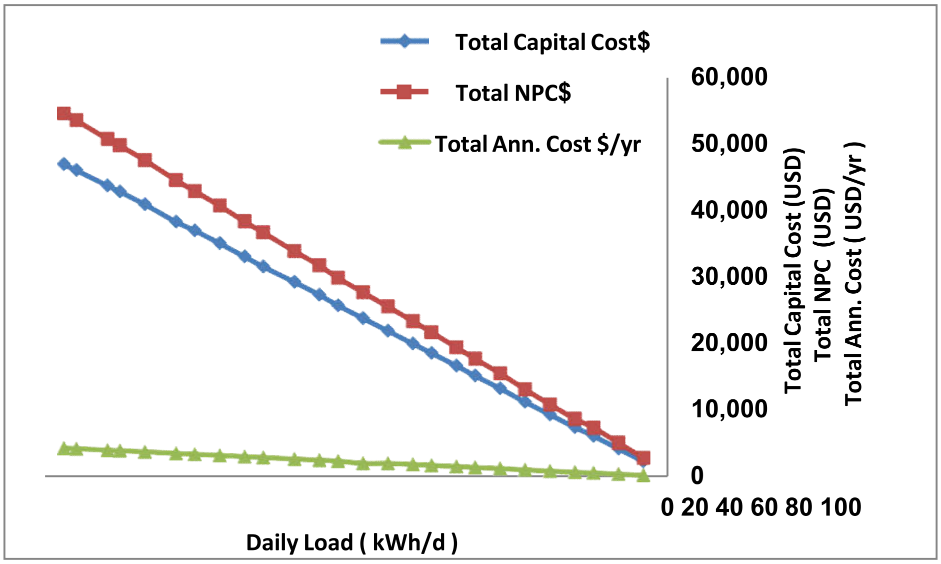

Fig. 8: Set the cost of capital and the total net cost of the system and the total annual cost versus load on the city of Najaf.

5.3Simulation Results of PV system design using Homer for Erbil

5.3.1 Daily load versus boarded power generation capacity, the number of batteries the ability to energy conversion for the city of Erbil.

As shown in Figure 9 below using Homer program, the optimal system for PV system power to the city of Najaf to the ability of power generation boarded PV panel Place between (1 – 31) kW, and the number of batteries ranges (1- 17) and the ability to energy converter be between (5 until 14.5) kW and the energy costs (COE) (0.144 -0.163) kWh compared with the daily load variable between (3 - 94 kW / day).

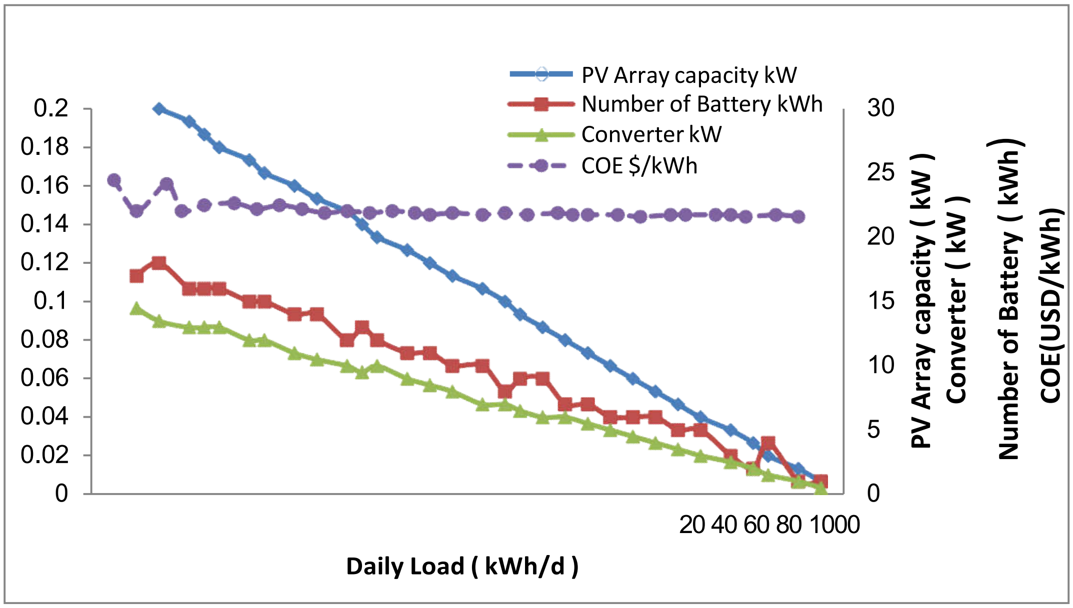

Fig. 9: Illustrates the change in PV Array capacity, boarded the number of batteries, the ability to convert the energy and COE compared to the daily load for the city of Erbil.

5.3.2 Daily load compared to the extent of PV to produce electricity, the lack of capacity and excess electricity compared to the daily load the city of Erbil.

In Figure 10, we have to get over the PV to produce electricity between (1671 to 51787) kWh / year, and the lack of capacity shortage ranges (from 7 to 1059) kWh / year, as well as, excess electricity will be between (452 to 138337) kWh / year versus variable between Daily Load (3-99) kW / day.

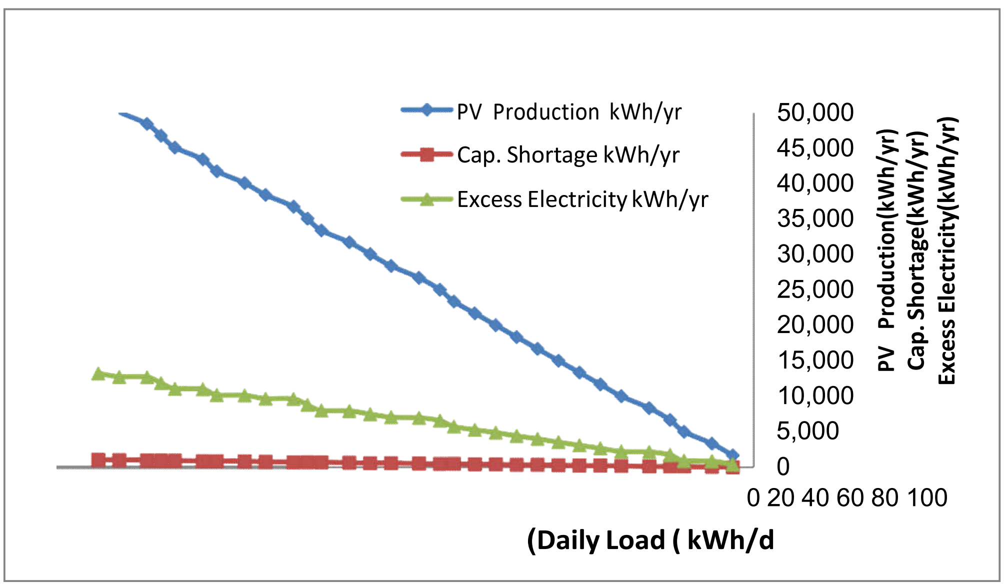

Fig. 10: Over PV to produce electricity, and the lack of capacity and excess electricity, compared to the daily load for the city of Erbil.

5.3.3 Daily load versus over the productivity of the battery, the number of batteries, chargers self-battery, and battery life time for the city of Erbil.

The following Figure 11 shows over of the productivity of the battery throughput which is change from (241 to 659) kWh / year, also the number of batteries between (1 - 17), as well as, self-charging battery autonomy ranges (10.337 – 19.968) hour and the battery life time between(8 - 10) a year, compared with the daily load variable between daily load (3- 94) kW / day.

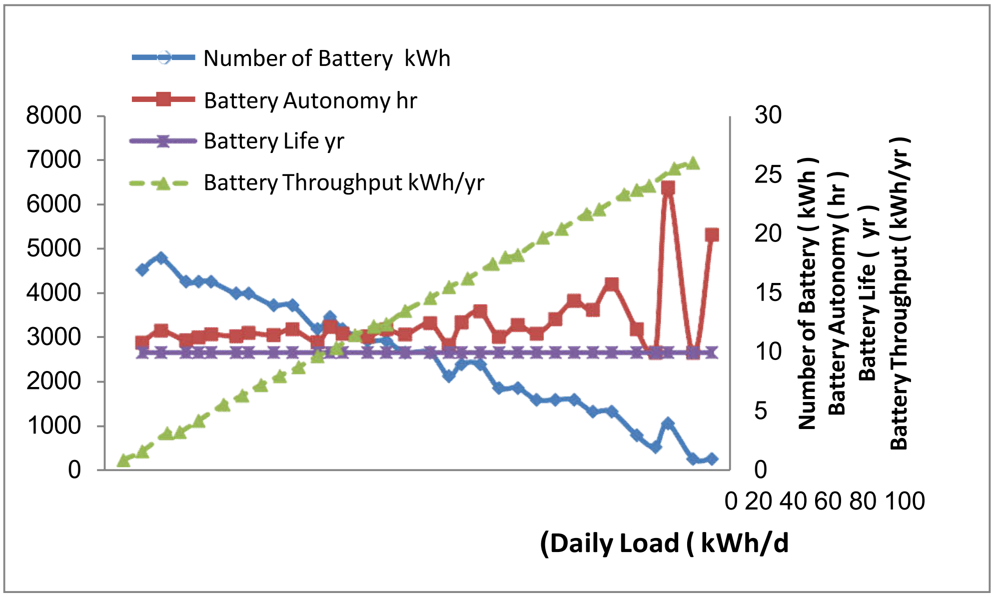

Fig. 11: over the productivity of the battery, the number of batteries, chargers self-battery, and the battery lifetime compared with the daily load for the city of Erbil.

5.3.4 Daily load for a set cost of capital, the total net cost of the system and the total annual cost the city of Erbil.

As shown in Figure 12 which are illustrates group of total capital cost (2910 to 54190) USD, the total net cost of the system (total NPC) (2275to 62072) USD and the total annual cost (Total Ann. Cost) (178 to 4856) USD versus the daily load (3 - 94) kW / day.

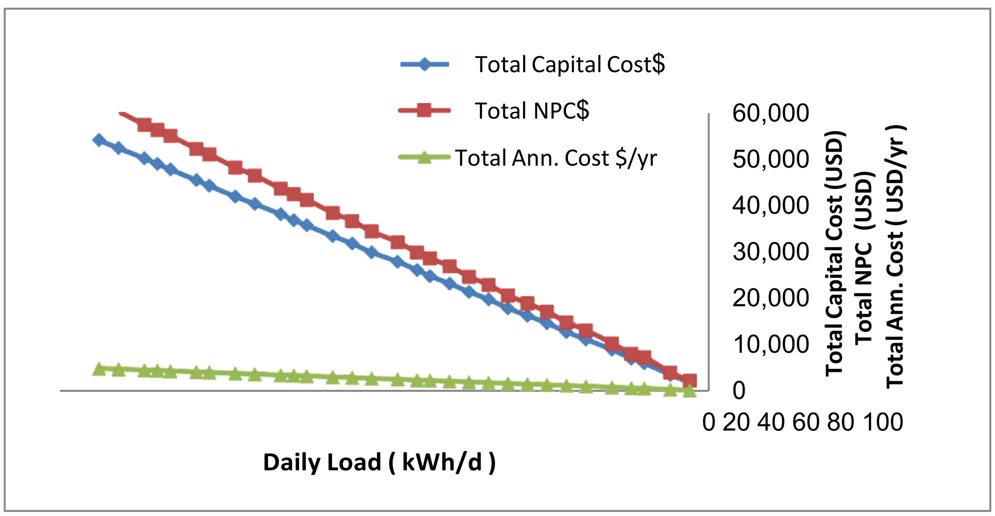

Fig. 12: Set the cost of capital and the total net cost of the system and the total annual cost versus load on the city of Erbil.

5.4 compare all the results and find the rate

In this section, we have compared the results of the simulation Homer program for all the selected sites to all parameters in order to find the best design of the photovoltaic system (PV). Then we have to find each average (rate) results as shown in Figures 13 - 16. The results show that all sites are close together which are allowing us to find the average as shown in Figure (13). This Figure shows over the convergence of sites selected Baghdad, Najaf and Erbil using Homer program, the optimized of PV system energy in terms of (PV Array capacity, the number of batteries, the ability to Converted energy and Total Energy costs the values are (1 - 25.71428-1) kW, (1.14285 - 14.714)kWh , (0.928571- 13.9285) kW, (0.130–0.166) kWh, compared to an hour daily load (3.8571 - 94.142857) kW / day, respectively. where found almost fixed values with a limited variation of less than 2% within the scope of load (10 - 99) kW / day. It can be concluded that the differences in the values of loads (10 - 99) kW / day limited parameters.

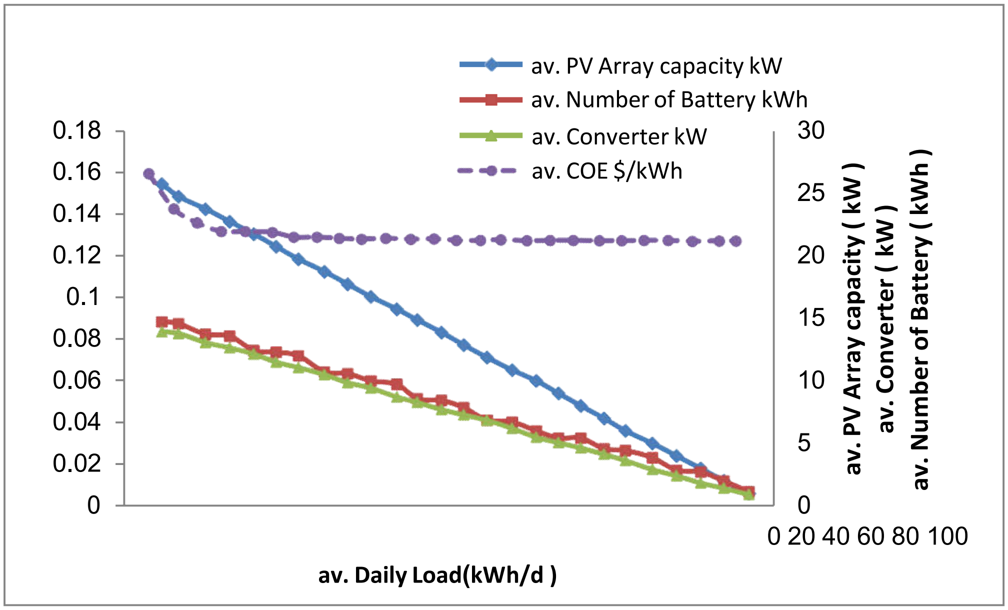

Fig. 13: Shows the selected sites to change the ability of power generation, boarded the number of batteries and the ability to convert the energy compared to the daily rate of load.

Figure 14 shows over the convergence of sites selected by using Homer program, which is represented the optimal system for PV energy of the relationship between the daily load (10 - 99) kW/day for the following technical standards: electricity production PV, the lack of capacity, and excess electricity for sites that has studied in Iraq which are Baghdad, Najaf, and Erbil, respectively.

It is clear to see that every part of information have shown similarity in three sites in exchange for loads (10 - 99) kW / day, the extent of PV electricity production is (1784 to 45870) kWh / year, the lack of capacity is (27.14286 to 1038.571) kWh / years, and excess electricity is (184.2857 to 6766.143) kWh / year compared to the daily load (-3.8571 - 94.142857) kW / day.

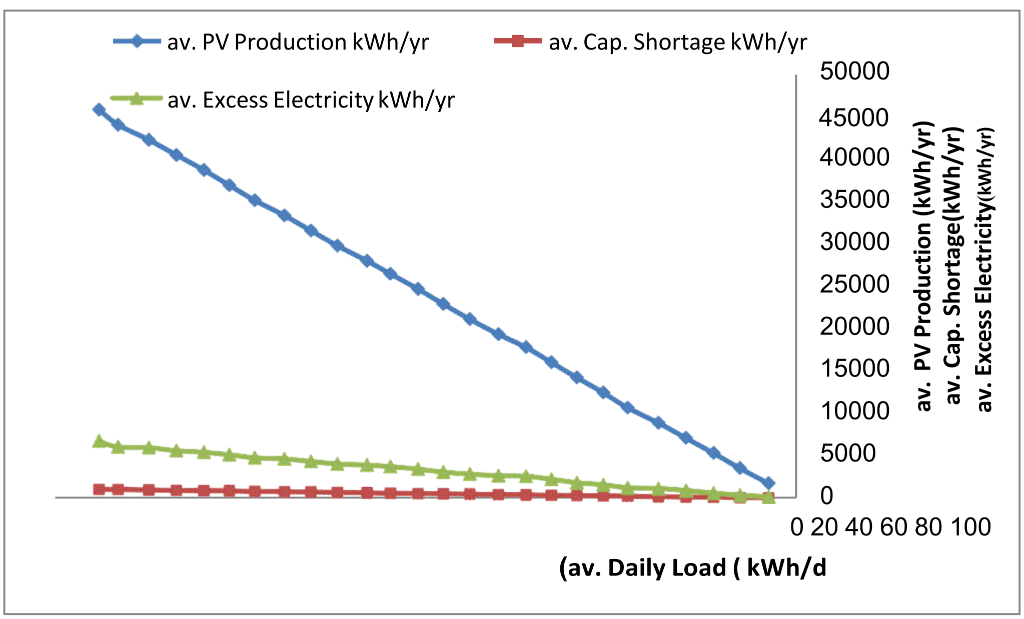

Fig. 14: Selected sites over the rate of PV to produce electricity, the lack of capacity, and excess electricity compared to the daily load.

From Figure15 which is the relationship between the daily load (10 - 99) kW / day and the following battery parameters: the extent of the productivity of the battery, the number of batteries, chargers self-battery, and battery life time) for all the studied locations Baghdad, Najaf, and Erbil, respectively.

It is shown that each parameter almost identical for the selected sites versus the loads (10 - 99) kW / day. the values of the extent productivity of the battery (358.4286 to 8098.714 kWh / year, the number of batteries (1.14285 - 14.714), Self-charging battery (9.411622 - 17.82857) hours, and battery life time (9.114286 -9.857143) years, versus with the daily load (3.8571 - 94.142857) kWh / day, respectively.

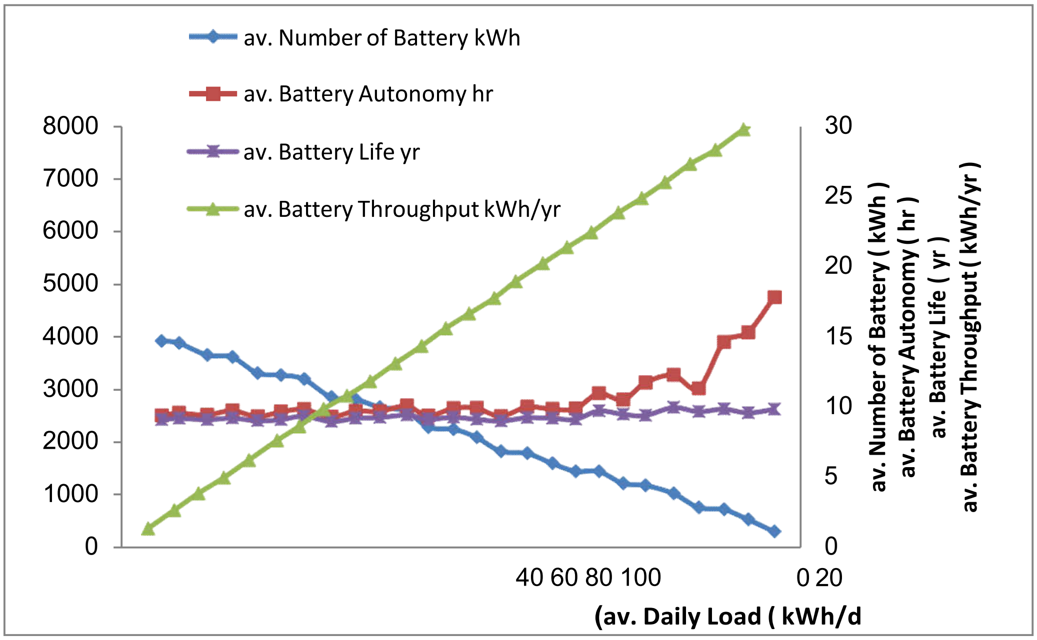

Fig. 15: Rates to the extent of the productivity of the battery, and the number of batteries, chargers self-battery, and the battery life, compared with the daily load for the areas studied.

Finally, Figure 16 show the relationship between daily load (10 - 99) kW/day with the parameters cost by the calculating the extent of the productivity of the battery, the number of batteries, chargers self-battery and battery life time for all the studied locations: Baghdad, Najaf, and Erbil, respectively.

The results show that each parameter almost has similarity to the location sites against the loads (10 - 99) kW/day. the values are: total capital cost (2304.286 to 46692.86) USD, the total net present cost of the system (Total NPC) (2827 to 54625.43) USD, and the total annual cost (Total Ann. Cost) (221.1429to 4274) USD for the daily load (3.8571 - 94.142857) kW / day, respectively.

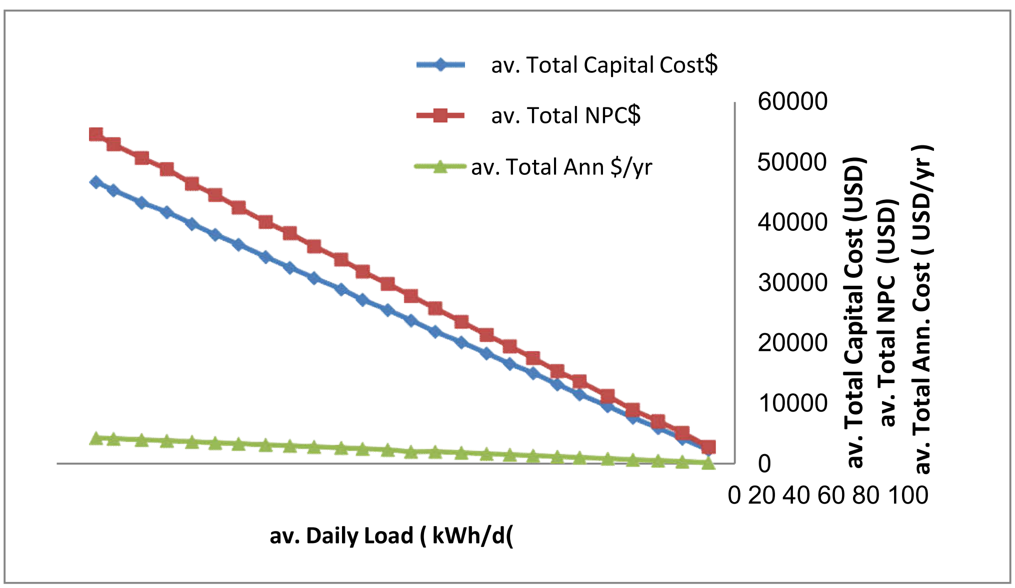

Fig. 16: The rate set of the total capital cost, the total net cost of the system, and the total annual cost versus daily load

CONCLUSION

The most important conclusions results are:

1. The effect of solar radiation data for the three locations by latitude within Iraq influenced a little bit by the technical standards.
2. The values of each of the regions that have undergone a similar study of almost daily compared to load and this can put disclose similar system includes all parts of Iraq.
3. This result encourages the researcher to predict a lot of information and technical standards for the design system and a wide range of areas to carry on the (10-100) kW / day is located in the same circle's show.
4. empirical equations suing in HOMER predicting PV energy values, the ability of the battery exchange of energy, size that were obtained in this study can be used as an easy reference for of the converter and the production of electricity panels are located at the same latitude within the Arab world in return for me over the download daily (10-100kWh) during the day.

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