Solar Energy as an Alternative to Conventional Energy in Gaza Strip: Questionnaire Based Study

الطاقة الشمسية كبديل للطاقة التقليدية في قطاع غزة: دراسة تستند إلى استبيان

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Abstract

Solar energy system is currently used in Gaza Strip as a replacement source or complementary source to the traditional source of energy. However, using solar energy is happening without any planning or clear vision. Gaza Strip is supplied by electricity from three main sources: Egypt, Israel, and local electricity plant in Gaza Strip. However, most of the time, one or two or sometimes the three sources are cut due to the political situation keeping Gaza Strip under darkness most of the time. This work aims to study the use of solar energy as an alternative to conventional energy in Gaza Strip: Questionnaire based study. The study has been implemented on local institutions (governmental, private and public) in Gaza Strip. To verify its aim, the authors distributed a questionnaire to a sample comprised 13 institutions where 53.8% of the sample are public institutions, 23.1% are government institutions and 23.1% are private institutions. The institutions in the sample do not use solar energy as a full replacement. The researchers analyzed the collected data using SPSS (Statistical Package for the Social Sciences), which include descriptive statistics (the percentage, the mean, the standard deviation and weighted arithmetic mean); Pearson correlation coefficient; Cronbach's Alpha coefficient; Spearman-Brown

Spilt Half; and One Samples t test. Results indicate that the local institutions chose to use solar energy due to the fact the system is environmentally safe and it is available in the market. Moreover, results show that the institutions prefer to use solar energy regardless to the price. This might be explained by the fact that solar systems are the safest replacement to the current systems. Results also did not depend on the institutions' attributes (institution type, the year at which the institution started using solar energy, the ratio of relying on solar power as an energy source). We recommend to use solar energy system to help overcome the current problem of electricity shortage and to extend the study to include other sectors in the local society.

Keywords: Solar Energy, Power in Gaza Strip, Electricity Generation, Types of Solar Systems.

ملخص

يستخدم نظام الطاقة الشمسية حاليا في قطاع غزة كمصدر بديل أو مصدر تكميلي لمصدر الطاقة التقليدي. يتم تزويد قطاع غزة بالكهرباء من ثلاثة مصادر رئيسية هي: مصر وإسرائيل ومحطة الكهرباء المحلية في غزة. ومع ذلك، معظم الوقت، واحد أو اثنين أو في بعض الأحيان يتم قطع المصادر الثلاثة بسبب الوضع السياسي في قطاع غزة. مما أدى إلى إبقاء قطاع غزة تحت الظلام في معظم الأوقات. ومع ذلك، استخدام الطاقة الشمسية كبديل أو تكميلية يحدث دون أي تخطيط أو رؤية واضحة. وتهدف هذه الدراسة إلى دراسة مدى استخدام الطاقة الشمسية كبديل للطاقة التقليدية في قطاع غزة، وتم تنفيذ الدراسة على المؤسسات المحلية (الحكومية والخاصة والعامة) في قطاع غزة. ولتحقيق هدفها، قام المؤلفان بتوزيع استبيان على عينة مكونة من 13 مؤسسة حيث يشكل 53.8٪ من العينة مؤسسات عامة، و23.1٪ مؤسسات حكومية أو خاصة. المؤسسات في العينة لا تستخدم الطاقة الشمسية كبديل تام، وقد قام الباحثون بتحليل البيانات التي تم جمعها باستخدام حزمة الإحصاء للعلوم الاجتماعية (SPSS) باستخدام الإحصاء الوصفي (ما في ذلك: النسبة المئوية، الوسط، الانحراف المعياري والمتوسط الحسابي المرجح)، معامل ارتباط بيرسون، معامل كرونباخ ألفا، و سبيرمان-براون التقسيم النصفي؛ وعينات واحدة ت الاختبار. وتشير النتائج إلى أن المعاهد المحلية اختارت استخدام الطاقة الشمسية نظرا لأن النظام آمن بيئيا وأنه متوفر في السوق، وعلاوة على ذلك، تظهر النتائج أن المعاهد تفضل استخدام الطاقة الشمسية على الرغم من أنها قد تكون مكلفة نظرا لأن هذا يدل على نوعية النظام، بالإضافة إلى ذلك، أنها آمنة. كما أن النتائج لم تعتمد على المؤسسات التي يعزى إليها (نوع المعهد، والعام الذي بدأ فيه المؤسسة استخدام الطاقة الشمسية، ونسبة الاعتماد على الطاقة الشمسية كمصدر للطاقة) . نوصي

باستخدام نظام الطاقة الشمسية للمساعدة في التغلب على مشكلة نقص الكهرباء الحالية وتوسيع الدراسة لتشمل قطاعات أخرى في المجتمع المحلي.

الكلمات المفتاحية: الطاقة الشمسية، الطاقة في قطاع غزة، توليد الكهرباء، أنواع الأنظمة الشمسية.

Introduction

Electrical energy is an important form of energy that can be transformed to any form of needed energy; i. e., heat, light, motive power etc. This has given electrical energy a vital role in the modern world (Mehta & Mehta, 1982). Electrical energy can be generated either by traditional energy sources including fossil fuels and nuclear energy or by renewable energy sources such as solar energy, wind energy and hydraulic energy.

Most places of the world depend on the fossil fuels to produce electrical energy. However, due to the limitations of fossil fuels, the theme of renewable energy (alternative) becomes one of the most important topics of scientific research. In fact, energy and its resources has become a concern for policy makers, scientists, and others (Chu & Meisen, 2011). According to the Environment Protection Agency, solar energy is defined as energy derived from the sun's radiation. Solar energy sustains life on earth. It is also becoming increasingly common that this energy is converted and used as an alternative to fossil fuels. It is considered an environmentally friendly source of energy because it comes directly from the sun (Jäger *et al*. 2014).

Gaza Strip is currently suffering from shortage of electricity supply, especially, fossil fuel, which is considered the worst among the crises and problems that cause pain to people in Gaza Strip due to its direct effect on the economic and social life (Al Mezan Center for Human Rights, 2016). The electricity crises started in 2006 when Israeli forces bombed power station located in the central Gaza Strip. Gaza Strip is supplied by electricity from three primary sources, namely, Israel (120MW), Egypt (27MW) and the Palestine Electric Company (PEC). However, the PEC supplies Gaza Strip by only 65MW of its full capacity (120 MW) which is more than 50% of its full capacity. The reason for that the PEC depends on the amount of fossil fuel available for the production of electricity, which is not usually available due to the closure imposed on Gaza Strip by Israeli government since 2006. The total supply of electric power in Gaza Strip from all the aforementioned sources is approximately 237MW, which is less than the actual needs for Gaza Strip (Pal Think for Strategic Studies, 2014).

The actual needs of electricity vary seasonally in Gaza Strip. During the summer and winter months it demands 440 MW. During the rest of the year, it necessitates 380 MW. Then, irrespective of the seasonal needs, there is significant deficit of approximately 150 MW through the whole of the year. This deficit causes recurring interruption of electrical supply to homes as well as economic and service facilities (Pal Think for Strategic Studies, 2014). In addition, the siege and bans on the trade or transport of supplies to repair or maintain infrastructure have devastated the energy sector since 2006 (Hamed, *et al*. 2013).

Due to the lack of traditional energy sources as mentioned above, people in Gaza Strip tried to use alternative sources to supply their houses with power for lighting and to run household appliances. They used either cheap sources like candles and gasoline stoves or expensive sources like household generators. However, these sources led to catastrophes including loss of souls and properties damages. AL–Mezan Center for Human Rights (2016) issued a report stating that the utility of alternative methods in Gaza Strip to produce energy such as candles and generators caused sorrowful episodes. These episodes led to the death of many people most of them are children and women. Most of these episodes happens bycatching fires in houses or small shops by misuse of candles, or by explosion of generators, which is fed by flaming fuel like kerosene or by gas heating devices. The fires lead to burning property in addition to fire injuries or fire death. Between the beginning of 2010 and mid-December of the year 2016, an average of 30 citizens (24 children, and 1woman) died and another 30 (16 children and 6 Women) were severely injured.

Looking for safer solutions, Gazans started to use solar energy as an alternative to fossil fuels. The sun is the most abundant energy source for the earth. Solar energy falls on the surface of the earth at a rate of 120 Peta watts (1 Peta watt = 10^{15} watt). The energy, which the earth receives from the sun in one day, can cover 20 years of the whole world's energy demand (Chuand Meisen, 2011). The Global Horizontal Irradiance for Gaza Strip is more than 1900 Kwh/m^2 (Abualtayef, 2016). In one year, Gaza Strip shines about 2861 hours per year (Ouda, 2001). Thus, Gaza Strip has good factors to produce the energy from the sun. In fact, people in Gaza Stripused solar technology in the sixties of the last century. They mainly used solar radiation to heat water by using what is recognized as the solar water heaters (Naim, 2010; Ouda, 2001).

Recently, Gazans used solar energy to produce electrical energy for heating, lighting and running home appliances. Therefore, Gazans adopt solar systems in which the solar photo voltaic (PV) converts solar energy to electrical energy. In Gaza Strip, these systems are available in three forms: stand-alone, grid-connected, and hybrid. Stand-alone systems, off-grid PV systems, consist of the PV modules and a load only or they can include batteries for energy storage. Grid-connected systems (on-grid) do not require batteries because an oversupply of PV electricity is transported into the grid directly while grid supplies the house with electricity in times of insufficient PV power generation. Hybrid systems combine PV modules with a complementary method of electricity generation such as a diesel, gas or a wind generator (Jäger et al., 2014).

There has been a significant trend by the government, donor institutions and private institutions to support the provision of electricity through solar energy projects. One can say that most of the projects, which have been implemented in Gaza Strip, depends on foreign aids. Therefore, Gaza Strip witnessed the implementation of solar power systems in different sectors. One of the early project was done in 2013 under auspice of the Ministry of Health to supply the intensive care unit at Al-Naser children hospital with electrical power using solar panels (ministry of health, 2017). There is a similar application of solar panels in Jericho hospital at West Bank (Palestinian electricity regulatory council). In the same year, the ministry of education and higher education equipped several schools with solar system such as Ihsan Al-Aga Girls secondary school and Bashir El-Rais Girls secondary school followed by similar projects to date (the ministry of education and higher education, 2017). Other bodies including ministry of agriculture, ministry of the interior, some local municipalities, some universities, some private companies and houses also adopt solar system to facilitate their electricity needs.

Gaza electricity distribution company (GEDCO)is planning to support citizens in Gaza Strip to install solar energy systems by paying the cost in installment, which will be included in the monthly bill. By doing so, they follow the footprints of donor institutions that help citizens of Gaza Strip to install solar systems. The number of houses that benefited from the project is450 homes (GEDCO, 2017).

Abu-Hafeetha (2009) studied the quality of energy consumption in all sectors (domestic, industrial and commercial), types of available fuels and their prices in the Palestinian territories. Moreover, the solar energy and its potential in the Palestinian territories were considered. The study presented the amount of incident radiation during the year, the various possible applications of solar system, and the projects that have been implemented in various regions in Palestine. It also presented a hierarchic system for planning of the energy sector in Palestine with maximum possible usage of solar energy as an indigenous, clean and cheap source of energy.

The analysis has shown that solar energy share can reach 11.4% of total energy consumption for the year of 2020 just by implementing solar thermal systems; passive and active (Abu-Hafeetha, 2009). Ouda (2001) presented prospects of renewable energy in Gaza Strip with special emphasis on biogas energy. He showed that there is a good potential for solar energy applications in different projects, comprising solar water desalination, solar pumping, solar crop drying and remote area electrification. In addition, Ouda (2001) encouraged local authorities to set rules and policies concerning the usage of renewable energy. He claimed further that donors’ support is required to promote the applications of renewable energy because of the financial difficulties in Gaza Strip.

Naim (2010) discussed the potential of utilizing available abundant solar energy in Palestine using photovoltaic (PV) system. In his paper, he explained that the solar pumping technology is an important issue in providing solution to attain fresh water supply in the Palestinian remote and deprived areas. He also called for minimizing the dependence on the traditional energy resources, supplying the deprived areas with water and electricity and participating in the international environmental protection actions.

Aydi (2011) investigated the solar energy potential in Gaza Strip based on measurements of a complete year's data at a coastal location. The paper summarized the data for the years (1989-2002), which have been processed from the solar radiation survey. Typical meteorological year files based on the direct beam component, and the archived hourly data. The paper analyzed the 11 years data. Results revealed that sufficient data probably now exist in order to enable one to identify the best places for locating solar power stations; in addition, extra years of data will be necessary before a sufficiently reliable data base will exist for the purpose of simulating solar- concentrator power plant performance and determining their economic benefit.

Hamed *et al*. (2013) discussed the challenges facing the Palestinian energy sector, and evaluated the renewable energy potential in meeting part of the energy demand. The study exhibited that the main renewable energy sources in Palestine are solar, wind biomass and geothermal. It was estimated that wind and solar energy sources have the potential to account for around 36% of electricity demand. Further, the conversion of agricultural waste into biodiesel can reduce diesel imports by 5%. Moreover, the conversion of animal waste into biogas has the potential to replace 1.6% of the imported liquefied petroleum gas and the use of geothermal energy for heating and cooling can reduce the cost of conventional energy used for these applications by 70%.

In Gaza Strip, people are in dire need for alternative sources of energy in particular solar systems because of political and economic situation in Gaza Strip. This leads us to the importance of this research paper, which dedicated to thoroughly study the implementation of solar systems, their benefit and the possibility to apply them in our region. The authors are unaware of any studies on studying implementation of solar energy in Gaza Strip: questionnaire based. Hence, this study can be considered of the essence since it surveys the current situation of solar energy in Gaza

Strip. The focus is on operation of solar systems by local institutions, especially, public, private and governmental institutions. The effect of institutions' attributes on adopting solar energy will be analyzed. The attributes of institutions are the institution type, the starting year of using solar energy by the institution, and the relying ratio on solar power as an energy source.

Research Problem

Electricity shortage is one of the most important problems in Gaza Strip. Therefore, to meet the needs of electricity in Gaza Strip from sources that are environmentally friendly and economically acceptable, solar energy as an alternative source of energy is required. Based upon literature review, we realized that there is scarcity of research, which surveyed the implemented projects on solar systems in Gaza Strip. The focus of this work is to study the implementation of these systems in particular the systems, which have been used by local institutions comprising private, public and governmental institutions.

This research attempts to answer the following main question: “Can solar energy be an alternative to conventional energy in local institutions in Gaza Strip?” In specific, the research problem will answer the following questions:

1. Is the environmental value provided by solar energy affects the institutions’ decision to adopt solar energy system?
2. Is the cost of energy affects the institutions’ decision to adopt solar energy system?
3. Is solar energy market affects the institutions’ decision to adopt solar energy system?
4. Are the attributes of institutions affect the decision of institutions to adopt solar energy system?

Importance of Research

The importance of research stems by providing an accurate information about the use of solar energy by surveying local institutions, which use solar energy in Gaza Strip.

Research Objectives

The main objectives of this research are to measure the benefit that the institutions in Gaza Strip achieve by using solar energy technology. The specific objectives of the research can be summarized in the following points:

1. Give an exact number of local institutions, which adopt solar system.
2. Examine the role of the available solar energy environmental value in the decision of local institution to adopt this technology.
3. Examine the impact of solar energy marketing in Gaza Strip and its effect on the local institution decision to adopt solar technology.
4. Find out the effect of the price of the solar energy system on the decision of the local institutions to adopt the solar energy system.
5. Find out the effect of institutions' attributes on adopting solar technology by local institutions.
6. Propose solutions and recommendations to avoid most of the gaps and obstacles that affect the willingness of local institutions to adopt solar technology.

Variables of Research

Figure 1 defines the independent variables and dependent variable.

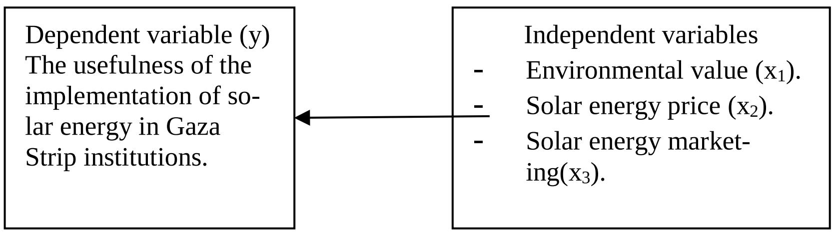

Figure (1): The relation between dependent and independent variables.

Hypothesis

The significance level is measured at $\alpha \leq 0.05$ (Al-Agha & Al-Ostaz, 2000).

1. There is a statistically significant relation between environmental value of solar energy and the willingness of the institutions in Gaza Strip to adopt solar energy technologies.
2. There is a statistically significant relation at a significance level between the solar energy price and the willingness of institutions in Gaza Strip to adopt solar energy technologies.
3. There is a statistically significant relation at a significance level between the solar energy marketing and the willingness of institutions in Gaza Strip to adopt solar energy technologies.
4. There are statistically significant differences at a significance level in using solar energy by Gaza Strip institutions and their attributes.

Methodology

In this section, we present the actions and steps taken in the field study, which addresses the methodology, the community of the study, and the sample of the study. Moreover, we clarify the tools used in the study, their steps, and statistical methods used to analyze the data to reach results and achieve the objectives of the study.

Study Approach

Researchers follow descriptive and analytical approach that attempts to answer the fundamental question in the science and the nature of the phenomenon, which is the research subject. This include analysis of the phenomenon, its environment, and the relationship between its components. This means the description is by units, conditions, relationships, groups, categories, or formats that exist indeed. It may include the opinions and attitudes about the phenomenon, its operations and the resulted effects. It means that the descriptive approach extends to address how the phenomenon works (Al-Agha, Al-Ostaz, 2000).

The study population

The study population consists of 50 institutions.

The study samples

The sample of the study comprised 13 institutions. Table 1 presents the distribution of the study sample in terms of type of the institutions. It can be seen that53.8% of the sample are public institutions, 23.1% are government institutions and23.1% are private institutions.

Table (1): shows the distribution of the sample by institutions type.

Institution type	Frequency	Percentage%
government	3	23.1
Public	7	53.8
Private	3	23.1
The total	**13**	**100.0**

The results shown in Table 2 indicate that 92.3% of the sample has on average more than 50 employees, and 7.7% of the sample has between 20 to 50 employees.

Table (2): shows the distribution of the sample institutions by the number of workers in the enterprise.

Number of workers	Frequency	Percentage%
20 - 50	1	7.7
More than 50	12	92.3
The total	**13**	**100.0**

Table 3 presents the year at which each institution started using solar energy system. Results show that 46.2% of the study sample used solar power between 2010 and 2014, 38.5% of the sample stated using solar energy after 2014, and 15.3% of the sample used solar energy before 2010.

Table (3): The distribution of the sample by year use of solar energy.

Starting Year	Frequency	Percentage%
Before 2010	2	15.3
2010-2014	6	46.2
After 2014	5	38.5
The total	**13**	**100.0**

The results in Table 4 indicate that 69.2% of the study sample use solar energy to cover less than 20% of their total energy consumption. While 15.4 % of the study sample consumes solar energy in a range from 20% to 50% of their total energy consumption, and 15.4% of the sample uses solar energy more than 50% of their total energy consumption.

Table (4): The distribution of the sample according to the ratio at which they rely on solar energy as a source of energy.

Ratio of rely	Frequency	Percentage%
<20%	9	69.2
20% - 50%	2	15.4
>50%	2	15.4
The total	**13**	**100.0**

Tools of the study

The researchers used a questionnaire titled: "Study the implementation of using solar energy at Gaza Strip institutions". The questionnaire is divided into two main parts. The first part includes private information about the institutions that compromised the sample. The second part presents the 18 items of the questionnaire on a five-point scale: strongly agree, agree, not certain, disagree, and strongly disagree. Further, the second part consists of three main parts:

- The First part: Environmental awareness and included three items.
- The second part: The cost and included seven items.
- The third part: Marketing of solar energy and included eight items.

Reliability of the questionnaire

The questionnaire in its initial state is given to five university professors who give back their valuable comments and views on the appropriateness of the items of the questionnaire and the clarity of the language. According to their comments and views, some items were excluded, some were added, and some were amended obtaining the questionnaire in its final stage with 18 items.

Validity of the questionnaire

The validity of the questionnaire means that the questionnaire is able to measure what it is intended to measure.

The validity of the study tool has been verified by internal validity measure.

Internal Validity

Internal validity means the consistency of each item of the questionnaire. The researchers calculated the internal consistency of the questionnaire using Pearson correlation coefficients between each item of questionnaire and the total score of the questionnaire. The results are shown in Table 5. Table (5) exhibits that the items of the questionnaire have strong correlation coefficients where the values range from 0.5-0.625 and statistically significant at significance level less than (0.05). This means that the items of the questionnaire have high validity factor.

Table (5): Coefficient of Correlation between each item of the questionnaire and the total score of the questionnaire.

First Item			Second Item			Third Item		
#	**Correlation Coefficient**	**significance level**	**#**	**Correlation Coefficient**	**significance level**	**#**	**Correlation Coefficient**	**significance level**
1	0.600	0.000**	**4**	0.552	0.000**	**11**	0.553	0.000**
2	0.625	0.000**	**5**	0.594	0.000**	**12**	0.500	0.000**
3	0.500	0.000**	**6**	0.608	0.000**	**13**	0.517	0.000**
			7	0.511	0.000**	**14**	0.532	0.000**
			8	0.537	0.000**	**15**	0.617	0.000**
			9	0.553	0.000**	**16**	0.577	0.000**
			10	0.607	0.000**	**17**	0.601	0.000**
						18	0.550	0.000**

** Correlation is statistically significant when $\alpha \leq 0.05$

//Correlation is not statistically significant when $\alpha \geq 0.05$

Questionnaire Reliability

Questionnaire reliability means its ability to create reproducible results if the questionnaire has been redistributed more than once under the same circumstances and conditions. In other words, questionnaire reliability means questionnaire results are stable and does not change significantly when the questionnaire is redistributed to the sample members several times in a certain periods. After distributing the questionnaire, there liability has been calculated by two methods:

Cronbach's Alpha Coefficient

The questionnaire was run to a sample of (13) members. After applying the questionnaire, Cronbach's alpha coefficient was run to check the consistency of the questionnaire. It is found that Cronbach's alpha value for the questionnaire is 0.893, which is an evidence that the questionnaire has high consistency (Sekaran, 2006, Al-Kilani & Al-Sharefin, 2014).

Split _half methods

After applying the questionnaire, the questionnaire items are divided into two parts: the odd-numbered questions, and the even-numbered questions. The correlation coefficient between the scores of the odd-numbered questions and the even-numbered questions (r) has value of 0.807. Then, the correlation coefficient is corrected using Spearman Brown equation

$$\text{The corrected Coefficient of Correlation} = \frac{2r}{1+r} = 0.893 \qquad (1)$$

The corrected coefficient of correlation indicates that the questionnaire has high reliability factor.

Statistical analysis

The researchers manually transfer the responses from the questionnaires into a spreadsheet. Then, the collected data is analyzed using SPSS (Statistical Package for the Social Sciences) comprising the following statistical methods:

- Descriptive statistics, including the percentage, the mean, the standard deviation and weighted arithmetic mean. This is used mainly in order to know repeated class of a variable and to help the researchers to describe the study variables.

- Pearson correlation coefficient (Zikmund, 2003, Hair et al., 2010):To verify the reliability of the internal consistency between the items of the questionnaire and the total score of the questionnaire. The coefficient value can range between -1.00 and 1.00. If the coefficient value is in the negative range, then that means the relationship between the variables is negatively correlated or as one-value increases, the other decreases. If the value is in the positive range, then that means the relationship between the variables is positively correlated, or both values increase or decrease together. If the value is zero, then that means there is no relation between the variables. Pearson correlation coefficient is calculated using the following formula:

$$r = \frac{N\,\Sigma xy - \Sigma x\,\Sigma y}{\sqrt{\left(N\,\Sigma x^{2} - (\Sigma x)^{2}\right)\left(N\,\Sigma y^{2} - (\Sigma y)^{2}\right)}} \tag{2}$$

where N is the number of data pairs, Σxy is the sum of the products of the paired data, Σx is the sum of x data, Σy is the sum of y data, Σx^2 is the sum of squared x data, and Σy^2 is the sum of squared y data.

- Cronbach's Alpha coefficient: To verify the stability of the items of the questionnaire. The desired values of Cronbach's Alpha coefficient is more than 0.7 (Christensen et al., 2015).
- Spearman-Brown Spilt Half: to predict the reliability of a test after changing the test length (Charter, 2000).
- One Samples t test: To determine whether the average degree of the response has reached a specific mean which is 2 or not (Seltman, 2015).

Research limits

The study identified the following limits:

- Objective limit: This study is limited to studying the implementation of solar power in the Gaza Strip institutions.
- Spatial limit: study confined in Gaza Strip.
- Sample limit: The study included only governmental, public and private institutions that use solar energy system.
- Time limits: This study has conducted in the last quarter of 2016.Thus, the data includes all institutions that uses solar energy before 2017.

Research Results and Analysis

The result of the main question:

The main question is “Can solar energy be an alternative to conventional energy in local institution in Gaza Strip?” To answer the main question, we calculated the mathematical mean, standard deviation, and the relative weight of the items of the questionnaire. The results in Table 6can be explained as follows:

− The first part of the questionnaire "environmental awareness" is ranked first with a relative weight of 81.54%.

− The third part "marketing of solar energy" is ranked second with relative weight of 76.54%.

− The second part "cost" is ranked third with a relative weight of 68.79%.

The relative weight of using solar energy at the Gaza Strip institutions is 73.92%.

Table (6): The mathematical mean, the standard deviation and the relative weight.

The main parts of the questionnaire	Mathematical mean	Standard deviation	Relative Weight %	order
The first part: Environmental Awareness	4.077	0.934	81.54	1
The second part: the cost	3.440	0.410	68.79	3
The third part: marketing of solar energy	3.827	0.670	76.54	2
General Average	3.696	0.509	73.92	

Results of the first hypothesis

The first hypothesis: “There is a statistically significant relation at a significance level 0.05 between environmental value of solar energy and the willingness of institutions in Gaza Strip to adopt solar energy technologies". To validate the first hypothesis, we used Pearson correlation coefficient to determine the relationship between the two variables as presented in Table 7.

From Table 7, we observe that there is a direct correlation relation statistically significant at the 0.05 level between environmental awareness and willingness of the institutions in Gaza Strip to adopt solar energy technologies where the value of the correlation coefficient is 0.899. This means that as the environmental awareness increases, the willingness of the institutions in Gaza Strip to adopt solar energy technologies increases.

Table (7): The number, value of the correlation coefficient and the significance level.

	The number	value of the correlation coefficient	The significance level
Environmental Awareness	13	0.899	0.000**
willingness of the institutions in Gaza Strip to adopt solar energy technologies	13		

Simple regression line equation:

From Table 8, the regression relation of the model follows Equation (3):

$$y = 1.701 + 0.489 x_1 \quad (3)$$

where y stands for willingness of the institutions in Gaza Strip to adopt solar energy technologies and $x_1$stands for environmental awareness. It is clear that the relation between the two variables is linearly positive relation. In addition, we can see from Table 8 that the significance level of the F test is less than 0.05. This means that the model is good and there is a statistically significant relation at 0.05 significance level between environmental awareness and the willingness of the institutions in Gaza Strip to adopt solar energy technologies.

Table (8): Coefficient and significance level.

	Coefficient	**Significance level**
The constant	1.701	0.000
Environmental Awareness	0.489	
Coefficient of Correlation	0.899	
F test	46.312	
The significance level	0.000**	

** significant at 0.01 * significant at 0.05 // not significant

Results of the second hypothesis:

The second hypothesis: “There is a statistically significant relation at a significance level 0.05 between the solar energy pricing and the willingness of the institutions in Gaza Strip to adopt solar energy technologies”. To validate the second hypothesis, we used Pearson correlation coefficient to determine the relationship between the two variables as presented in Table 9.

Table 9 displays a direct correlation statistically significant at significance level 0.05 between the solar power price and willingness of the institutions in Gaza Strip to adopt solar energy technologies, where the value of the correlation coefficient is 0.756. This means that as the solar energy price increases the willingness of the institutions in Gaza Strip to adopt solar energy technologies. This can be explained by the fact that the institutions in Gaza Strip care more about the environment factors and the quality of the system to stand for long time. It also mean that the institutions look for a replacement for regular power shortage even though it might be expensive.

Table (9): The number, value of the correlation coefficient and the significance level.

	The number	**value of the correlation coefficient**	**The significance level**
price of solar power	13	0.756	0.000**
willingness of the institutions in Gaza Strip to adopt solar energy technologies	13		

Simple regression line equation:

From Table 10, the regression relation of the model follows Equation (4):

$$y = 0.472+0.937\,x_2 \quad (4)$$

where y stands for willingness of the institutions in Gaza Strip to adopt solar energy technologies and $x_2$stands for the cost of the system. It is clear that the relation between the two variable is linearly positive relation. In addition, we can see from Table 10 that the significance level of the F test is less than 0.05. This means that the model is good and there is a statistically significant relation at 0.05 significance level between the price of the system and the willingness of the institutions in Gaza Strip to adopt solar energy technologies.

Table (10): Coefficient and the significance level.

	coefficient	**The significance level**
The constant	0.472	0.589
price of solar power	0.937	0.000
Coefficient of Correlation	0.756	
F test	14.034	
The significance level	0.000**	

** significant at 0.01 * significant at 0.05 // not significant

Results of the third hypothesis

The third hypothesis: "There is a statistically significant relation at a significance level 0.05 between the solar energy marketing and the willingness of the institutions in Gaza Strip to adopt solar energy technologies". We used Pearson correlation coefficient to determine the relationship between the two variables as presented in Table 11.

From Table 11, it is clear that there is a direct correlation statistically significant at 0.05 level between the solar energy market and willingness of the institutions in Gaza Strip to adopt solar energy technologies. The value of the 0.878 correlation coefficient means that the greater the solar energy market the greater the willingness of the institutions in Gaza Strip to adopt solar energy technologies.

Table (11): The number, value of the correlation coefficient and the significance level.

	The number	value of the correlation coefficient	The significance level
solar energy marketing	13	0.878	0.000**
solar energy technologies	13		

Simple regression line equation

From Table 12, the regression relation of the model follows Equation (5):

$$y = 1.146 + 0.666x_3 \quad (5)$$

where y stands for willingness of the institutions in Gaza Strip to adopt solar energy technologies and $x_3$stands for solar energy marketing. It is clear that the relation between the two variables is linearly positive relation. As seen from Table 12, the significance level of the F test is less than 0.05. This means that the model is good and there is a statistically significant relation at 0.05 significance level between the solar energy marketing and the willingness of the institutions in Gaza Strip to adopt solar energy technologies.

Table (12): coefficient and the significance level.

	Coefficient	The significance level
The constant	1.146	0.021
solar energy marketing	0.666	0.000
Coefficient of Correlation	0.878	
F test	37.013	
The significance level	0.000**	

** significant at 0.01 * significant at 0.05 // not significant

Results of the fourth hypothesis

The fourth hypothesis: "There are statistically significant differences at a significance level 0.05 in using solar energy by Gaza Strip institutions and their attributes". We used "F" One Way ANOVA (Seltman, 2015) to determine the differences between the attributes under study.

First attribute: The Institution type

Table 13 presents the results of the "F" One Way ANOVA to check the effect of the first attribute in using solar energy by Gaza Strip institutions. Results show that there is no statistically significant differences at significance level 0.05 in using solar energy (environmental awareness, the price of energy, energy marketing) in Gaza Strip institutions due to institutions type.

Second attribute: The starting year of using solar energy by the institution

Table 14 presents the results of the "F" One Way ANOVA to check the effect of the second attribute in using solar energy by Gaza Strip institutions. Results show that there is no statistically significant differences at significance level 0.05 in using solar energy (environmental awareness, the price of energy, energy marketing) in Gaza Strip institutions with the year at which Institution started using solar energy.

Table (13): Sum of squares, the degree of freedom, the value of the average squares, the "F" test and the level of significance.

		Sum of squares	**the degree of freedom**	**the value of the average squares**	**the "F" test**	**the level of significance**
Environmental Awareness	Between groups	1.516	2	.758	3.880	.057//
	Within groups	1.954	10	.195		
	The total	3.471	12			
Price of solar power	Between groups	.195	2	.098	.277	.764//
	Within groups	3.528	10	.353		
	The total	3.723	12			
Solar energy marketing	Between groups	.401	2	.200	.401	.680//
	Within groups	4.991	10	.499		
	The total	5.392	12			
The total	Between groups	1.516	2	.758	3.880	.057//
	Within groups	1.954	10	.195		
	The total	3.471	12			

** significant at 0.01 * significant at 0.05 // not significant

Table (14): Sum of squares, the degree of freedom, the value of the average squares, the "F" test and the level of significance.

		Sum of squares	the degree of freedom	the value of the average squares	the "F" test	the level of significance
Environmental Awareness	Between groups	.249	3	.083	.232	.872//
	Within groups	3.221	9	.358		
	The total	3.471	12			
Price of solar power	Between groups	.838	3	.279	.871	.491//
	Within groups	2.885	9	.321		
	The total	3.723	12			
Solar energy marketing	Between groups	.983	3	.328	.669	.592//
	Within groups	4.408	9	.490		
	The total	5.392	12			
The total	Between groups	.416	3	.139	.464	.714//
	Within groups	2.690	9	.299		
	The total	3.107	12			

** significant at 0.01 * significant at 0.05 // not significant

Third attribute: The relying ratio on solar power as an energy source

Table 15 presents the results of the "F" One Way ANOVA to check the effect of the third attribute in using solar energy by Gaza Strip institutions. Results show that there is no statistically significant differences at significance level 0.05 in using solar energy (environmental awareness, the price of energy, energy marketing) in the Gaza Strip institutions due to the relying ratio on solar power as an energy source.

Table (15): Sum of squares, the degree of freedom, the value of the average squares, the "F" test and the level of significance.

		Sum of squares	**the degree of freedom**	**the value of the average squares**	**the "F" test**	**the level of significance**
Environmental Awareness	Between groups	.562	2	.281	.966	.414//
	Within groups	2.909	10	.291		
	The total	3.471	12			
Price of solar power	Between groups	.341	2	.170	.504	.619//
	Within groups	3.382	10	.338		
	The total	3.723	12			
Solar energy marketing	Between groups	.308	2	.154	.303	.745//
	Within groups	5.084	10	.508		
	The total	5.392	12			
The total	Between groups	.168	2	.084	.285	.758//
	Within groups	2.939	10	.294		
	The total	3.107	12			

** significant at 0.01 * significant at 0.05 // not significant

Conclusion and Recommendations

In this work, authors studied the using of solar energy systems as an alternative source of energy in Gaza Strip. The study conducted on a sample of 13 institutions including public, private and governmental institutions. The question that has been raised in the study addresses different reasons, which might be the motivation for the local institutions to use solar energy. These reasons are the environmental factor, marketing and prices. The institutions in the sample do not use solar energy as a full replacement. The results of analyzing the collected data from the questionnaire using SPSS show that the local institutions chose to use solar energy because of its environmental value, marketing and its price. Though the price might be a barrier in some cases, the institutions in Gaza Strip do not mind to the price rise. The results did not depend on the attributes of the institutions. We recommend using the solar system to overcome the current problem of electricity shortage. Moreover, we recommend extending the study to include other sectors in the local society; i.e., household, small shops, and hotels.

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