El-Khozondar and El-batta
Energy, Sustainability and Society (2022) 12:17
https://doi.org/10.1186/s13705-022-00343-7

Energy, Sustainability and Society

ORIGINAL ARTICLE

Open Access

Solar energy implementation at the household level: Gaza Strip case study

Hala J. El-Khozondar[1*] and Fady El-batta[2]

Abstract

Background: The Gaza Strip in Palestine is currently facing a serious electrical power deficit due to the local political situation. In addition, the main source of energy in Gaza Strip is traditional fossil fuel which is environmentally harmful. To ensure that electrical power in the Gaza Strip can be maintained continuously without any day-long power failures is a challenging task for decision-makers. The lack of reliable electrical power has motivated the inhabitants of the Gaza Strip to adopt an alternative source of energy which is reliable, sustainable, environmentally friendly and abundantly exists. Therefore, they decided to implement solar energy systems to power their houses in order to replace or to complement the traditional sources of energy. This has motivated the current study which aims to find out whether solar energy can be an alternative source of energy to the conventional energy for domestic use in the Gaza Strip to sustain inhabitants' daily life. This has been tested by studying the readiness and attitudes of household people in the Gaza Strip to adopt solar energy in their homes. This work is a novel study in its contents. According to the authors' knowledge, this is one of few studies considering this topic.

Methods: To understand the reasons for successful solar energy system adoption by individual households in Gaza, the authors have created an electronic questionnaire. The dependent variable is chosen to be the adoption of energy, and independent variables are the environmental benefit, the cost of adoption of solar energy, and the economic savings of solar energy measured. The electronic questionnaire consists of two parts: part one consists of personal questions; the second part consists of 22 items on a five-point Likert scale and the studied sample population consists of the 10% of the Al-Shifa Medical Complex employees (1819 employees). The electronic questionnaires were electronically circulated to the study sample. The data were then collected and analyzed using an SPSS program.

Results: The authors found that only 19.5% of the studied sample population have installed solar energy systems on their houses. The results show that some factors, including the governorate in which employees are living, house ownership, total cost of energy/month, available space to install the solar panels, and the desire to share the cost with neighbors did not affect the decision to use solar energy. On the contrary, the type of house and the knowledge of renewable energy influenced the decision. Compared to previous studies, we also found that knowledge is an important factor in implementing renewable energy (Zakaria et al. in Earth Environ Sci 268:012105. https://doi.org/10.1088/1755-1315/268/1/012105, 2019, Szakály et al. in Energies 14:1–25. https://doi.org/10.3390/en14010022, 2021). Though our study did not reveal an impact of cost of installing the system on making the decision to adopt renewable energy (Assali et al. in Renew Energ 136:254–263. https://doi.org/10.1016/j.renene.2019.01.007, 2019), we will it regard it as an important factor.

*Correspondence: hkhozondar@iugaza.edu
[1] Electrical Engineering and Smart Systems Department, Engineering College, Islamic University of Gaza, P. O. Box 108, Gaza, Palestine
Full list of author information is available at the end of the article

Conclusion: The adoption of solar energy in Gaza is limited. The kind of the house and the knowledge of renewable energy are imperative to increase utilization of solar energy by households in Gaza. Therefore, it is important to start a public information campaign on the advantages of solar energy through the universities by giving classes to all university students and/or by giving general talks for the public. To conquer the limiting factors, the public authority ought to consider the framework and support the neighborhood occupants.

Keywords: Solar energy, Fostering solar system, Energy cost, Energy marketing, Environmental effect

Background

Renewable energies are a clean and sustainable source of energy. One of the most common sources of renewable energy is solar energy, capable of meeting most of the challenges that confront the world. It provides people with a safe and environmentally friendly energy source.

Photovoltaics, PV, are the basic element of a solar power system. Photovoltaics harvest solar irradiance to produce clean electrical energy, decreasing the green house emission and the reliance on customary non-renewable energy sources. Solar energy systems capture the light, converting it to electrical energy, and distributing it to the user. The systems consist of solar panels (PV connected in parallel and series), an inverter, a battery pack, and a charge controller [4]. Other secondary equipment consists of solar array mounting racks, a DC disconnect array, a power meter, a utility meter, a kilowatt meter and a backup generator. Various types of solar systems for residential use exist on the market. Those commercial solar systems offer various features, including grid connections, type of materials and type of battery. The solar system might be connected to the grid, stand alone or exist as a hybrid system [5].

The energy sector plays a vital role in development of the economy in many societies [6], especially in the Gaza Strip where about 75% of its energy needs are imported, i.e., 66.6% from Israel and 8.5% from Egypt, while the remaining 25% of energy is generated locally by the sole Palestinian power plant [7]. Table 1 summarizes the quantity of imported energy and its average consumer prices in The Gaza Strip according to the type of energy [7]. The Gaza Strip receives 120 MW from Israel, 37 MW in case all the lines from Egypt are operating, and approximately 80 MW (which is usually less than its full capacity of 120 MW) from the local power plant [8]. However, currently the local power plant and the Israeli line only provide Gaza with 54 MW and 70 MW, respectively, instead of their full capacity due to the political situation in the Gaza Strip. Additionally, the electrical demand depends on the season, e.g., in the summer and winter seasons, the energy consumption reaches 440 MW and decreases to 380 MW for the rest of the year [9]. By simple math, it is easy to see that most of the year the electrical power deficit varies between 220 to 280 MW [8, 9].

In a recent report by the Palestinian investment promotion agency (https://bit.ly/3u0znxO), the cost of electricity for different customers in the Gaza Strip is given in Table 2. Table 2 shows that the price of energy is a burden for any investment.

Palestine is in a strategic location at the crossroads of three continents, Africa, Asia and Europe. The Gaza Strip is situated in the southeast of Palestine and has a 41-km coastline on Mediterranean Sea (Fig. 1). Its width varies from 6 to ~ 12 km and its total area is 365 km^2. It lies on Longitude 34°26′ east and Latitude 31° 10′ north of the equator. The Gaza Strip is a highly populated area. By the end of 2020, 2.1 million persons were living in Gaza according to the Palestinian Central Bureau of Statistics (https://rb.gy/nsmlfk) with an annual growth rate of 2.7% making it one of the highest populated densities in the world. The Gaza Strip has a Mediterranean climate of hot summers with 300 sunshine days, and cool, rainy, short winters. It has annual global horizontal irradiance (GHI) above 2000 kWh/m^2, as presented in Fig. 1. The rapid population growth

Table 2 Average electricity prices in Gaza Governorate ($)

	Household	Commercial	Industry	Agricultural
Fixed fee	2.9	5.8	5.8	5.8
Price per kilowatt	0.14	0.17	0.17	0.17

Table 1 Quantity and consumer prices of imported energy in the Gaza Strip. Source: Palestinian Central Bureau of Statistics, 2017, Ramallah

	Electricity	Gasoline	Diesel	Kerosene	LPG	Bitumen	Oils and lubricants	Wood and charcoal
Quantity	1,024,120 MWh	53,999 m^3	239,707 m^3	150 m^3	59,915 ton	748 ton	25 ton	427 ton
Price [7]	0.56 NIS/kWh	5.75 NIS/L	5.09 NIS/L	5.79 NIS/L	61.0 NIS/kg	1.8 NIS/kg	10.0 NIS/kg	1.0 NIS/kg

USD = 3.588 NIS (source: https://m.sa.investing.com/currencies/usd-ils at 27/04/2018)

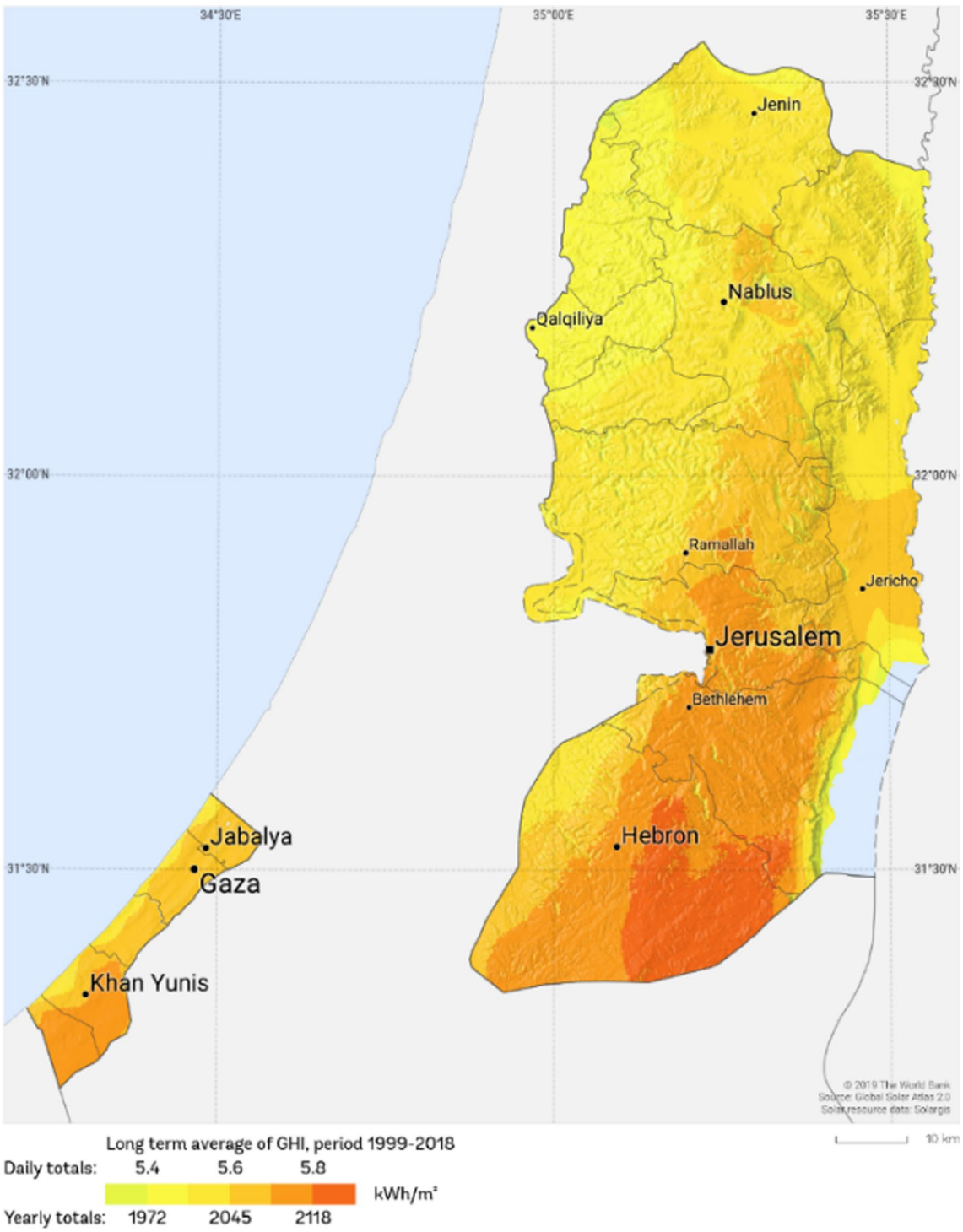

Fig. 1 Location and global horizontal irradiation (GHI) for The Gaza Strip, Palestine (source: https://rb.gy/nsmlfk)

combined with low water and fossil fuel resources makes the Gaza Strip a harsh environment to live in. The electricity crises started in 2006 when the local power plant was destroyed by an Israeli attack causing a 61% electricity deficit. As a result, two million inhabitants live with as little as 3 to 4 h/day of electricity,

forcing locals to search for alternatives including electric generators and solar energy in particular to power homes, hospitals and schools [8, 9]. The problem is made worse due to the tension between local political parties in Palestine over custom tax revenues.

Accordingly, the electricity deficit in the Gaza Strip is considered a major problem that severely limits the local economy, the social welfare and consequently the living standards of Gazans. Gazans are desperate to adopt different energy sources because of the situation in which they live. Thus, it is important to make a thorough study of the benefits of using of any alternative energy systems and their applicability in peoples' lives.

The main sources of renewable energy are solar energy, wind, biomass and geothermal energy. Solar energy is considered the most important of all these systems and highly applicable in the Gaza Strip. In 2019, Nassara and Alsadib presented a study on implementation of solar energy in the Gaza Strip as replacement for fossil fuels [7]. They studied the possibility of using photovoltaic (PV) and concentrating (CS) solar systems in the Gaza Strip. They analyzed solar radiation data for five major cities in Gaza that had been collected for 15 years from 2000 to 2015 using a System Advisor Model. They concluded with a strong recommendation for the use solar energy to power the Gaza Strip [7].

Wind energy is considered the second source of renewable energy that has high potential in the Gaza Strip. Nassara and Alsadib in 2018 [10] assessed using wind energy in three different places in the Gaza Strip (Rafah, Deir-albalah and Jabalia). They analyzed data which were collected for wind speed and its direction in 16 years (2000–2015). According to their study, the monthly mean velocity in Rafa is 6.34 m/s, in Deir-albalah is 4.41 m/s and in Jabalia is 3.98 m/s [10]. The result of their analysis unveiled that the best place for a wind farm in Palestine is Rafah city in the southern part of Palestine on the border with Egypt. They explained that Rafah city has the highest wind energy capacity and being on the border with Egypt simplifies the process of getting the needed equipment and experts due to the low cost of transportation and communications. Moreover, the low population density of Rafah City makes the economic viability of exploiting wind energy a possibility. It has been estimated that each wind turbine will produce 15,952 MWh; therefore, it requires 110 wind turbines to cover the shortage of 200 MW [10].

A specific demonstration project was done by installing a 5-kW wind turbine on the top of a residential building. At a height of 10 m, the wind turbine produced 2695 kWh annually. A wind turbine mounted at 70 m will increase the annual electricity produced by 120%. The electric energy obtained via wind systems could provide up to 84% of the annual output of a photovoltaic energy system [11].

In addition to solar energy and wind energy, biomass plays an important role as a source of energy as it is abundant by nature. Biomass is significantly more environmentally friendly than the hazardous exhaust gases from petrochemical fueled vehicles and power sources. Biomass energy could be used for cooking, heating, electricity production, steam and liquifying biofuels. Biomass energy provides about 9–13% of the global energy source and around 8% of Palestinian energy [12].

Geothermal energy is the least explored energy in Palestine. In a study by Beithou and Al-Ganam [13], the accessibility of geothermal energy as a source of energy and electricity in Palestine was discussed. Their results indicated that the Gaza Strip and north Palestine south of Tabariya Lake are good sources for geothermal energy. Moreover, the produced geothermal energy can be independently used to produce electrical power.

Implementation of renewable energy, and in particular solar energy, in the Gaza Strip started in 2012 when the Ministry of Health used solar energy to power several clinics and hospitals, e.g., department of care cardiac surgery in Al-Shifa medical complex [14]. The Ministry of Education and Higher Education followed the same strategy and used solar energy to power schools and some administrative offices. The Ministry of equipment and Higher Education and the Palestine Investment Fund (PIF) in Palestine have an agreement to equip 500 public schools with solar energy systems [15]. The Ministry of Agriculture and the Ministry of the Interior also started to adopt solar energy systems for their departments. Other local institutes, municipalities, universities, and homes are also starting to use solar energy systems. Gaza Electricity Distribution Corporation (GEDCO) is encouraging people to use solar systems to power their houses by selling their customers installation systems [16].

In recent years, several researchers conducted studies on handling the issue of applying solar energy systems in Palestine and in the Gaza Strip in particular. Nassar and Alsadi studied and assessed the energy situation in the Gaza Strip and accordingly they suggested four solutions for the electricity crisis in Gaza [7]. In their study, they performed an economical and environmental assessment of the four solutions to identify the one which is the best solution. Later the same authors gave an assessment of the potential of solar energy in the Gaza Strip in order to eliminate the suffering of Gazans due to lack of electricity [17]. They proposed solving the Gaza Strip energy needs by building PV systems on the roofs of local houses that would then produce 555 MW. Although the solution will cost more than the existing utility company feed line, this solar energy solution will

minimize unemployment by providing new jobs and eliminate Gazans dependence on imported fuel. The Gaza Electricity Distribution Company (GEDCO) has determined that 550 MW of electricity will meet all of the Gaza Strip energy needs.

Ismail et al. presented a survey of several operating renewable energy projects using different technologies. The authors studied the viability of these systems and their potential for providing stable energy for Palestine [18]. In a study performed in 2011, Aydi used the data from a solar radiation survey for years (1989–2002) to investigate the possibility of adopting solar energy in the Gaza Strip. His result shows that it is possible to locate places for solar power plants. However, in order to determine the economic benefits, more data were needed for the simulation [19].

Hamed et al. (2013) listed the types of renewable energy that could be implemented in Palestine: solar, wind, biogas and geothermal energy. The study estimated that 36% of energy demand can be generated from wind and solar energy [20]. A study of renewable energy in the Gaza Strip by Juaidi [21] gave a review of potential renewable energy sources and also concludes that main sources are wind and solar energy. That combination of wind and solar energy will help Gazans to get stable delivery of energy and decrease its dependence on fossil fuels [11].

Researchers [11, 19, 21–26] have previously studied issues related to renewable energy in Palestine in general and more specifically in the Gaza Strip. They studied the electrical energy needs of the Gaza Strip, and they recommend the use of new sources of energy, i.e., solar, wind and wave energy. Other researchers (e.g., [9]) present new plans to construct solar power plants in the Gaza Strip. In 2014, PalThink for Strategic Studies published a case study report titled "Renewable Energy in the Gaza Strip: Short-, Mid-, and Long-Term concepts". This report presented the obstacles, challenges and recommendations provided by key participants of six workshops and round table discussions organized by PalThink and Friedrich-Ebert-Stiftung for the project titled "Renewable Energy as a Sustainable Solution to the Electricity Crisis in the Gaza Strip" [8]. Recommendations and approaches have been divided into short-, medium- and long-term concepts for appropriate adoption by individuals at different levels of the decision-making process [8]. In 2016, researchers examined the energy sector in Palestine and emphasized the use of renewable energy as a promising replacement for fossil fuel energy. The possible RE technologies are solar energy, wind energy, geothermal energy and/or biomass. Solar energy is already extensively utilized inside the Gaza Strip for domestic water heating; however, it is not as widely used for electricity production [21].

The environmental impact of energy production is an important factor in deciding to switch to renewable energy. The financial cost of traditional distillated oil fuel to produce 110 MW power/year is 735,475,000 [ILS/year] in the Gaza Strip and the environmental damage cost is 445,069,320 [ILs/year]. However, using renewable energy will increase the quality of the environment, reducing the amount of CO_2 emitted to the atmosphere by 484,250 kg/day [17]. Thus, when environmental damage costs are taken into account in the economic cost calculations, the energy market clearly favors solar energy production in the Gaza Strip [17].

An important factor to implement renewable energy is public awareness. Therefore, researchers considered studying public awareness. In a study performed in Malaysia, researchers explored public awareness based on respondents' educational level and area of residence. In the study, random population samples from urban and rural areas are contacted to fill in a questionnaire. The main results indicated that most Malaysians have already learned about renewable energy and sustainability awareness (90.3% of the sample). However, 98.8% of respondents agreed that renewable energy technologies were not optimized due to the expensive costs [1].

In a different study that has been conducted in Hungary, researchers performed their study on a sample consisting of 1002 people in 2019. In their study, they analyzed awareness of renewable energy sources. In particular, their work examined the correlation between typical attitudes of different social groups to energy, comparing them with international experience. Their results show that people with better education, a higher income, and a health- and environment-conscious approach to life definitely possess a higher level of knowledge of renewable energy sources. Age, on the other hand, did not play a significant role [2].

In Palestine, in particular at the West Bank, a survey study was performed to measure the level of university students' knowledge regarding renewable energy including technical, economical and policy aspects. The sample consists of all students affiliated to AN-Najah University. The results show that gender, educational level, and parental education level have no significance on the awareness level. However, the university degree subject and high school specialization have a strong impact on the awareness level. As a general conclusion, authors found that the students' awareness and knowledge about renewable energy are limited [3].

In a recent study, the motivations for the local institutions to install solar energy were studied [9]. The authors considered three reasons for adopting a solar energy system, which are the environmental savings, market value and solar system cost. The institutions in the sample do

not use solar energy as a full replacement for conventional power sources. The main results of their study show that the local institutions used the solar energy system to complement the current power system mostly for its environmental value despite its cost. In addition, the types of institutions have not affected their decisions on adopting solar systems. Thus, authors recommend solar energy systems be used as a source of energy [9]. However, authors in their study did not consider other sectors in the local society, e.g., household, small shops, and hotels.

Table 3 presents the current types of solar energy systems used in different sectors. It can be seen that most domestic users use an off-grid system, while industry users apply a solar system to lower the cost of fuel.

A further study [27] analyzed solar usage by households. The population sample consisted of employees from a local hospital in Gaza. This is due to the fact that authors could not find a good source of people who installed solar systems on their houses, or they would have directly contacted those house owners who installed solar systems. They included the responders' gender, job title and income to determine the most important attributes that affected the decision to adopt a solar energy system among household owners. The results show that gender and job titles have no effect on the decision to adopt a solar energy system. However, income has a direct effect on the decision to adopt solar energy systems. The authors extended their research work to include additional attributes; i.e., geographic region, type of house, and house ownership, which are very important for understanding the reasons why local Gazans decided to install a solar system for their houses. The results will help decision-makers determine the degree of acceptance among Gazans for installing solar systems at their houses. Moreover, the results will help policy-makers to take major steps in the energy market and to create new power stations to power the Gaza Strip using solar energy.

Methods

Research's methodology

The authors chose the analytical descriptive approach in the study. They used an electronic questionnaire that had been distributed to the study sample. In choosing the study population, authors tried to get detailed information about local people who adopted a solar system at their houses, but there was no available documentation on this. Thus, the authors identified a sufficiently large community that could be surveyed, which in this case was the employees of Al-Shifa Medical Complex (1819 employees). The study sample amounted to around 10% of the total community (200 employees).

The statistical analyses used in the study have been performed using an SPSS program. The analysis included descriptive statistics, Pearson correlation coefficient, Cronbach's Alpha coefficient, Spearman Brown split half, and one-sample t test.

Research's questions and hypothesis

This work tries to answer the following main question: "Can solar energy be an alternative to conventional energy for domestic use in the Gaza Strip?" The significance level is measured at $\alpha \leq 0.05$. In the work, researchers chose "the usefulness of the implementation of solar energy in the Gaza Strip private houses" as the dependent variable and "environmental value of the system, initial installation cost of solar energy systems, and solar energy economic values" as the independent variables.

Thus, there is the following hypothesis that has been assumed in this research and derived from the main question.

There exist statistically significant differences in the employees' attitudes regarding successfully implementing solar energy technology (environmental benefit, initial installation cost of solar energy systems, and solar energy economic values) due to the following attributes:

1. The governorate, which they are living in.
2. Home ownership.
3. The types of houses, which they are living in.
4. The knowledge of renewable energy types.
5. The knowledge of the use of solar energy or solar panels.
6. Energy cost per month.
7. Availability of space for solar panels.
8. Willingness to share solar systems with neighbors.
9. Possibility of sharing the cost of the solar systems with neighbors.

Table 3 Type and cost of solar energy systems used in all sectors

Sectors	Domestic	Industrial	Commercial	Service	Education
Type	Hybrid—off-grid system	Fuel save controller system	Fuel save controller system	Hybrid—on grid with backup system	Hybrid—on grid with backup system
Cost (USD $ /kWp)	2200	600	600	2500	2500

10. Presence of a preexisting solar system in his/her house.
11. The year that the worker insulated the solar systems in his/her house.
12. Percentage of dependency on using solar systems in his/her house.

Results and discussions

Description of the study sample

The sample (200 employees) are randomly chosen to answer the questionnaire. The geographical distribution of the sample is 63.5% of the sample live in the Gaza governorate, 20% live in the Middle governorate, 11.5% live in the north governorate, 2.5% live in the Khan Younis governorate and 2.5% live in the Rafah governorate. 66.5% of the sample live in houses that they own, 20% of the sample live in their parents' house, and 13.5% of the sample live in rented houses. 67.5% of the sample live in an apartment building, 29% of the sample live in an independent house, and 3.5% of the sample live in a farmhouse.

In terms of knowledge about the important types of renewable energy, 86% of the sample knew about the most important types of renewable energy, and 14% were not familiar with the most important types of renewable energy. 77% of the sample had some background on solar energy or used solar panels, and 23% of the sample had no background on solar energy or had not used solar panels. 49.5% of the sample has an average monthly energy bill between 150 and 300 NIS, 41.5% of the sample has an average monthly energy bill less than 150 NIS and 9% of the sample has an average monthly energy bill more than 300 NIS. 62.5% of the study sample had enough space to install solar cells, 29% of the sample did not have enough space to install solar cells, and 8.5% of the sample are not sure that they have sufficient space to install solar cells. 50.5% of the sample would not share a solar system with their neighbors, and 49.5% of the sample would share a solar system with their neighbors. 79% of the sample can only afford to invest less than 5000 NIS in constructing a solar system, 20.5% of the sample can invest between 5000 NIS and 10,000 NIS in building a solar system, and 0.5% of the sample can invest more than 10,000 NIS in building a solar system. 80.5% of the sample do not use solar energy in their house, and 19.5% of the sample uses solar energy in their house. Among the ones who have solar systems in their houses, 46.2% installed the system before 2010, 33.3% installed the system after 2014, and 20.5% installed the systems in years between 2010 and 2014. 64.1% of the sample who use solar energy in their houses are employing a solar system to supply between 20 to 50% of the total use of energy, and 30.8% use solar energy to supply less than 20% of their energy needs, and 5.1% use solar energy to supply more than 50% of their energy demands.

Statistical analysis results

In this section, the sample members are categorized according to their likelihood to support the adoption of a solar energy system to replace fossil fuel energy for domestic use in the Gaza Strip for the environmental benefit, the initial cost of a solar energy system and the economic savings. To answer this question, arithmetic mean (A.M) and relative weight (R.W.) are calculated for each item of the questionnaire. The results are exhibited in Tables 4, 5 and 6.

Table 4 shows the opinion of study sample members on adopting a solar system for its environmental benefit. The highest score goes to item 8, "the sample

Table 4 Respondents who would choose to adopt solar energy for the environmental benefit

Item no.	Item	A.M	Standard deviation	R. W. %	Order
1	You were aware of the environmental value of solar energy	3.370	1.273	67.40	7
2	You are very interested in environmental aspects	3.475	1.177	69.50	4
3	The environmental benefits of solar energy contribute to reducing the negative impact of high prices on traditional energy	3.635	2.347	72.70	2
4	The environmental cost of energy is in your opinion more important than the material cost	3.195	1.243	63.90	8
5	Environmental awareness campaigns are of great benefit and would increase awareness of the environmental benefits	3.440	1.214	68.80	5
6	Awareness of environmental risks caused by the use of conventional energy sources	3.380	1.250	67.60	6
7	Traditional energy sources are polluting the environment and depleting natural resources from renewable sources of green energy	3.620	1.298	72.40	3
8	If the cost of solar and conventional energy were equal, you would choose solar energy	3.655	1.472	73.10	1
	General Average	3.471	1.409	69.43	

Table 5 Respondents who would choose to adopt solar energy depending on the initial cost of the solar system

Item no.	Item	Mean	Standard deviation	Relative Weight %	Order
9	Your initial system cost affects your choice of the power source you are using	3.625	1.289	72.50	2
10	The increase in the initial cost of solar energy contributes to deciding to choose traditional energy instead of solar energy	3.500	1.276	70.00	3
11	Government subsidies, if any, for solar energy installation will push you towards adoption	3.710	1.230	74.20	1
12	Solar energy cost is less than traditional energy cost in the long term	3.350	1.363	67.00	7
13	The lack of conventional energy because of the political situation prompts you to adopt solar energy	3.135	1.231	62.70	8
14	Dwelling in a remote location will prompt you to adopt solar energy	2.965	1.343	59.30	9
15	The availability of solar energy throughout the year prompts you to adopt solar energy	3.415	1.212	68.30	6
16	Knowing the details of the cost you pay for solar energy contributes to your dependence on it	3.425	1.175	68.50	5
17	Easy installation of solar panels and availability of spare parts and easy maintenance contributes to your adoption	3.445	1.202	68.90	4
	General Average	3.625	1.258	67.93	

Table 6 Respondents choose to adopt solar energy for the economic savings

Item no	Item	Mean	Standard deviation	Relative Weight %	Order
18	Solar energy will displace traditional energy in the future	3.435	1.214	68.7	4
19	You prefer to use solar energy as a green renewable energy source	3.69	1.149	73.8	3
20	You see the need for government centers specialized in green renewable energy research	3.85	1.106	77	1
21	You desire using various green renewable energy sources	3.22	1.161	64.4	5
22	You encourage alternative energy sources to create competition and lower prices	3.815	1.182	76.3	2
General average		3.602	1.162	72.04	

opinion goes to adopt solar energy system in the case when the cost is equal to conventional energy system cost", which is ranked first with a R. W. of 73.10%. Item 4 "The environmental cost of energy in your opinion is more important than the material cost" is ranked the last with a R. W. of 63.90%. This shows there is a lack of awareness about the necessity to protect the environment.

The total R.W. of the respondent's awareness of the environmental benefits of adopting solar technology of 69.43% is relatively low, pointing at a need to increase environmental awareness among the population of the Gaza Strip.

Table 5 shows that item 11 "The government subsidy, if any, for the prices of solar energy that drives you to adopt it" is ranked the first with a R. W. of 74.20%. While item 14 "Dwelling in a remote place drives you to adopt solar energy" is ranked the last with a R. W. of 59.30%.

The total relative weight of the respondent's awareness about the initial solar system cost on the adoption of solar energy technology amounted to 67.93%. This value is relatively low, indicating that the cost does not have high impact on the respondent's decision to adopt solar system.

Table 6 displays that item 20: "You see the need for specialized governmental centers to research renewable green energy" is ranked the first with an R.W. of 77% and item 21 " You desire using various green renewable energy sources" is ranked the last with a R. W. of 64.40%.

The total R.W. of the respondent's awareness of the economic savings on adoption of solar energy technology amounted to 72.04%. This relatively high value shows that the economic savings has an important effect on the decision to adopt solar systems by the respondents.

First hypothesis results: To authenticate the first hypothesis "There are statistically significant differences in the attitudes of the employees of Al-Shifa Medical Complex in Gaza regarding the advantages of adopting solar energy technology (due to the environmental benefit, the initial installation cost of solar energy systems, the economic savings) who live in different governorates." The one-way ANOVA test "F test" was used to find the differences between the two variables as shown in Table 7.

Table 7 Comparison of the study sample responses from residents of the different governorates

	Squares' sum	The degree of freedom	The average squares value	The "F" test	Significance level
Environmental benefit					
Between groups	7.743	4	1.936	1.893	0.113//
Within groups	199.404	195	1.023		
The total	207.147	199			
Initial Solar System Cost					
Between groups	8.439	4	2.110	2.463	0.047*
Within groups	167.006	195	0.856		
The total	175.445	199			
Economic savings					
Between groups	8.599	4	2.15	2.581	0.039*
Within groups	162.441	195	0.833		
The total	171.039	199			
The total					
Between groups	7.917	4	1.979	2.646	0.035*
Within groups	145.833	195	0.748		
The total	153.749	199			

**Significant at 0.01

*Significant at 0.05

// Not significant

As displayed in Table 7, the results of the one-way ANOVA test "F test" show that there are no statistically significance differences in the success of the adoption of solar energy technology due to the environmental benefit, with respect to the governorate of residence. Contrastingly, there are significantly statistical differences in the success of the adoption of solar technology (due to the initial installation cost of a solar system, the economic savings, the total) by the sample members with respect to the governorate of residence. To illustrate these differences, Scheffe tests were used and results are given accordingly.

Comparison of the sample members responses from different governates with respect to how much the decision to adopt a solar system depends upon the initial installation cost of a solar system, the economic savings and the total are given in Tables 8, 9 and 10, respectively.

Table 8 shows that there are no statistically significant differences in the success of the adoption of solar energy technology with respect to the initial installation cost of solar systems, by the sample members due to the governorate in which they live. Furthermore, Table 9 exhibits that there are no statistically significant differences in the success of the adoption of solar energy technology, economic savings, which depend upon the governorate where the sample members live.

Table 10 shows that there are no statistically significant differences in the success of the adoption of solar energy technology, due to the total, which depend upon the governorate where the sample members live.

The second hypothesis results

To check the second hypothesis, "There are statistically significant differences in the attitudes of the employees

Table 8 The differences between the categories of the governorate in which the employee lives with respect to installation cost of solar energy systems

	North V = 2.932	Gaza V = 3.436	Central V = 3.458	Khanyounes V = 4.178	Rafah V = 3.267
North V = 2.932	-	0.503	0.526	1.245	0.334
Gaza V = 3.436	−0.503	-	0.023	0.742	−0.169
Central V = 3.458	−0.526	−0.023	-	0.719	0.192
Khanyounes V = 4.178	−1.245	−0.742	−0.719	-	−0.911
Rafah V = 3.267	−0.334	0.169	0.192	0.911	0.192

of Al-Shifa Medical Complex in Gaza regarding the success of adopting solar energy technology (environmental benefit, initial solar system cost, economic savings) due to the house ownership." The one-way ANOVA test "F test" was used to find the differences between the two variables, as shown in Table 11.

The results of the one-way ANOVA test "F test" shows that there is no statistically significant difference in the degree of success of adopting solar energy technology

Table 9 The differences between the categories of the governorate in which employee lives with respect to the economic savings

	North V = 3.096	**Gaza V = 3.704**	**Central V = 3.545**	**Khanyounes V = 4.040**	**Rafah V = 3.360**
North V = 3.096	-	0.608	0.449	0.944	0.264
Gaza V = 3.704	− 0.608	-	− 0.159	0.336	− 0.344
Central V = 3.545	− 0.449	0.159	-	0.495	− 0.185
Khanyounes V = 4.040	− 0.944	− 0.336	− 0.495	-	− 0.680
Rafah V = 3.360	− 0.264	0.344	0.185	0.680	-

Table 10 The total differences between the categories of the governorate in which employee lives with respect to the environmental benefit and economic savings

	North V = 3.024	**Gaza V = 3.555**	**Central V = 3.494**	**Khanyounes V = 4.148**	**Rafah V = 3.284**
North V = 3.024	–	0.532	0.469	1.124	0.260
Gaza V = 3.555	− 0.532	–	− 0.062	0.592	− 0.271
Central V = 3.494	− 0.469	0.062	–	0.654	− 0.209
Khanyounes V = 4.148	− 1.124	− 0.592	− 0.654	–	− 0.864
Rafah V = 3.284	− 0.260	0.271	0.209	0.864	–

Table 11 Comparison between the study sample responses according to house ownership

	Squares' sum	**The degree of freedom**	**Average squares value**	**The "F" test**	**The significance level**
Environmental benefit					
Between groups	0.621	2	0.311	0.296	0.744//
Within groups	206.526	197	1.048		
The total	207.147	199			
Initial Solar System Cost					
Between groups	0.004	2	0.002	0.002	0.998//
Within groups	175.440	197	0.891		
The total	175.445	199			
Economic savings					
Between groups	0.282	2	0.141	0.163	0.850//
Within groups	170.757	197	0.867		
The total	171.039	199			
The total					
Between groups	0.028	2	0.014	0.018	0.982//
Within groups	153.722	197	0.78		
The total	153.749	199			

**Significant at 0.01

*Significant at 0.05

//Not significant

(due to the environmental benefits, the solar energy, the economic savings and the total) by the sample with respect to house ownership as presented in Table 11.

The third hypothesis results

To check the third hypothesis "There are statistically significant differences in the attitudes of the employees of Al-Shifa Medical Complex in Gaza regarding the success of adopting solar energy technology (due to the environmental benefits, the initial solar system cost, or the economic savings) due to the type of house, in which they live". One-way ANOVA test "F test" was used to find the differences between the two variables.

Table 12 demonstrates that there are statistically significant differences in the degree of success of adopting solar energy technology (due to the environmental benefits, the initial solar system cost, the economic savings and the total) by the respondents with respect to the type of house. To illustrate the differences between the categories of the type of houses in which the employees live with respect to the environmental benefit, the initial solar system cost, the economic savings, and the total, Scheffe tests are used and the results are given in Tables 13, 14, 15, and 16, respectively.

As shown in Table 13, there are statistically significant differences in the attitudes of the respondents in the degree of success of adopting solar energy technology, due to the environmental benefits, which depend upon the type of houses, those who live in an apartment building are the most in favor of solar energy systems while those who live in an independent house are second, those who live on a farm are last. However, the residents of all three categories are in favor of solar energy.

Table 14 indicates that there are no statistically significant differences in the attitudes of the respondents regarding the success of adopting solar energy

Table 12 Comparison between the study sample responses according to type of house

	Squares' sum	The degree of freedom	Average squares value	The "F" test	The significance level
Environmental benefit					
Between groups	13.536	2	6.768	6.887	0.001**
Within groups	193.611	197	0.983		
The total	207.147	199			
Initial solar system cost					
Between groups	5.998	2	2.999	3.487	0.032*
Within groups	169.446	197	0.860		
The total	175.445	199			
Economic savings					
Between groups	5.815	2	2.907	3.467	0.033*
Within groups	165.224	197	0.839		
The total	171.039	199			
The total					
Between groups	7.599	2	3.799	5.121	0.007**
Within groups	146.150	197	0.742		
The total	153.749	199			

**Significant at 0.01

*Significant at 0.05

//Not significant

Table 13 The differences between the categories of the type of houses in which the employee lives with respect to environmental benefit

	Independent house V = 3.190	Apartment in a building V = 3.637	House in a farm V = 2.607
Independent house V = 3.190	–	0.447*	− 0.582
Apartment in a building V = 3.637	− 0.447*	–	− 1.029*
House in a farm V = 2.607	0.582	1.029*	–

Table 14 The differences between the categories of the types of houses in which the employee lives with respect to the initial solar system cost

	Independent house V = 3.285	**Apartment in a building V = 3.485**	**House in a farm V = 2.619**
Independent house V = 3.285	–	0.1993	− 0.666
Apartment in a building V = 3.485	− 0.1993	–	− 0.866
House in a farm V = 2.619	0.666	0.866	–

Table 15 The differences between the categories of the type of house in which the employee lives with respect to economic savings

	Independent house V = 3.559	**Apartment in a building V = 3.665**	**House in a farm V = 2.743**
Independent house V = 3.559	–	0.107	− 0.816
Apartment in a building V = 3.665	− 0.107	–	− 0.922*
House in a farm V = 2.743	0.816	0.922*	–

Table 16 The differences between the categories of the types of houses in which the employee lives with respect to the total

	Independent house V = 3.345	**Apartment in a building V = 3.596**	**House in a farm V = 2.656**
Independent house V = 3.345	–	0.251	− 0.688
Apartment in a building V = 3.596	− 0.251	–	− 0.939*
House in a farm V = 2.656	0.688	0.939*	–

technology, with respect to the economic savings, which depend upon the categories of housing type (an apartment in a building, an independent house, a house on a farm).

And there are statistically significant differences in the attitudes of the sample members regarding the degree of success of adopting solar energy technology, with respect to economic savings, which depend upon the categories of housing types (an apartment building, and a house on a farm) with an apartment building house most in favor of a solar energy system, as shown in Table 15.

Likewise, Table 16 indicates that there are statistically significant differences in the attitudes of the sample members regarding the success of adopting solar energy technology, and the total, with respect to the categories of housing type (apartment in a building, an independent house, a house on a farm).

The fourth hypothesis results

To check the fourth hypothesis, "There are statistically significant differences in the attitudes of the employees of Al-Shifa Medical Complex in Gaza regarding the success of adopting solar energy technology (due to the environmental benefit, the initial solar system cost, the economic savings) with respect to the knowledge of renewable energy types." the independent sample "T" test was used to determine the differences between the two variables (Yes and No). "Yes" indicates that they know renewable energy. "No" indicates that they do not know renewable about energy.

Table 17 displays the statistically significant differences in the success of adopting solar energy technology (due to the environmental benefit, the initial solar system cost, the economic savings and the total) by respondents depending upon their answer to the question "Do you know about the most important types of renewable energy" the majority answered "Yes" they did know about the most important types of renewable energy.

The fifth hypothesis results

To verify the fifth hypothesis, "There are statistically significant differences in the attitudes of the employees of Al-Shifa Medical Complex in Gaza regarding the degree of success of adopting solar energy technology (due to the environmental benefit, the initial solar system costs and the economic savings) depending upon the degree of knowledge about the use of solar energy or solar panels." The independent sample "T" test was used to find

Table 17 Comparison between the study sample responses with respect to the knowledge of renewable energy types

	Number	Arithmetic average	Standard deviation	The "T" test	The significance level
Environmental benefit					
Yes	172	3.609	0.917	4.096	0.000**
No	28	2.625	1.216		
Initial solar system cost					
Yes	172	3.495	0.839	2.856	0.008**
No	28	2.79	1.263		
Economic savings					
Yes	172	3.722	0.808	3.534	0.001**
No	28	2.864	1.243		
The total					
Yes	172	3.609	0.767	3.772	0.001**
No	28	2.76	1.151		

**Significant at 0.01

*Significant at 0.05

//Not significant

Table 18 Comparison between the study sample responses with respect to the knowledge of usage of solar energy or solar panels

	Number	Arithmetic average	Standard deviation	The "T" test	The significance level
Environmental benefit					
Yes	154	3.578	0.93	2.375	0.021*
No	46	3.114	1.223		
Initial solar system cost					
Yes	154	3.447	0.838	1.152	0.254//
No	46	3.227	1.213		
Economic savings					
Yes	154	3.704	0.816	2.388	0.020*
No	46	3.261	1.177		
The total					
Yes	154	3.576	0.773	2.114	0.039*
No	46	3.201	1.129		

**Significant at 0.01

*Significant at 0.05

//Not significant

the differences between the two variables. "Yes" indicates that they have knowledge of the use of solar energy and solar panels. "No" indicates that they do not have knowledge of the use of solar energy and solar panels.

Table 18 shows that there are no statistically significant differences with respect to the success of adopting solar energy technology (due to the initial solar system cost) by respondents depending upon their answer to the question "Do you have a background on solar energy or the use of solar panels". But there are statistical differences in the success of adoption of solar energy technology (due to the environmental benefit, the economic savings and the total) by the respondents depending upon their answer to the question "Do you have a background on solar energy or the use of solar panels" for the benefit of their background on solar energy or solar panel.

Results related to the sixth hypothesis

"There are statistically significant differences in the attitudes of the employees of Al-Shifa Medical Complex in Gaza regarding the success of adopting solar energy technology (environmental benefit, initial solar system cost and economic savings) due to the energy cost per month." To validate the hypothesis, the one-way ANOVA "F" test was used to determine the differences between the two variables.

Table 19 indicates that there are no statistically significant differences in the degree of success of the adoption of solar energy technology (due to the environmental benefit, the initial solar system cost, the economic savings, and the total) by the respondents with respect to the energy cost per month payable to the utility company.

The seventh hypothesis results

To verify the seventh hypothesis "There are statistically significant differences in the attitudes of the employees of Al-Shifa Medical Complex in Gaza regarding the success of adopting solar energy technology (due to environmental benefit, the initial solar system cost and the economic savings) due to the availability of space for solar panels" the one-way ANOVA "F" test was used to find the differences between the two variables.

From Table 20, it is evident that there are no statistically significant differences in the success of the adoption of solar energy technology (due to the environmental benefit, the initial solar system cost, the economic savings and the total) by respondents with respect to the availability of space for solar panels.

The eighth hypothesis results

To verify the eighth hypothesis, "There are statistically significant differences in the attitudes of the employees of Al-Shifa Medical Complex in Gaza regarding the success of adopting solar energy technology due to the (environmental benefit, the initial solar system cost, the economic savings) depending upon their willingness to share solar systems with their neighbors", the independent sample "T" test was used to find the differences between the two variables.

Table 19 Comparison between the study sample responses with respect to the energy cost per month

	Squares' sum	Degree of freedom	Average squares value	"F" test	Significance level
Environmental benefit					
Between groups	5.045	2	2.523	2.459	0.088//
Within groups	202.102	197	1.026		
The total	207.147	199			
Initial solar system cost					
Between groups	3.116	2	1.558	1.781	0.171//
Within groups	172.328	197	0.875		
The total	175.445	199			
Economic savings					
Between groups	0.756	2	0.378	0.437	0.646//
Within groups	170.283	197	0.864		
The total	171.039	199			
The total					
Between groups	2.608	2	1.304	1.7	0.185//
Within groups	151.141	197	0.767		
The total	153.749	199			

**Significant at 0.01

*Significant at 0.05

//Not significant

Table 20 Comparison between the study sample responses with respect to the availability of space for solar panels

	Squares' sum	Degree of freedom	Average squares value	"F" test	Significance level
Environmental benefit					
Between groups	1.095	2	0.547	0.523	0.593//
Within groups	206.052	197	1.046		
The total	207.147	199			
Initial solar system cost					
Between groups	4.288	2	2.144	2.468	0.087//
Within groups	171.156	197	0.869		
The total	175.445	199			
Economic savings					
Between groups	0.412	2	0.206	0.238	0.788//
Within groups	170.627	197	0.866		
The total	171.039	199			
The total					
Between groups	1.548	2	0.774	1.001	0.369//
Within groups	152.202	197	0.773		
The total	153.749	199			

**Significant at 0.01

*Significant at 0.05

//Not significant

Table 21 shows that there are no statistically significant differences in the success of adopting solar energy technology (due to the environmental benefit, the initial solar system cost, the economic savings and the total) by respondents that depend upon their willingness to share solar systems with their neighbors.

Table 21 Comparison between the study sample responses with respect to the willingness to share solar systems with their neighbors

	Number	Arithmetic average	Standard deviation	"T" test	Level of significance
Environmental benefit					
Yes	99	3.534	0.894	0.864	0.389//
No	101	3.41	1.131		
Initial solar system cost					
Yes	99	3.477	0.828	1.202	0.231//
No	101	3.318	1.034		
Economic savings					
Yes	99	3.709	0.801	1.624	0.106//
No	101	3.497	1.029		
The total					
Yes	99	3.573	0.743	1.335	0.183//
No	101	3.408	0.991		

**Significant at 0.01

*Significant at 0.05

//Not significant

The ninth hypothesis results

To verify the ninth hypothesis, "There are statistically significant differences in the attitudes of the employees of Al-Shifa Medical Complex in Gaza regarding the success of adopting solar energy technology (due to the environmental benefit, the initial solar system cost, the economic savings) depending upon possibility of cost sharing of solar system installation", the one-way ANOVA "F" test was used to find the differences between the two variables.

Table 22 indicates that there are no statistically significant differences in the success of the adoption of solar energy technology (due to the environmental benefits, the initial solar system cost, the economic savings and the total) by sample members that depend upon possibility of cost sharing of the solar systems installation with neighbors.

The tenth hypothesis results

To verify the tenth hypothesis, "There are statistically significant differences in the attitudes of the employees of Al-Shifa Medical Complex in Gaza regarding the success of adopting solar energy technology (due to the environmental benefits, the initial solar system cost, the economic savings) depending upon whether the workers already have a solar system in their house. The independent sample "T" test was used to find the differences between the two variables.

Table 23 indicates that there are no statistically significant differences in the success of the adoption of solar energy technology (due to the environmental benefit,

Table 22 Comparison between the study sample responses depending upon possibility of cost sharing of the solar system installation

	Squares' sum	Degree of freedom	Average squares value	"F" test	The significance level
Environmental benefit					
Between groups	1.185	2	0.567	0.567	0.568//
Within groups	205.963	197	1.045		
The total	207.147	199			
Initial solar system cost					
Between groups	1.391	2	0.695	0.787	0.457//
Within groups	174.054	197	0.884		
The total	175.445	199			
Economic savings					
Between groups	0.403	2	0.202	0.233	0.793//
Within groups	170.636	197	0.866		
The total	171.039	199			
The total					
Between groups	0.830	2	0.415	0.535	0.587//
Within groups	152.919	197	0.776		
The total	153.749	199			

**Significant at 0.01

*Significant at 0.05

//Not significant

Table 23 Comparison between the study sample responses depending upon whether the workers already have a solar system in their house

	Number	Arithmetic average	Standard deviation	"T" test	Level of significance
Environmental benefit					
Yes	39	3.510	0.962	0.261	0.794//
No	161	3.262	1.037		
Initial solar system cost					
Yes	39	3.427	0.884	0.227	0.821//
No	161	3.389	0.954		
Economic savings					
Yes	39	3.851	0.797	1.884	0.061//
No	161	3.542	0.948		
The total					
Yes	39	3.596	0.797	0.84	0.402//
No	161	3.464	0.898		

**Significant at 0.01

*Significant at 0.05

//Not significant

the initial the solar system cost, the economic savings and the total) by respondents due to the fact they already have a solar system in their house.

The eleventh hypothesis results

To verify the eleventh hypothesis "There are statistically significant differences in the attitudes of the employees of Al-Shifa Medical Complex in Gaza regarding the success of adopting solar energy technology (due to the environmental benefit, the initial solar system cost and the economic savings) depending upon the year that the workers installed the solar systems in their house", the one-way ANOVA "F" test was used to find the differences between the two variables.

There are no statistically significant differences in the success of the adoption of solar energy technology (as measured by the environmental benefit, the initial solar system cost, the economic savings and the total) by the respondents due to the year that the employee insulated the solar systems in their house as presented in Table 24.

The twelfth hypothesis results

To verify the twelfth hypothesis, "There are statistically significant differences in the attitudes of the employees of Al-Shifa Medical Complex in Gaza regarding the success of adopting solar energy technology (as measured by the environmental benefit, the initial solar system cost, the economic savings) that depends upon the percent of electrical power in their houses that comes from a solar system." The one-way ANOVA "F" test was used to find the differences between the two variables.

Table 24 Comparison between the study sample responses depending upon the year that the workers installed the solar systems in their house

	Squares' sum	Degree of freedom	Average squares value	"F" test	The significance level
Environmental benefit					
Between groups	0.902	2	0.451	0.474	0.626//
Within groups	34.235	36	0.951		
The total	35.137	38			
Initial solar system cost					
Between groups	0.755	2	0.377	0.469	0.629//
Within groups	28.938	36	0.804		
The total	29.692	38			
Economic savings					
Between groups	2.05	2	1.025	1.671	0.202//
Within groups	22.087	36	0.614		
The total	24.137	38			
The total					
Between groups	1.113	2	0.556	0.871	0.427//
Within groups	23.01	36	0.639		
The total	24.123	38			

**Significant at 0.01

*Significant at 0.05

//Not significant

Table 25 indicates that there is no statistically significant difference in the success of the adoption of solar energy technology (as measured by the environmental benefit, the initial solar system cost, the economic savings and the total) by the respondents that depends upon the percentage of electrical energy supplied by solar systems in their houses.

In summary, only the third and fourth hypotheses have been accepted which shows that there is a statistically significant difference in the attitudes of the employees of Al-Shifa Medical Complex in Gaza regarding the success of adopting solar energy technology (due to the environmental benefits, the initial solar system cost, or the economic savings) depending to the type of house, in which they live and their the knowledge in renewable energy types in agreement with previous studies in particular [1, 2]. The results of the hypotheses have been rejected meaning that the results do not show any relevance for the rest of attributes, which have been considered by the study to explore the employees of Al-Shifa Medical Complex in Gaza regarding their success of adopting solar energy technology. Though the costs of installing solar panels have no significantly effect in this study, as has been indicated in [3], they should be regarded as an important factor. We believe this is caused by the difference of the sample type of both studies. In our case, the sample consists of employers while in [3] the sample consists of students only.

Conclusions

The goal of this study was to ascertain the main reasons Gazan households should adopt solar energy systems in their houses, replacing traditional sources of energy. Accordingly, the attitudes of homeowners in Gaza regarding successfully implementing solar energy technology (as measured by environmental benefit, initial installation cost of solar energy systems, and solar energy economic values) due to different attributes are considered. The attributes that are used in this study are area of residence (governorate), home-ownership, type of house, knowledge of renewable energy types, use of solar panels, energy cost per month, availability of space, willingness to share a solar system with neighbors, the preexistence of a solar energy system at the home and in which year it has been installed, and the current dependency on using solar systems at local houses.

The study has been conducted on a sample consisting of 200 employees working Shifa et al. medical complex in the Gaza Strip. The questionnaire was designed and distributed to the sample electronically. The collected data have been analyzed using an SPSS program. The authors found out that the sample members use solar energy to complement the current traditional energy system. The

Table 25 Comparison between the study sample responses that depend upon the percent of electrical power provided by solar systems in their houses

	Squares' sum	Degree of freedom	Average squares value	"F" test	Significance level
Environmental benefit					
Between groups	2.019	2	1.009	1.097	0.345//
Within groups	33.118	36	0.92		
The total	35.137	38			
Initial solar system cost					
Between groups	2.925	2	1.462	1.967	0.155//
Within groups	26.767	36	0.744		
The total	29.692	38			
Economic savings					
Between groups	1.832	2	0.916	1.479	0.241//
Within groups	22.305	36	0.62		
The total	24.137	38			
The total					
Between groups	2.166	2	1.083	1.775	0.184//
Within groups	21.957	36	0.61		
The total	24.123	38			

**Significant at 0.01

*Significant at 0.05

//Not significant

results show that the governorate in which employees are living, house ownership, total cost of energy/month, space to install the panels, and the desire to share the cost with neighbors do not affect the sample-members' decisions on adopting solar energy. In contrary to study [3] which found costs as an important factor in adopting solar energy systems, it did not affect the decision of our sample. It might be because the sample in this study includes mainly workers who might succeed to get loans to adopt such a system.

However the type of house, the knowledge of renewable energy and how to use solar panels affected the sample-members' decision on adopting solar energy systems which agrees with the findings of earlier studies [1, 2].

Recommendations

Implementing solar energy systems in homes is a good replacement or complement to the current system to overcome the electricity deficiency in Gaza. The current study should expand to include a larger sample from different sectors in the society. Extra research work is recommended in ways to inform local people of the benefits of adopting other renewable energy sources, i.e., wind energy, in Palestine and specially in the Gaza Strip. The local government should provide a clear policy for the implementation of solar energy systems. Furthermore, the local government should provide support for Gazans to adopt solar energy systems. In addition, universities should educate the local society about the benefits of solar energy systems through general lectures, training courses and/or required courses. Finally, businessmen are recommended to invest in the renewable energy sector, in particular in solar energy systems.

Acknowledgements
The authors would like to thank both Professor Dr. Thomas Shay (Department of Electrical and Computer Engineering, University of New Mexico, USA, tshay@unm.edu) and Professor Isabelle Fitzmaurice-O'Neill, University of Glasgow, Isabelle.Fitzmaurice-ONeill@glasgow.ac.uk for English proofing this paper.

Author contributions
HJE: provided the idea of the work, built the questionnaire, analyzed the data collected and wrote the manuscript. FE wrote the methodology and helped in analyzing the collected data. Both authors read and approved the final manuscript.

Funding
There is no available funding to declare.

Availability of data and materials
The data are a collection of information from the questionnaires. It will be provided upon request.

Declarations

Ethics approval and consent to participate
Not applicable.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Author details
[1]Electrical Engineering and Smart Systems Department, Engineering College, Islamic University of Gaza, P. O. Box 108, Gaza, Palestine. [2]Electrical Appliances Department, Ministry of Health, Gaza, Palestine.

Received: 22 June 2021 Accepted: 11 April 2022
Published online: 28 April 2022

References

1. Zakaria SU, Basri S, Kamarudin SK, Majid NAA (2019) Public awareness analysis on renewable energy in Malaysia. IOP Conference Series Earth Environ Sci 268:012105. https://doi.org/10.1088/1755-1315/268/1/012105
2. Szakály Z, Balogh P, Kontor E, Gabnai Z, Bai A (2021) Attitude toward and awareness of renewable energy sources: hungarian experience and special features. Energies 14:1–25. https://doi.org/10.3390/en14010022
3. Assali A, Khatib T, Najjar A (2019) Renewable energy awareness among future generation of Palestine. Renew Energ 136:254–263. https://doi.org/10.1016/j.renene.2019.01.007
4. Roos C (2009) Solar Electric System Design. Washington State University Extension Energy Program, Olympia, Operation and Installation
5. Mohanty P, Muneer T, Kolhe M (2019) Solar Photovoltaic System Applications. Springer, London
6. Dar-Mousa RN, Makhamreh Z (2019) Analysis of the pattern of energy consumptions and its impact on urban environmental sustainability in Jordan: Amman City as a case study. Energ Sustain Soc 9(15):1–12. https://doi.org/10.1186/s13705-019-0197-0
7. Nassar YF, Alsadi SY (2019) Assessment of solar energy potential in Gaza Strip-Palestine. Sustain Energy Technol Assess 31:318–328. https://doi.org/10.1016/j.seta.2018.12.010
8. Case Study: Renewable Energy in the Gaza Strip: Short, Mid, and Long-Term. 2014: Gaza. http://palthink.org/en/wp-content/uploads/2014/11/Case-Study-Renewable-Energy-in-the-Gaza-Strip.pdf
9. El-Khozondar HJ, El-batta FF (2018) Solar Energy as an alternative to conventional energy in Gaza Strip: Questionnaire based study. An Najah Univ J Res 32(1):47–74
10. Nassar YF, Alsadi SY (2018) Wind energy potential in Gaza Strip-Palestine state. Solar Energy Sustain Develop 7(2):41–57. https://doi.org/10.51646/jsesd.v7i2.73
11. Elnaggar M, Edwan E, Ritter M (2017) Wind energy potential of gaza using small wind turbines: a feasibility study. Energies 10:1–13. https://doi.org/10.3390/en10081229
12. Abo Hamed T, Flamm H, Azraq M (2012) Renewable energy in the Palestinian territories: opportunities and challenges. Renew Sust Energ Rev 16:1082–1088. https://doi.org/10.1016/j.rser.2011.10.011
13. Beithou N, Abu Al-Ganam Z (2017) Geothermal energy in Palestine: practical applications. J Appl Res Ind Eng 4(3):174–179. https://doi.org/10.22105/jarie.2017.54753
14. Ministy of Health (2017) Solar energy implementation at local hospitals. Ministry of health: Gaza.
15. MOEHE (2017) Solar system to power schools in Gaza: Gaza.
16. GEDCO (2017) Gaza Electricity Distribution Corporation: Gaza.
17. Nassar YF, Alsadi SY (2016) Economical and environmental feasibility of the renewableenergy as a sustainable solution for the electricity crisis in the Gaza Strip. Int J Eng Res Technol 12(3):35–44
18. Ismail M, Moghavvemi M, Mahlia T (2013) Energy trends in Palestinian territories of West Bank and Gaza Strip: possibilities for reducing the reliance on external energy sources. Renew Sustain Energy Rev 28:117–129. https://doi.org/10.1016/j.rser.2013.07.047
19. Aydi JY (2011) The solar Energy potential of gaza strip. Global Journal of researches 7:47–51

20. Abo Hamed T, Flamm H, Isma'il L (2013) Assessing renewable energy potential in Palestine. Am Sol Energy Soc 31:1–6
21. Juaidi AF, Montoya FG, Ibrik IH, Manzano-Agugliaro F (2016) An overview of renewable energy potential in Palestine. Renew Sustain Energy Rev 65:943–960. https://doi.org/10.1016/j.rser.2016.07.052
22. Ouda M (2001) Prospects of Renewable Energy in Gaza Strip. NET2001. Energy Research and Development Center, China. p. 1–6. http://site.iugaza.edu.ps/mouda/files/2010/02/NET2001_con_paper.pdf
23. Naim AN (2010) Potential of Solar Pumping in Palestine, in International Water Technology Conference (IWTC), Cairo. p. 1–11.
24. Nassar Y, Hafez A, Alsadi S (2020) Multi-factorial comparison for 24 distinct transposition models for inclined surface solar irradiance computation in the state of Palestine: a case study. Front Energy Res 7(163):1–19. https://doi.org/10.3389/fenrg.2019.00163
25. Yaseen BT (2009) Renewable Energy Applications in Palestine, in 2nd International Conference on the Palestinian Environment. An-Najah University: Nablus, Palestine. p. 52–65. https://hdl.handle.net/20.500.11888/9664
26. Abu-Hafeetha MFN (2009) Planning for Solar Energy as an Energy Option for Palestine. In: Urban and Regional Planning. Thesis, An-Najah National University: Palestine
27. El-Khozondar HJ, El-Batta FF (2018) Survey Study for the Usage of Solar Energy at Household by the Employees of Al-Shifa Medical Complex in Gaza Strip. J Phys 1108:1. https://doi.org/10.1088/1742-6596/1108/1/012093

Publisher's Note