



## Investigating the role of solar panels in the energy self-sufficiency of residential buildings

Khairuddin Musazada<sup>1</sup>, Hamed Sirat<sup>2</sup>

1-Graduated from Asia Institute of Higher Education, Faculty of Civil Engineering

2-Academic vice chancellor of Asia Higher Education Institute (Herat)

### Abstract

The main purpose of this research is to investigate the role of solar panels in the energy self-sufficiency of residential buildings in the sixth district of Shahr Herat. Solar energy is an endless source of abundance and is free from pollution and protects the environment. The method carried out in this research was carried out in two statistical and computational sections, in which 40 people were determined in the statistical section and randomly distributed to experts, university professors and companies importing solar panels, and the obtained data were obtained by the Excel program. He came and was kidnapped. And in the calculation part of the electricity requirement of one day of the building, the cost of electricity purchased for two months in the building, the cost of the solar panels system was determined with the amount of energy that a building needs. According to the findings of the research, if solar panels are used, it helps in energy self-sufficiency of residential buildings in Herat city by about 62.5%. Every two months, households buy electricity in their building for an average amount of 5,000 thousand Afghanis, and the cost of creating a solar panel system with 1.5 kilowatt hours of energy is estimated at 61,560 Afghanis. And the result of this research is that you can get the cost of this system for two years and one month by using the purchased solar panels and achieve economic benefits for several years. Also, the citizens of Herat city can earn through this system and sell their produced electricity to the government.

**Keywords:** Solar panels, building, self-sufficiency, economic provisions, environment, cost, Herat city.



## Introduction

Solar energy is one of the most important types of renewable energy in Afghanistan. People's daily life is dependent on energy production; Therefore, its supply and demand in human societies is continuously increasing. Energy is one of the most important factors in the progress and development of human societies, the majority of the energy consumed in Herat was imported from countries like Iran and Turkmenistan at a huge cost, and also households in Herat city. It buys energy at a high cost. This purchased energy is a day and not a day. With the heat of summer, the coldness of winter, and the need for energy that households have, they cannot lead their lives normally. Currently, almost a few million people in the world are facing the problem of lack of electricity.

Today, the lack of electricity in Herat city, especially in the sixth district, is a major problem. Energy is the currency of technology. Without energy, social life and basically technology and its progress will be completely stopped. A clear example is the power cut of a city for 24 hours. Computers and elevators stop working, hospitals stop caring and accepting patients, and the whole city stops moving and doing its usual activities. In the summer season, when the electricity in the building is cut off, households cannot have access to coolers, air conditioners, refrigerators, televisions, vacuum cleaners, and washing machines. Not having access to technology today in the hot season, life is very difficult and difficult; Because it lives in the homes of children, women, elders, pregnant women, etc. Today, households buy energy at an exorbitant cost, and these problems have plagued the people of Afghanistan for years. In poor countries, especially in Africa, which are economically and politically similar to Afghanistan, it can be a model for this country. In some African countries, the use of complementary solar power system packages, which are usually produced by European and Chinese companies, has given good results. These packages mostly consist of several light bulbs, solar panels, and batteries, which can increase its capacity at a higher cost. It is also possible to connect this system to the central electricity grid. According to the statistics of Afghanistan's Central Bureau of Statistics (Amar) and social media, it can be seen that a significant number of families, especially in rural areas, use renewable energy sources. Breshna company buys 280 to 300 million US dollars of electricity annually from countries such as Tajikistan, Uzbekistan, Kazakhstan, Turkmenistan and Iran, and Breshna company said that any company or person wants to create a solar energy base, Breshna company is one of such measures. welcomed and will purchase the electricity of the mentioned company so that they can take a valuable and beneficial step for the development, development and self-sufficiency of energy in the country. The questions that are discussed and studied in this research are: What is the role of solar panels in the energy self-sufficiency of residential buildings in Herat city? And to what extent the use of solar panels during the course of the project can achieve economic benefits? Based on these questions, the mentioned article will be researched so that we can solve the problem of lack of electricity in Herat city. What seems to be the current growth of population and migration in Herat city is increasing. With the growth of the population in the cities, the construction of buildings also increases. With the growth of cities, the need for energy increases. A suitable plan for the future of energy in Herat city is the goal of energy experts in this city today. There are many problems in the absence of energy in buildings.

The purpose of this research is to investigate the role of using solar panels in the energy self-sufficiency of residential buildings in Herat city. In this research, the energy consumption that is consumed daily in a building and based on the electricity needs of a building around the clock will be measured. And the cost of an energy production system using solar panels will be calculated. And we will share with you the results of the study of the role of solar panels in energy self-



sufficiency in Herat city and we will provide suggestions in the field of energy improvement in Herat city.

### **Research background**

All papers must be written in either English or Persian (Farsi). Paper will be presented in the Based on studies done in the works of this topic, the role of solar panels in energy self-sufficiency in residential buildings has been stated as follows.

A- Hasan Eftekhari, Pouria Naimi Amini, Mehdi Zamiri Bidari, Mohammad Reza Rihani (2013) in his research entitled "Technical-Economic Study of Using Solar Energy to Supply Energy to the Buildings of North Khorasan Gas Company" the results of the studies conducted in this research This indicates that unlike the newly constructed headquarters of the North Khorasan Gas Company, changes in the existing buildings of the Gas Company and the installation of new solar systems in them are economically feasible.

B- Seyyed Mohammad Shibri, Mehsa Bayati (2012) in his research entitled "Study of the social acceptance of solar energy systems from the perspective of the people of Arak city" the results show that the level of awareness of the people of Arak city about renewable energies and fossil fuel alternative energies in the position It is located above. The majority of people have a positive view of using solar systems. Also, surveys show that a smaller percentage of people are aware of photovoltaic systems and their uses, and solar water heaters are more accepted compared to photovoltaic systems.

C- Mansoura Sahrani Khavah, Zainab Sadat Razavi (2012) in their research entitled "Comparison of solar energy extraction and use in the sunny land of Afghanistan and Germany" the findings show that Afghanistan is in a much better and more capable condition in terms of receiving solar energy. It is higher than Germany, but Germany has been more successful in using this energy.

D- Mojtabi Samrah (2012) in his research entitled "A new method of using solar energy for building lighting" the results show that the use of electric energy for the production of light is the most important part of the three sectors of energy consumption. Replacing this energy with other sources can generate considerable savings in electricity consumption. One of the suitable sources for this work is natural sunlight.

### **Research Methodology**

This research has been done by computational and statistical methods. The method of collecting materials in this research is a combination of both library and field methods, in the same way that the literature part of the research and the expression of concepts from library sources such as books, articles, and internet sites were used, but for investigating the role of solar panels in energy self-sufficiency in Herat city, Field research has been carried out. In this research, a questionnaire tool was used to collect data, and 40 questionnaires were randomly answered by university professors, specialists, employees of Breshna Company, employees of solar importing companies, and the general public. The employees of the solar importing companies have been closely interviewed in order to understand the needs of the current research and analyze them in relation to answering the research questions and testing the hypotheses, and also in the places where solar panel projects were used for energy production. we visited Its results are explained in detail below.

### **Theoretical concepts of research**

**Solar panels:** This section is actually a converter of solar energy into electrical energy without mechanical intervention. Photovoltaic panels that are exposed to sunlight are composed of photovoltaic cells. It is necessary to mention that the output current and voltage of these panels is DC.



Battery and energy storage: The radiant energy of the sun varies during the day, so in many applications of solar energy, an energy storage source is necessary. Increasing the performance of the photovoltaic system and the time of use, storing solar energy converted into electrical energy, providing the required electrical energy in the absence of sunlight, the ability to connect in series and parallel to achieve more power.

Inverter, AC/DC converter: The conversion of power from DC to AC is done by a converter (inverter). In photovoltaic systems, the resulting electricity is DC and since most of the loads in the industry and electrical uses work with AC power, this electricity can be converted by an inverter device and its characteristics such as voltage and frequency can be matched with the components required by the consumer.

**Analysis and discussion of research data**

**The cost of purchasing energy in the building**

To check the electricity bills of buildings, a series of energy analyzes and comparison of their values in different months of the year is needed. For this purpose, the amount of electricity consumption of each unit separately for every two months of the year, based on the questionnaire that was explained among the people of Dawar, that the average amount of 5000 thousand Afghani was said about the electricity bills in every two months.

**Table 1- Calculation of energy consumption in the building**

Number	The monthly cost of energy consumption in the building	12 months	2 Years
1	2,500 Afghanis	30,000 Afghanis	60,000 Afghanis

Source: research findings

**Calculation of energy consumption in the building**

Today, various technologies are used in buildings. In the building, households use technology based on their needs to provide comfort and convenience in their lives. Energy consumption in Herat city is considered based on the custom of the society that uses technology.

- o LG refrigerator with energy consumption of 71-watt hours
- o in a set of seven lamps for lighting the building with energy consumption of 140-watt hours
- o LCD TV with a power consumption of 145-watt hours
- o Cooler with energy consumption of 100-watt hours
- o TV accessories around 150-watt hours
- o Other electrical equipment 200-watt hours

The energy consumption set in a building is 806-watt hours (0.806 kwh) and it is also necessary to make calculations to know how much energy each of the devices consumes during the day, which is necessary to determine the number of hours of their use. let's show for this purpose, the consumption hours of all of them are considered to be about 8 hours.

Therefore, the total electrical energy consumed during the day is equal to 6448-watt hours or 6.448 kilowatt hours, a part of which can be received from the panel and another part from the batteries, but for this, a detailed inspection of the equipment's performance is required. Therefore,



in this example, we consider all the energy consumed on the battery. Now, by dividing the total energy consumption by the battery voltage, the battery capacity is also determined, in this example, we consider the battery voltage to be 12 volts. The calculated capacity is approximately equal to 600-amp hours, which is enough to reach the final value. Divide by 0.6, which is the proper discharge depth for the battery. The result of this calculation is something around 900-amp hours. To prepare this capacity, you can use 4 batteries of 200-amp hours and 1 battery of 100 amps and place them in parallel with each other. Also, as mentioned in the previous section, by multiplying the number of 0.1 by the capacity, the current required to charge the battery is also determined, where the number of 0.1 is multiplied by 900-amp hours because this amount of battery capacity is used. Therefore, in this example, a current equal to 90 amperes is needed, in which case it takes 5.4 hours to charge the batteries.



**Figure 1- Solar panel on top of the roof of a residential building in the south part of the community mosque in Herat city. Source of research findings**

#### **The cost of the solar panel system**

Based on the present research, data analysis in the case of energy consumption in a building has been done. The electricity requirement that a building needs is 806-watt hours. For the sake of certainty, we consider 1500-watt hours for energy production. The equipment needed to produce 1.5 kilowatt hours of electricity is listed below.



**Table 2- cost of solar panels system**

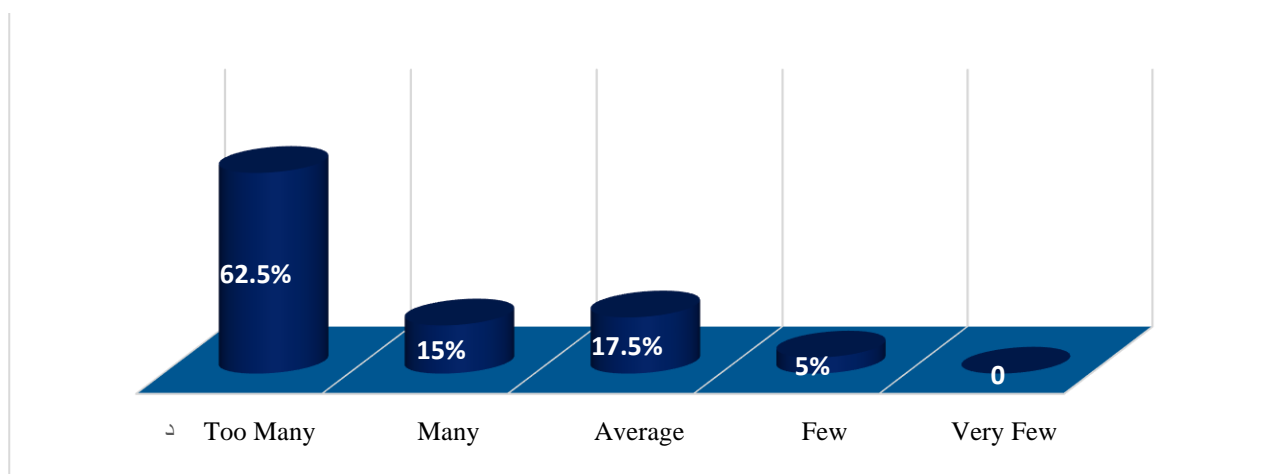
Number	Equipment	Cost
1	☼ solar panels of 520 watts, energy production set of 1.56 watts per hour) 1.56Kwh .(	21,360 Afghanis
2	Inverter (DC-VC converter) for 4 kW energy	6,200 Afghanis
3	Base for solar installation	4,000 Afghani
4	Lane requirements of this system	1,000 Afghani
	wage earner	2000 Afghanis
5	batteries of 200 amperes, set of 800 amperes and 1 ☼ battery of 100 amperes, set of 900 amperes	27000 Afghanis
6	Collection	61560 Afghanis

Source: research findings

By looking at this table, we come to the conclusion that the cost of 1.5 kilowatt hours of solar energy costs 61,560 Afghanis, and with this amount of money, we can have a solar power system in our building and meet the necessary needs.

**To what extent do solar panels play a role in energy self-sufficiency in Herat city?**

**Diagram 1- explaining the number of answers**

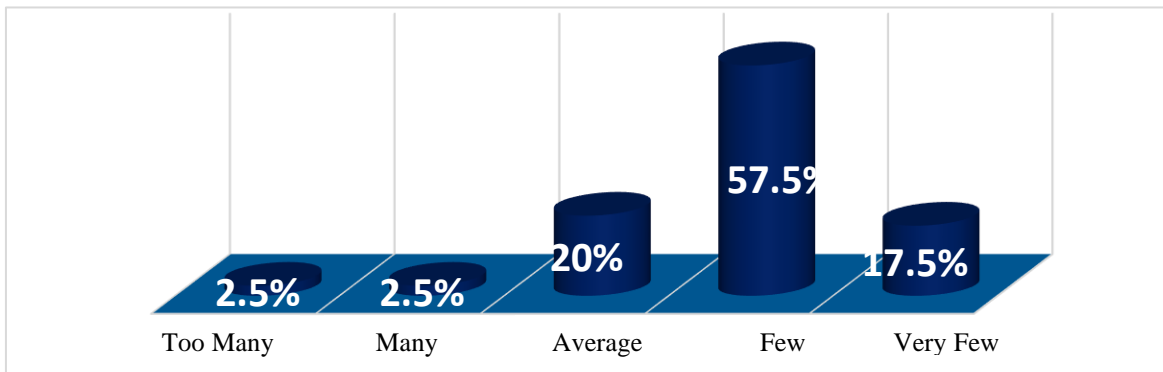


By observing this graph, we come to the conclusion that solar panels play an effective role in energy self-sufficiency in Herat city, and a high percentage are above this because; 62.5% chose a very high option, 15% chose a high option, 17.5% chose an average option, 5% chose a low option, and 0% chose a very low option.



**How many buildings in Herat use solar panels?**

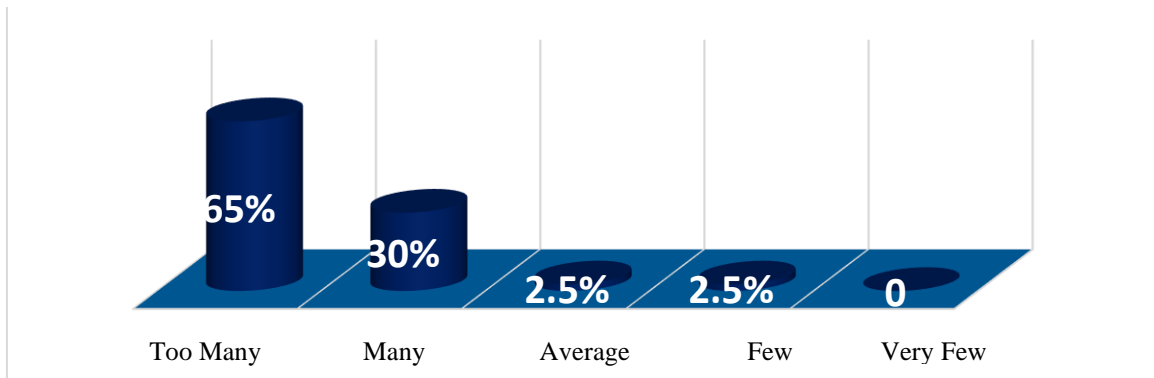
**Diagram 2- explaining the number of answers**



By looking at this graph, we come to the conclusion that the buildings in Herat use very little solar panels and a large percentage agree on this question because; 57.5% chose the low option, 17.5% the very low option, 20% the medium option, 2.5% the high option, and 2.5% the very high option.

**How effective are solar panels on air pollution and the environment?**

**Diagram 3- explaining the number of answers**

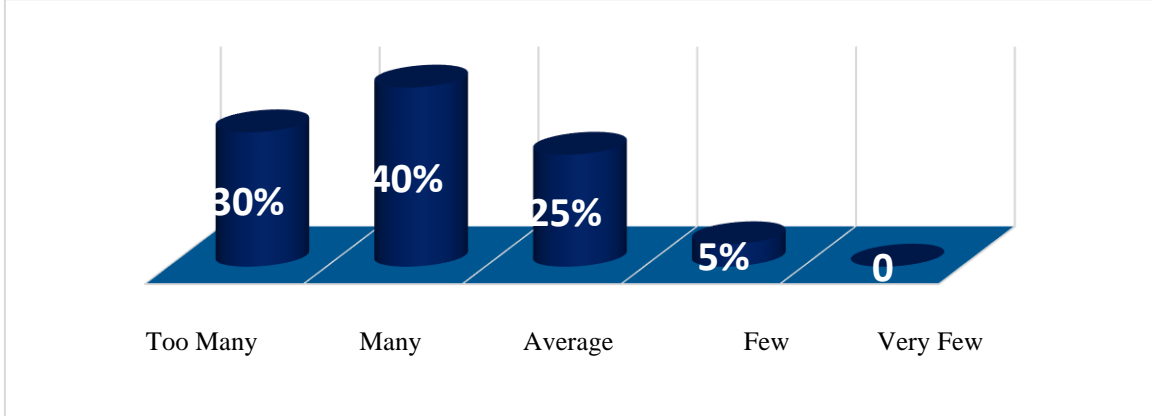


By looking at this graph, we come to the conclusion that solar panels are very effective against air and environmental pollution and a large percentage agree on this question because; 65% have chosen too many options, 30% have chosen many options, 2.5% have chosen an average option, and 2.5% have chosen a few options.

**To what extent can solar panels provide thermal comfort and technological satisfaction compared to municipal electricity?**



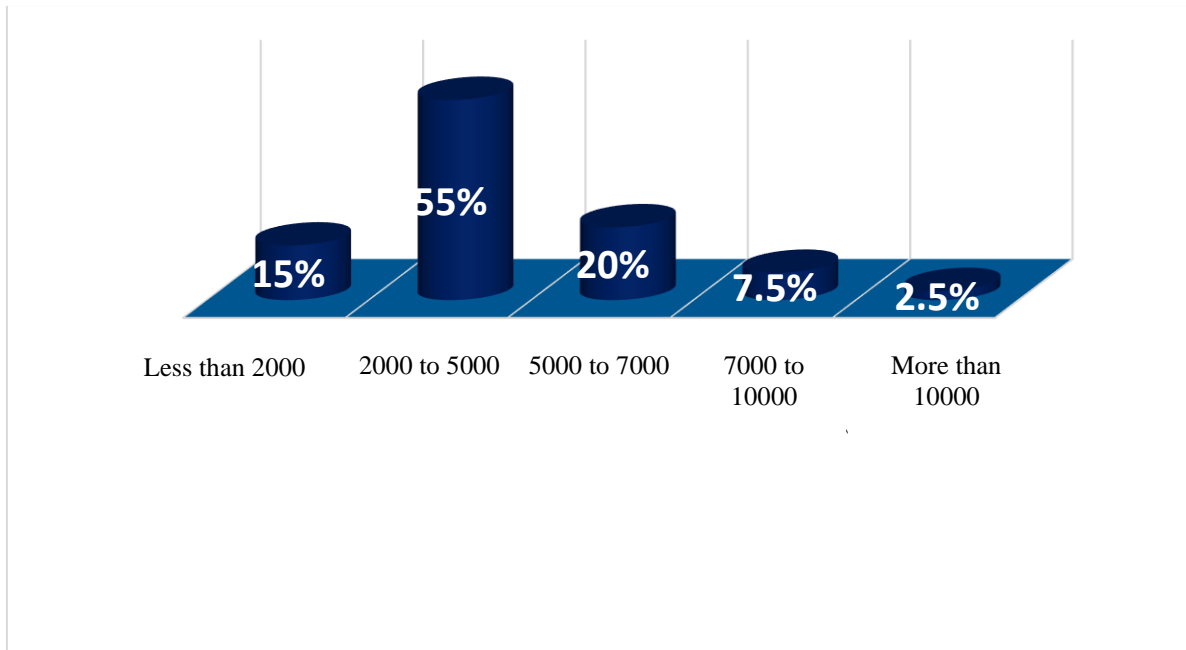
**Diagram 4- explaining the number of answers**



By looking at this diagram, we come to the conclusion that solar panels can provide thermal comfort and technological satisfaction, and a large percentage agree on this question because; 40% chose a high option, 30% chose a very high option, 25% chose an average option, and 5% chose a low option.

**How much money do you pay to Breshna company every two months to buy city electricity in your building?**

**Diagram 5- explaining the number of answers**



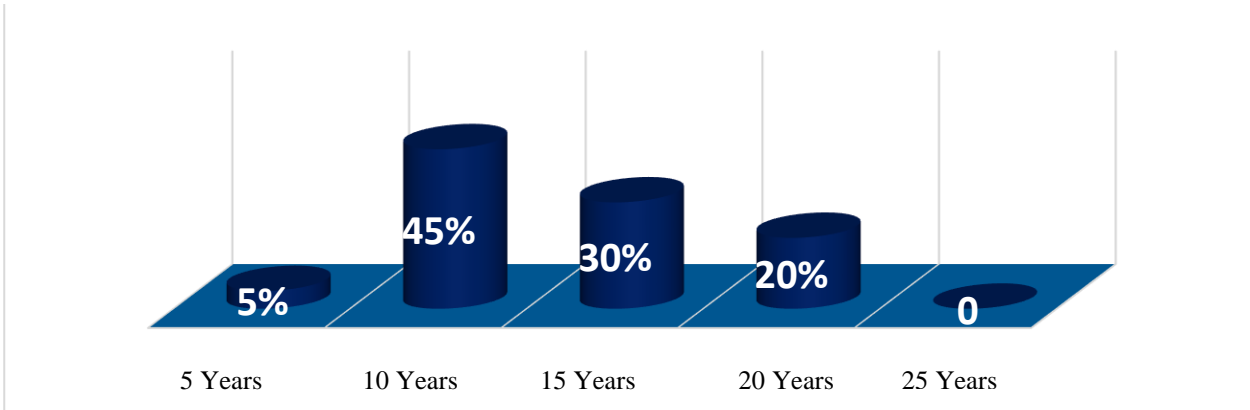
By looking at this graph, we come to the conclusion that in both of our households, they pay a huge amount to the Breshna company to buy electricity, and a large percentage of them are successful in this question because; 55 percent chose 2000-5000 thousand, 20 percent chose 5000-7000 thousand, 15 percent chose below 2000 thousand, 7.5 percent chose 7000-10000 thousand and 2.5 percent chose more than 10000 thousand.





How many years of using solar panels in Herat city can we achieve energy self-sufficiency?

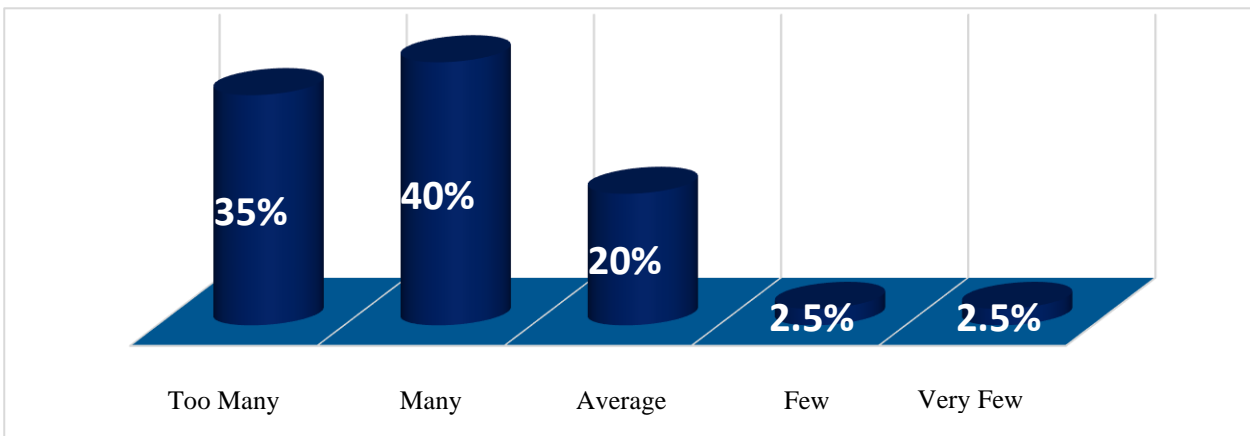
Diagram 6- explaining the number of answers



By looking at this graph, we come to the conclusion that we can achieve self-sufficiency in the field of energy after 10 years of using solar panels, and a large percentage agree with this because; 45 percent chose the 10-year option, 30 percent chose the 15-year option, and 5 percent chose the 5-year option.

To what extent do you have power cuts in your building during the critical seasons of the year (summer and winter)?

Diagram 7- explaining the number of answers

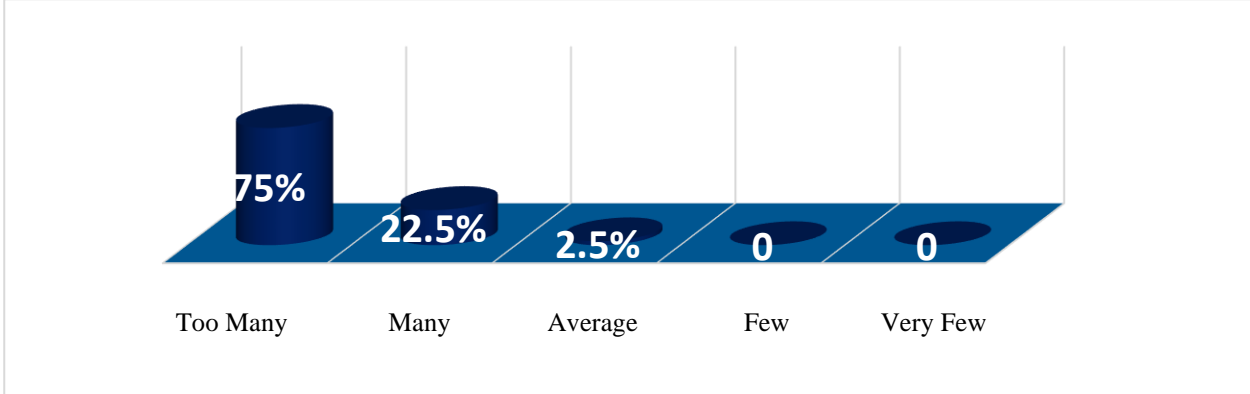


By looking at this graph, we come to the conclusion that there are many disconnections in the buildings during the critical seasons of the year (summer and winter) and a large percentage agree on this because; 40% chose a high option, 35% chose a very high option, 20% chose an average option, 2.5% chose a low option, and 2.5% chose a very low option.

To what extent do solar panels help for the lack of electricity in Shahrherat?



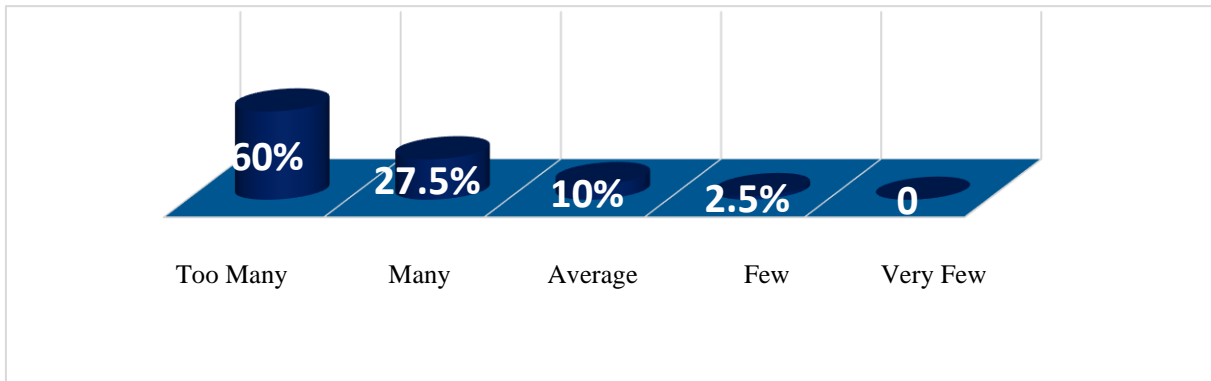
**Diagram 8- explaining the number of answers**



As can be seen in this graph, we come to the conclusion that solar panels are very effective in the absence of electricity in Herat city and a high percentage agree on this because; 75% have chosen a very high option, 22.5% have chosen a high option, and 2.5% have chosen an average option.

**To what extent are solar panels used in areas that do not have city electricity?**

**Diagram 9- explaining the number of answers**

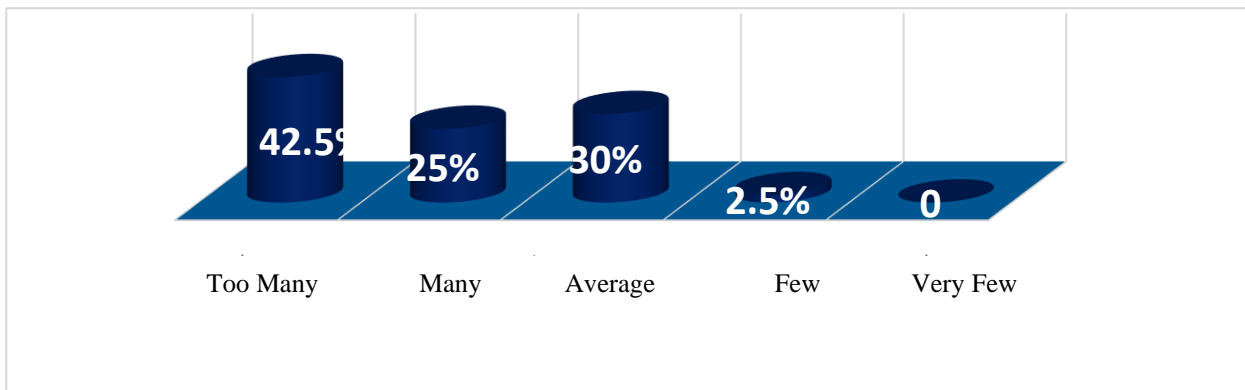


Based on the observation of this graph, we come to the conclusion that in areas that do not have city electricity, they use solar panels to meet their electricity needs. A high percentage agree on this because; 60 percent chose very much, 27.5 percent chose a high option, 10 percent chose an average option, and 2.5 percent chose a low option.

**To what extent is it possible to use city electricity and solar in combination in the building?**



Diagram 10- explaining the number of answers



By looking at this diagram, we come to the conclusion that there is a great possibility to use urban and solar electricity in a combined way. When the electricity in the city is cut off, we can use solar energy and a large percentage agree on this because; 42.5% chose very high, 25% high, 30% medium and 2.5% low.

### Conclusions

According to the problems mentioned in the problem statement, in the critical seasons of the year (summer and winter) in residential buildings in Herat city, according to the graph (1-7), there are about 35 percent of electricity disconnections. These problems have caused a lot of trouble for households in the seasons. According to the findings of the present research, we come to the conclusion that the citizens of Herat city can solve their electricity problems by creating a solar power system in their building. According to the research that was done, the energy consumption of a building in one hour is 806 watts. To be sure, we consider 1.5 kilowatt hours, and at night and it is still necessary to know how much energy all electrical appliances consume in a day. For this purpose, the number of consumed hours is considered to be about 8 hours, which is 6.448 kilowatt hours per day, with 4 batteries of 200 ampere and 1 battery of 100 ampere, the set of 900 ampere is necessary to provide the same amount of energy at night. The cost of the solar panel system in energy production is 61,560 Afghanis, which is used all day long. According to the questionnaire, the estimated cost of Herat citizens every two months is 5000 Afghanis, this huge cost has a great impact on the economy of households in Herat city. If you multiply this cost by two years of purchased electricity, the amount will be 60,000 Afghanis. We come to the conclusion that the use of solar panels for two years and one month can cover the cost of this system in addition to the purchased electricity and achieve economic benefits for several years to come. Solar panels can be used in a combination in the building, and when there is city electricity, use city electricity, and if there is no, use solar power, on the contrary, if the days are cloudy in winter, you can use city electricity, and if He did not use solar power. In some Asian countries, for example, India, solar panels are used in a combined way, when the required electricity is provided in the building, it automatically transfers electricity to the outside of the building in the city electricity lines. If the electricity required for their building is not provided by solar panels, city electricity will be used automatically. This system requires very little cost with the number of solar, transfer, inverter and a meter is necessary for calculation and later you can sell your produced electricity and get economic provisions. This action provides the electricity needs of the households and at the same time makes the city electricity strong. According to the graph (1-6) for 10 years of using this energy, you can reach energy self-sufficiency and have independence in the field of energy in your building. Today, according to the graph (1-2), solar panels are used in Herat city in about 2.5



percent. And more solar panels are used in Herat city to draw water in agricultural lands. Solar energy is an energy that is dust-free and pollution-free and protects the environment.

### **suggestions**

According to the research that was done, the cases that are proposed are stated below.

- o Replace solar energy instead of fossil energy.
- o Increasing public awareness of solar energy.
- o Investment in the field of solar energy.
- o Establishing a solar power plant in Herat city to increase energy needs.
- o The government should establish a solar energy department in Herat University and other provinces.

Citizens of Herat city can create a solar power plant in their building and sell their excess energy to the government. This action helps a lot in the energy field of the country.

- o the people of Herat city should use this energy because it is cheap and helps in the country's energy field.



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