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THE EVALUATION OF ALGERIANS' ATTITUDE TOWARD THE USE OF THE PHOTOVOLTAIC SOLAR ENERGY

CHEMS EDDINE BOUKHEDIMI

Ph.D. Student. Department of Commerce. Laboratory of Organisation Management Research (LAREMO). University of Mouloud MAMMERI in Tizi Ouzou, Algeria. (*Corresponding Author)

MESSAOUD ZEROUTI

Assistant Professor, Laboratory of Managerial Innovation, Governance and Entrepreneurship (LIMGE), High National School Of Management (ENSM), University Pole Of Kolèa, TIPAZA, Algeria.

LAMIA NEDIL

Ph.D. in Management, Laboratory of Managerial Innovation, Governance and Entrepreneurship (LIMGE), High National School of Management (ENSM), University Pole of Kolèa, TIPAZA, Algeria.

Abstract

The aim of this paper is to check the nexus between the demographic factors and the use of Photovoltaic solar energy between two Algerians cities Algiers and Tizi Ouzou. To check this issue, we collected 42 questionnaires online and face-to-face in order to measure the relationship between demographic factors and the willingness of respondents to install the PV solar kit. Moreover, in this paper, a novel method of consumer's segmentation in green Marketing is presented. Finally, a feasibility study was done to examine the profitability of the photovoltaic solar energy in a virtual house located in Algiers. The findings of the study indicate that the majority of respondents are aware of the use of renewable energies through results obtained after the use of the McNemar test. However, after checking our feasibility study, the main result shows that there is no profitability that belongs to the use of photovoltaic solar energy in houses for the residential sector. It should be remembered that the only demographic factor, which affects the PV instalment decision, is the city of living.

Keywords: Photovoltaic Solar Energy, Energy Transition, On Grid Solar Energy, Green Marketing, Green Consumer, Algeria, Chi Square Test, Mc Nemar Test, SPSS.

1. INTRODUCTION

Humanity's incessant need for energy grows over time and directly linked to development, due to the remarkable use of new electronic devices [1]. In addition, the need to decline of fossil fuels forced us to switch to the renewable energy such as solar energy, which is more adapted for earthly houses.

Solar energy offers one of the cleanest energies. It is the most renewable source exploited with wind energy. It can be defined that renewable energies are energies, which derive from nature [2] & [3].

Photovoltaic solar energy is commonly discussed in renewable electricity projects especially for the residential sector to decline Fossil Fuels and fight against global warming, the depletion of non-renewable resources and carbon dioxide emissions. require energy planning by promoting energy transition, many solutions are available, and solar energy, wind power, biomass and other types of energy that require the

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exploitation of inexhaustible, free and non-polluting energy resources. Photovoltaic solar panels generate electricity that is eco-friendly for the ecological environment as well as for the health of consumers, by converting sunlight into electricity [4]. It is exploited only for the residential sector or small electricity power needs for lighting Streets because of its low electricity voltage. The name Photovoltaic comes from Greek, it is composed of two parts:

- Photos: Light.

- Volta: Unit of electrical tension, named Alessandro Volta.

This invention was discovered in the 19th century by the physicist Alexandre Edmond Becquerel. The first photovoltaic cell was developed in earlier 1954 to power energy from satellites. Since 1958, photovoltaic cells have only supplied the satellite energy system until its first terrestrial applications at the beginning of the 1970s, when they were used in small isolated houses.

Many advantages are associated with using PV solar kits; one of the major advantages is that this kind of energy is independent of fossil fuels, then, it is clean and non-polluting energy because it does not generate waste and carbon dioxide (CO2). Another important advantage, it generates income for consumers who install the Photovoltaic solar kits. Finally, it doesn't make any noise like the turbines in the wind energy. This is possible with the move to Green Marketing in order to promote ethical behaviour in terms of electricity consumption and to improve the attitude of consumers toward the use of PV solar energy. In other words, it seeks to increase the awareness of those who do not care about ecological issues. In addition, this paper aspires to present new value about green marketing and the segmentation of the green consumer.

The research problem undertaken for study must be carefully selected.[5]Therefore, the problem to be investigated in our study may be posed as follows:

Is there any impact between the demographic factors of the electricity consumers and the willingness to use photovoltaic solar energy in Algeria?

Furthermore, it is important to know if the survey contributed to improving the awareness of respondents, another issue that must be clear; it is the profitability of the PV solar energy. Thus, the sub-research questions are the following:

1. **Will the respondents be more aware after the survey?**
2. **Is the instalment of PV solar energy profitable in the residential segment?**

Additionally, the hypotheses which belong to the study objectives are structured as follow:

1) There isn’t any impact of demographic factors on the decision to get the PV solar system installed among the houses
2) There is the nexus between the demographic variables and the instalment of the PV solar energy is possible.

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3) There is no positive improvement on choice of the respondents.
4) The respondents are agreeing to purchase the PV solar kits.
5) There is no profitability on the instalment of the Photovoltaic for the householders.
6) The process of the PV solar instalment is profitable in residential sector

1.1 Literature review

Over the past decade, there are several studies which hold about the promotion of safe types of energies to ensure energy transition, through the transformation of the energy sector from fossil-based to zero-carbon or by minimising its emission to limit climate change. To achieve sustainable development, the countries should increase their efforts to promote the use of renewable energy [4]. The goal of green promotion is to make an effect on the buying behavior of consumers by encouraging them to buy products that do not harm the environment and directing their attention to the positive consequences of their purchasing behavior, on themselves and on the environment [6]. Out of all the renewable sources of energy, solar energy has become more and more used [7]

[8] Showed that solar energy was not developed in Pakistan yet. In terms of study finding, 81% of the respondents showed high interest in solar home system (SHS). However, the expensiveness of solar panels, lack of information about solar energy characteristics and trust on solar panel providers are the major limitations which block SHS instalment.

[9] Presented a study for a decision to opt for household solar PV in Germany. He found that environmental and energy-saving causes impact on consumers' decision to hold PV solar in their houses roof-top. Besides, [10] showed that the social effect strategies resulted in an increase of 19.27% on average in the total number of adopters of solar panels in Chilie.

[11] Mentioned that the initial capital cost of solar energy development is still expensive compared to fossil fuel technologies. Furthermore, the lack of awareness among people and users about solar energy breaks the development of PV solar energy in the UAE.

As alleged by [12], the combination of wind and solar energy is more economically competitive compared to nuclear power. [13] Evaluated the increase of electricity consumption was a result of installing photovoltaics by consumers. In fact, the pricing regime inadvertently rewards consumers who over-consume electricity. In the same country, another more recent study done by [14] about Rooftop photovoltaics, it found that the capacity produced is around 15 TWh of electricity per year in this country, but it should be increased because the area of roof and field-based photovoltaics are sufficient. Moreover, the researcher highlighted that each KWh provided into the grid for household systems pays only 0.0653 €, while households earn a marginal benefit of 0.334 € for each kWh of their own electricity they consume.

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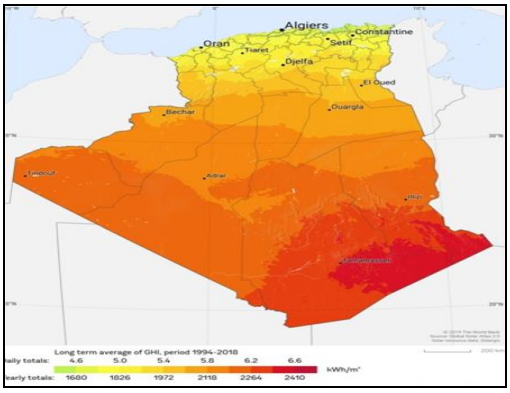
1.2 Photovoltaic Solar energy in Algeria:

Algeria covers an area of 2,381,741 square kilometres in North Africa as a largest country by area in the continent and ninth in the whole world. It is bordered by the Mediterranean Sea, Tunisia and to the northeast, Libya to the southeast, Niger, Mali to the south, Mauritania and the Western Sahara to the Southwest and finally Morocco to the west.

Figure.1 Solar radiation in Algeria



Source: [18]

The solar sunshine duration exceeds 2000 hours annually on the entire [15] it means that Algeria has a daily average of solar radiation more than 5 kWh/m^2, which is the highest in the world [16]. Furthermore, the highest radiation value is 6.4 KWh/ m^2 per day in the southeast region. Although, 4.6 KWh/ m^2 is the lowest per day [17] & [18].

Table1: Global horizontal irradiation/Day in Algeria

ID	Cities	Geographical localisation	Global horizontal radiation/Day (KWh/m^2)
01	Adrar	Sub-Saharan & Sahara	6.05
02	Chlef	North	4,91
03	Laghouat	Sub-Saharan & Sahara	5.45
04	Oum El Bouaghi	Highlands	4.99
05	Batna	Highlands	5.24
06	Bejaia	North	4.72
07	Biskra	Sub-Saharan & Sahara	5.27
08	Bechar	Sub-Saharan & Sahara	5,76
09	Blida	North	4.61
10	Bouira	North	4,93
11	Tamanrasset	Sub-Saharan & Sahara	6.28
12	Tebessa	Highlands	5.24
13	Tlemcen	North	5.17
14	Tiaret	Highlands	5.21
15	Tizi Ouzou	North	4.72
16	Algiers	North	4.69
17	Djelfa	Sub-Saharan & Sahara	5.4

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18	Jijel	North	4.46
19	Setif	Highlands	5
20	Saida	Sub-Saharan & Sahara	5.12
21	Skikda	North	4.67
22	Sidi Bel Abbes	Highlands	5.61
23	Annaba	North	4.6
24	Guelma	Highlands	4.6
25	Constantine	Highlands	4.83
26	Media	Highlands	4.94
27	Mostaganem	North	4.95
28	M'sila	Highlands	5.04
29	Mascara	Highlands	5.01
30	Ouargla	Sub-Saharan & Sahara	5.75
31	Oran	North	4.96
32	Bayadh	Sub-Saharan & Sahara	5.65
33	Illizi	Sub-Saharan & Sahara	6,03
34	Bourdj Bou Arreridj	Highlands	5.01
35	Boumerdes	North	4.73
36	El taref	North	4,6
37	Tindouf	Sub-Saharan & Sahara	6.07
38	Tissemsilt	Highlands	4.99
39	El oued	Sub-Saharan & Sahara	5.49
40	Khenchela	Highlands	5.35
41	Souk Ahras	Highlands	4.89
42	Tipaza	North	4.77
43	Mila	North	4,91
44	Ain Defla	Highlands	4.91
45	Naama	Sub-Saharan & Sahara	5,47
46	Ain Timouchent	North	5
47	Ghardaia	Sub-Saharan & Sahara	5.7
48	Relizane	Highlands	4.94
49	Timimoun	Sub-Saharan & Sahara	5.84
50	Bordj Badji Mokhtar	Sub-Saharan & Sahara	6.12
51	Ouled Djellal	Sub-Saharan & Sahara	5,43
52	Benni Abbes	Sub-Saharan & Sahara	5.94
53	In Salah	Sub-Saharan & Sahara	6.02
54	In Guezzam	Sub-Saharan & Sahara	6,33
55	Touggourt	Sub-Saharan & Sahara	5.51
56	Djanet	Sub-Saharan & Sahara	6,4
57	El M'ghair	Sub-Saharan & Sahara	5.38
58	El Meniàa	Sub-Saharan & Sahara	5.94
$\sum xi$		310,12	
Mean $\frac{\sum xi}{N} = \frac{310,12}{58}$		5.34	

Source: Developed by Authors

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The table above describes the global horizontal radiation per day in Algeria taken from [17]; the mean is **5.34 KWh/m^2** which is close to the extreme value (**6.4 KWh/m^2**). In fact, despite of Algeria contains 58 cities; the regions are not equal in terms of global horizontal radiation/Day in Algeria, because it contains three major sides:

- **North:** It brings together 17 cities with a mean of global horizontal irradiation/Day of **5, 06 KWh/m^2**;
- **Highlands:** It contains17 cities with global horizontal irradiation/Day mean's **5.04 KWh/m^2**;
- **Sub-Sahara & Sahara:** It is composed of 24 cities with global horizontal irradiation/Day mean's **5, 76 KWh/m^2**.

[19] Asserts that the law n° 04-09 aims to promote the use of renewable energy in order to protect the environment, mitigate climate change by reducing greenhouse gas emissions. Therefore, Algeria has signed the Paris agreement in 2015 by committing to reduce carbon emissions by 7% by 2030.

Furthermore, Algeria has exceeded the objective set in the national plan for the development of renewable energies (2011) which estimated the generation of 22 GW. Based on [20], in the year of 2021, 700 GW was achieved. The renewable energy development program consisted of 13,575 GW from the PV (Photovoltaic) solar, i.e. 61.70% of all the renewable energy, and the amount of the PV solar energy consumed in 2020 was 430.55 GW.

Consequently, Algeria has been categorised by statistics of the World Economic Forum on energy transition in 79th rank among 115 countries [21]. In terms of capacity installed. PV solar energy exceeds the energy solar thermal by installing 400 MW in 2017, i.e. 94.12% of all solar energy, including the two types. Moreover, the installed capacity of PV energy does not exceed 423 MW between 2018 and 2021.

In the macroeconomic measurement, [22] found that the primary sector is more receptive to using renewable energy and investments in energy efficiency among a survey of 117 Algerian companies.

1.3 Green consumers segments:

The other characteristic of green marketing is the variety of consumers who don't share the same profile. As may be seen in the table below, [23] described the 5 types as Roper Starch Worldwide has identified in their survey. However, according to [24] and [25] added another class according to a recent survey concerning green customers in Algeria.

1. TRUE BLUE-GREEN: This category is ideal because of their high interest in ecological and healthcare issues. In addition, they still contribute to the promotion of environmental activities, such as attending environmental seminars, which aim to give more importance to this kind of issue. Furthermore, they fund the associations, which have an interest in protecting the ecological environment.

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In addition, it should be to stand that they are real consumers of green products (Organic foods, Electric vehicles, PV Solar kits...) because they have high-income levels. However, most of them have a high educational level. (Post-graduate-Graduate).The other characteristic, these consumers avoid buying products that are not made by environmentally friendly companies.

2. GRENBACK GREENS: These consumers share the same characteristics as the first class 'True blue Greens' (important income level, awareness about green products). However, they are less aware of environmental causes compared to the first category. On the other hand, they do not always buy green products, but they ensure the funding of environmental organisations and attend environmental seminars.

3. SPROUTS: This category is less aware than the Greenback Greens and True Blue Greens. In fact, they do not consume green products despite their high-income level and education status. In other words, they have some awareness such as attending environmental seminars and funding green organisations.

4. GROUSERS: This type of person is not involved in pro-environmental behaviours and events in general, because they think that they are not concerned with ecological issues, which means that the use of green products must be in charge of state sectors. Take the example of solar energy, for them; the companies are the only direction that must be involved in. It should be noted that since their income level is so down especially when we see that most of them are employees and retirees). However, they participate only in the recycling operation by participating in the collection of empty bottles, to avoid the penalties imposed by the authorities.

5. BASIC BROWNS: This category avoids being involved in environmental issues at all, In addition, they do not blame other persons/organisations for environmental issues such as pollution. In other words, they do not make any effort to save their environment. However, they have a low-income level and small educational status.

6. ANTI- GREEN CUSTOMER: It should be stated that the present people are the worst, because of their unethical behaviours toward the ecological environment. To be honest, the Roper survey doesn't indicate this category but in the recent papers authored by [24] & [25] a new addition has been given, we talk about anti-green consumers who have a high-income level and prestigious educational rank, but they like not to buy the green products. Besides, they do not overlook ecological matters.

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Table2. Characteristics of consumers in green marketing approach

Green Customer Segment	Income level		Ability to purchase of a green product			Awareness of ecological and healthcare issues			
			Levels: From 0 to 2			Levels: From 0 to 3			
			0	1	2	0	1	2	3
	Low	High	0%	Less than 50%	More than 50%	0%	Less than 33%	Less than 66%	More than 66%
True blue-greens		✓			✓				✓
Green back greens		✓		✓					✓
Sprout		✓	✓					✓	
Grousers	✓		✓				✓		
Basic browns	✓		✓			✓			
Anti-green consumers		✓	✓			✓			

Source: [24]

In order to simplify the table above, the researchers should ask the following questions take the example of Photovoltaic solar power use:

Part one: Income level

1. The income level is high for those who occupy prestigious professional status such as Managers, doctors, businessmen…
2. The income level is low for people who are retirees and employees.

Part Two: Ability to purchase of a green product

1. Did you install the Photovoltaic solar kit?

- If the answer is yes, we have to check in the box “More than 50 %”

2. Do you plan to install the Photovoltaic solar kit?

- If the answer is yes, we have to check in the box “Less than 50 %”
- If the answer is no, we have to check in the box “0 %”

Part three: Awareness of ecological and healthcare issues

Here, it is not important to respect the order of question, it means, each time the respondent gives a positive response, the level of ecological awareness increases.

1. Do you take into account the ecological and societal aspects of the consumption of electricity?
2. Do you financially help organisations and associations to raise citizens' awareness of the importance of renewable energies to protect the environment?
3. Do you attend renewable energy fairs and exhibitions to follow recent developments?

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The assumptions:

-If the sum of positive response is 3, we check in the box “More than 66 %”

-If the sum of positive response is 2, we check in the box “Less than 66 %”

-If the sum of positive response is 1, we check in the box “Less than 33 %”

-If the sum of positive response is 3, we check in the box “0 %”

2. METHODOLOGY

The current study involved 42 people randomly selected via an online and face-to-face survey between March 2 and July 19, 2022. The target people were investigated among their willingness to save money to buy photovoltaic solar kit. It should be noted that respondents must live in land houses which are more suitable for installing photovoltaic solar energy.

Moreover, the respondents should have an income in order to cover the cost of photovoltaic solar kit purchasing.

It’s important to know that Our Survey isn’t exploratory, because we hold assumptions earlier. The survey questions are critical because they allow researchers to acquire the necessary first-hand data [24].Moreover; the results have been interpreted with the use of SPSS software version 26. It seems clear that the method used is the quantitative approach.
Besides, a qualitative approach is developed to describe and to present the green marketing and its evolution, then, to discuss about the segments of consumers.

3. RESULT

According to the results thus obtained below, it has been found that the sample size of the study is 42 respondents, 20 online and 22 Face-to-face. It is mentioned too, that 5 respondents missed the survey, 3 of them from online and the rest from Face-to-face.

Table3. Sample size of the survey

Online questionnaires distributed	Online questionnaires collected	Face-to-face questionnaire distributed	Face-to-face questionnaire collected	Final sample size
23	20	24	22	42

Source: Survey data

To meet the aim of the study, we hold on 1 dependant variable which is the willingness of citizens to install PV solar kits and 7 demographic variables (Independent variables) which are as follow:

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1. Gender: There are obvious differences between women's behaviour and men's in various situations [25]. Take the example of smoking in eastern society; men are more consumer's than women are less

2. Age: It has been pointed out that there were many types of age classes [26] & [27] who suggested the following segmentation of generations:

- **The older generation:** all people born before or during the Second World War;
- **The baby-boom generation:** anyone born between 1946 and 1964;
- **Generation X:** Anyone born between 1965 and 1985;
- **Generation Y:** Anyone born between 1986 and 2002;
- **Generation Z:** Also called pre-adolescent, it includes people born from 2003.

3. Occupation level: Refers to economic status of respondents. Or, we can talk about income level which is defined by [25] as the accrued income minus taxes and duties.

4. Educational level: In general, the post-graduated and graduated persons should be considered more aware than others, because education is a keystone that contributes to the improvement of ideas and choosing eco-friendly products.

5. City of living: In some situations, geographic localizations play an important role in consumer decisions. For example, the conditioner air is wanted in the Middle East and African countries than in European countries. Besides, in the same area, the consumers don't share the same viewpoint toward one or several products.

6. Possession of the house: In the current survey, the possession of the house may play a key role in the instalment of the PV solar Kit decisions. It is difficult to think about this issue for those who do not have a house contract.

7. Marital status: Sometimes, the persons who are married have a particular behaviour in terms of consumption, such as the purchase of family cars.

3.1 Reliability test:

The interpretation of alpha varies statistically from 0.0 to 1.0. [28] & [29]**.** The value is accepted when going from 0‹6 to 0‹7. [30].The reliability of our questionnaire is acceptable (0.749), so we can run the other tests.

Table4. Cronbach alpha test

Cronbach alpha coefficient	Items
0.749	21

Source: Developed by authors

3.2 statistics descriptive: The statistics descriptive of the demographic characteristics of the respondents are summed up in Tables 5 and 6:

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Table5: The central tendency of demographic factors

Index / Factor	Mean	Standard deviation	number of respondents
Gender	1.19	0.397	42
Age	3.48	0.804	42
Occupation level	2.8	1.209	41
Educational level	2.26	0.701	42
Marital status	1.4	0.497	42
City of living	1.43	0.501	42
Possession of the house	1.64	0.485	42

Source: Developed by authors

As reflected in Table 4, the majority of variables are dispersed from their arithmetic means, except the occupational level (SD=1.209). However, the other values of standard deviation are close to zero.

Table6: Statistics of demographic factors

Variables		Frequency	Percent (%)
Gender	Man	34	81
	Woman	08	19
Age	1946-1964	06	14.3
	1965-1985	12	28.6
	1986-2002	22	52.4
	2003 and above	02	4.8
Occupational level	High director	05	12.2
	Director	14	34.1
	Liberal Profession	11	26.8
	Employee	08	14.6
	Retired	05	12.2
Educational Level	Post-Graduated	06	14.3
	Graduated	19	45.2
	Under-Graduated	17	40.5
Marital status	Married	25	59.5
	Not married	17	40.5
City of living	Algiers	24	57.1
	Tizi Ouzou	18	42.9
Possession of the house	Yes	15	35.7
	No	27	64.3

Source: Developed by authors

It was found that the majority of the respondents are men (81 %) and the age category the most present is the “Generation Y’’ who were born between 1986 and 2002 with the rate of 52.4 % followed by the ‘’generation X’’ who were born between 1965 and 1985

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(28.6 %). The rest is shared between those born between 1946 and 1964 (14.3 %) and Generation Z who are born starting from 2002 and above (4.8 %).

[31] Highlights that many researchers use the words male-female in the analyses of the gender, but it is not true, because the words (male-female) refer to the biological aspects. However, when we use the terms of man and woman, we talk about respondents' economic and social status. In other hands, we need to use the duo of man-woman in the social sciences. Furthermore, the respondents, in general, are aged 19 years and above, so the right calling to them is men and women.

For the occupational level, the directors are present with a rate of 34.1 % followed by Liberal Profession (26.8 %), Employee (14.6 %) and both Retired/ High directors with the same rate (12.2 %).

About the educational level, sum of Post-Graduated and Graduated presented on 25 persons and 17 Under-graduated. In this survey we collected 25 married and 17 non-married, 24 respondents from Algiers and 17 from Tizi Ouzou. Besides, 15 from 42 persons possess houses.

3.3 Chi square test: A hypothesis is an assumption/statement about the relationship between two or more variables under investigation [32]. It is the only manner to locate the right answer to the research problem. In our case, the test which must be used is Chi square of independence.

- **Null Hypothesis (H_0):** There is no statistically significant relationship between two qualitative variables if p-value is > 0.05.
- **Alternative Hypothesis (H_1)**: There is a statistically significant difference between two qualitative variables if p-value is < 0.05.

Table7. Chi square tests

Hypotheses	Demographic Variables	p-value	Results of study
hypothesis a	Gender	0.734	There is difference (Independency)
hypothesis b	Age	0.534	There is difference (Independency)
hypothesis c	Occupational level	0.548	There is difference (Independency)
hypothesis d	Educational level	0.072	There is difference (Independency)
hypothesis e	Marital status	0.276	There is difference (Independency)
hypothesis f	City of living	0.038	There is no difference (Dependency)
hypothesis g	Possession of the house	0.307	There is difference (Independency)

Source: Authors

3.4 The measure of respondent's willingness before and after the survey

It is vital to know the willingness of respondents to use PV solar energy before and after the survey. In other words, we should analyse the answers to the following questions through the McNemar test which aims to check the improvement before and after testing the nominal variable:

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- **Question 5:** Have you already installed a photovoltaic solar kit?
- **Question 11:** Are you ready to install the Photovoltaic Solar kit?

Table8. Respondent's willingness before and after the survey

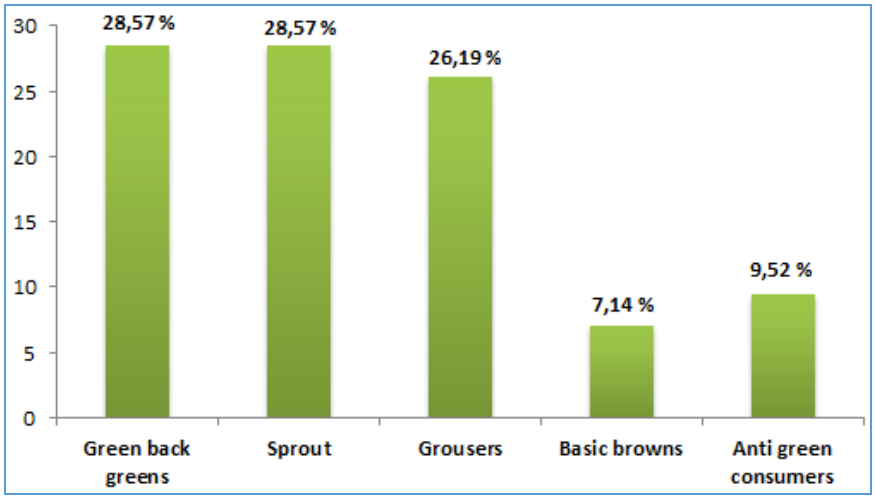
		Before	Total
		No	
After	Yes	22	22
	No	20	20
Total		**42**	**42**

Source: Developed by Authors

Table 7 shows that a positive evolution has been observed. Before starting our questionnaire, we had 42 answers with (No) and after the end of the survey, the number of respondents who replied with (No) was reduced to 20. In fact, we can't use the McNemar test in this case, because there is no positive replay before the second question. In the other hands, the cross-tabulation is sufficient

3.5 Segmentation of respondents: As result for respondents segmentation, we obtained 28.57 % (Green back greens), 28.57 % (Sprout), 26.19 % (Grousers), 7.14 % (Basic browns) and 9.52 % (Anti green consumers). We missed the first segment because we didn't find anyone who had installed the PV solar kit yet.

Figure. 2 Respondents segmentation



Source: Data survey

3.6 Feasibility study of PV solar system for residential sector in Algiers

The following table (9) presents a virtual consumption of electricity in one of the residential accommodations in Algiers. In order to minimise the costs of the photovoltaic solar system, we suggest using only the solar panels and the inverters, which means that the consumers in this case can't stock it overnight. Thus, the average of potential

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solar radiation hours per day in Algiers is 5.36h according to [18]. In this subject, the quantity generated of green electricity can be calculated below:

Table9. Estimated electricity consumption for residential accommodation in Algiers:

Devices & Power in Watt/h	Number of hours operated		Consumption per day (Watts/h)		Number of days utilised	Consumption per week (Watts/h)	
	Day	Night	Day	Night	-	Day	Night
Freezer : 45W	5.36	18.64	241.2	838.8	7	1688.4	5871.6
Television: 100 W	0.5	1.5	50	150	7	350	1050
Vacuum cleaners:400 W	1/2	-	200	-	4	800	-
Microwave: 800 W	-	1.5	-	1200	7	-	8400
Extractor hood:150 W	-	1/4	-	37.5	2	-	75
Blender:200 W	-	1/2	-	100	4	-	400
7 Lamps:10 W	-	7	-	490	7	-	3430
Washing machine:2500 W	1	1/2	2500	1250	3	7500	3750
Laptop computer:15 W	2	5	30	75	6	180	450
Printer:5 W	-	1/4	-	1.25	1	-	1.25
Modem:10 W	5.36	18.64	53.6	186.4	7	375.2	1304.8
Phones Charger:5 W	-	3	-	15	7	-	105
Total	**-**	**-**	**3074.8**	**4343.9**	**-**	**10893.6**	**24837.6**
			7418,7			**35731,2**	

Source: Developed by authors

It should be noted that the consumer can benefit from 5.36 hours during the availability of the sun and the rest (18.64 hours) for the electric devices which need to be fully charged such as the Freezer and Modem.

Step 1: Before the instalment of Photovoltaic solar kit

The electricity bill per trimester that it administrated by the state Society for Gas and Electricity Distribution (SONELGAZ) includes subscription fees, value-added taxes, accommodation tax, payment stamps, and fixed duty on consumption. Therefore, we need to search for the consumption per trimester as it is shown in table 10:

Table10. Estimated electricity consumption for residential accommodation per period in Algiers before the instalment of Photovoltaic solar kit

	Electricity consumption per day kWh	Electricity consumption per week	Electricity consumption per trimester
	7.42	35.7	428,4
Unit price: 4 DZD/Kwh	-	-	1713.6

Source: Developed by authors

It has been indicated in tables 10 & 11, the cost of traditional electricity is 1713.6 DZD, which represents 63.94 % of the electricity bill, without including other charges. However, the total payment estimated per year is 10720.24 DZD.

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Table11. Electrification bill before the instalment of PV solar system

Titles	Charges (DZD)
Electricity consumption	1713.6
Subscription fees	164.16
Pre-tax amount	**1877.76**
Value-added tax (9%)	169
Value-added tax (19%)	356.77
Accommodation tax	150
Fixed duty on consumption	100
Total exclude stamps	2653.53
Payment stamps (1% of total)	26.53
Total after payment of stamps	**2680.06**

Source: Developed by authors

Step 2: After the installation of the PV solar system

Therefore, we need to install 3KWh for PV solar energy per day, at the angle of 31/180°. However, It should be indicating that the size of solar panel to use is 164*99 (cm) and its maximum power is 250 Watts because the model used is Polycrystalline which is less expensive and less weight compared to the Monocrystalline model. Additionally, the cell efficiency is 17.8 %. On the other hand, the solar cell converts 17.8 % of the sunlight received to electricity (see Fig 3 & Fig 4).

Figure.3 Datasheet of Monocrystalline Solar panel model

Maximum Power(W)	250
Optimum Power Voltage(Vmp)	30
Optimum Operating Current(Imp)	8.33
Open Circuit Voltage(Voc)	36
Short circuit current(Isc)	9.25
Cell Efficiency(%)	17.8
Tolerance Wattage(%)	±3%
Size of Mudule(mm)	1640*990*40
Weight Per Piece(KG)	16
Temperature Range	-40℃ to +85℃
Standard test conditions	AM1.5 1000W/㎡ /25℃

Source: [33]

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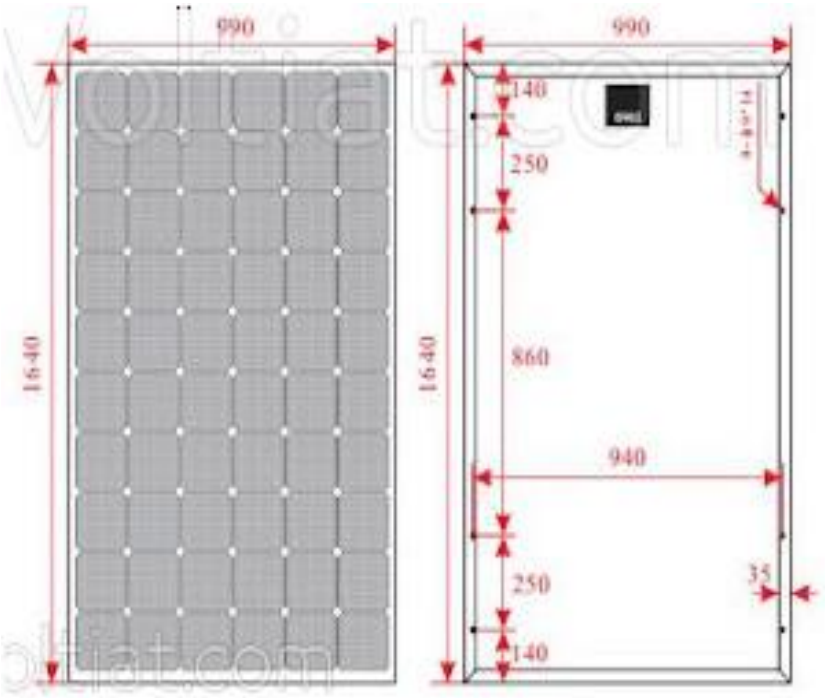
Figure.4 Monocrystalline Solar panel size model



Source: [33]

Consequently, the system of 3.075 KWh cost 230.000 DZD as it is demonstrated in the table below:

Table12. The installation cost of 3 KWh solar PV

Item	Unit price	Total price
12 Solar panels Polycrystalline	15.000 DZD	180.000 DZD
1 Inverter	50.000 DZD	50.000 DZD

Source: Developed by authors

Table13. Estimated electricity consumption per period excluded the sunlight time for residential accommodation in Algiers

	Electricity consumption per day kWh	Electricity consumption per week kWh	Electricity consumption per trimester kWh
	4.34	24.84	298.08
Unit price: 4 DZD/Kwh	-	-	1192.32

Source: Developed by authors

The table above presents the quantity of electricity consumed from fossil resources (Gas) after the installation of PV solar energy. Per trimester, the costs are 1192.32 DZD for 298.08 KWh. In this case, the new electricity bill will be calculated as follow:

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Table14. Electrification bill after the instalment of PV solar kit

Titles	Charges (DZD)
Electricity consumption	1192.32
Subscription fees	164.16
Pre-tax amount	**1356.48**
Value-added tax (9%)	122.08
Value-added tax (19%)	257.73
Accommodation tax	150
Fixed duty on consumption	100
Total exclude stamps	1986,29
Payment stamps (1% of total)	19.86
Total after payment of stamps	**2006.15**

Source: Developed by authors

The payment due the electricity consumption per trimester is 2006.15 DZD (see **Table 14**) and yearly 8024.6 DZD versus 10720.24 DZD before the instalment of the PV solar system.

Therefore, a win of 2695.64 DZD is achieved. But to cover the costs, the consumer needs to wait 85 years and 4 month to save the money invested which means that this operation isn't profitable

$$85.32 = \frac{230\ 000}{2695.64}$$

- **230 000 DZD:** Cost of PV Solar system (12 Solar panels and inverter);
- **2695.64 DZD:** Benefit by instalment of PV solar system per year;
- **85.32 Years:** Number of years left to recover costs.

4. DISCUSSION

From the above analysis, we can conclude that the only factor which impacts the willingness of respondents to use the PV solar energy is the city of living (hypothesis f) because the p-value (0.038) is below 0.05 (statistically significant), which signifies we reject the null hypothesis (H0) and we accept the alternative hypothesis (H1). On the other hand, the city of living impacts the decision on the PV solar energy use. In this issue, the respondents who live in Tizi Ouzou are more aware and impressed to install a PV solar system (61, 11 %) compared to Algiers citizens (29, 17 %).

In statistics, Cramer's V (sometimes referred to as "Cramer's phi" and denoted as φ_c) is a measure of association between two nominal variables giving a value between 0 and +1 [34]. It is based on Pearson's chi squared statistic and was published by Harald Cramer in 1946.

It should be confirmed that the strength between the two variables here is moderate because the value presented in the Cramer's V test is: 0.38.

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While there is no impact of the rest of the demographic variables on the PV solar energy instalment as it is clarified below:

- **Hypothesis a:** The null hypothesis is true because the p-value is 0.734. So the gender doesn't impact the willingness to install the PV solar kits.
- **Hypothesis b:** There is not any nexus between age and the willingness to install PV solar kits (p-value = 0.534).
- **Hypothesis c:** As the p-value = 0.548, the occupational level doesn't impact the willingness to install the PV solar kits.
- **Hypothesis d:** The educational level doesn't affect the willingness to install PV solar kits (p-value = 0.072).
- **Hypothesis e:** Marital status doesn't affect citizens' willingness to install PV solar kits, because the p-value is 0.276.
- **Hypothesis g:** Possession of the house doesn't have any relationship with the willingness of citizens to install the PV solar kits because the p-value is 0.307.

For the second question, most respondents have the willingness to purchase the photovoltaic solar kit after filling the questionnaire. This evolution is measured with a rate of 52.38% from the owners of residential photovoltaic systems. In other words, we conclude that the present survey changed the ecological behaviours of 22 persons. In this regard, the state must raise the challenge and make access to PV solar energy easy with the promotion of this type of energy for the residential sector.

In addition, as it mentioned earlier, the installation of PV solar is not profitable at all for the residential sector, due to the expensiveness of the PV solar kits, such as inverter (50.000 DZD) and solar panel (15.000 DZD).

Furthermore, it should be remembered that we have not included gas consumption in the electricity bill and the consumption of other devices such as the air conditioner. Moreover, at night the price of electricity consumption is higher than 4 DZD per KWh.

To clarify the obstacles which stop the instalment of PV solar energy in the residential sector, we start by the price of conventional electricity which is subsidised by the state from 16 DZD to 4 DZD, and the corposants of PV solar kit are relatively expensive, especially the inverter. Besides, the sale of renewable energy produced by consumers is not operational yet in Algeria.

However, we have to cite the other limits of Photovoltaic solar energy, which do not benefit from the same solar radiation per geographical localization, and it is different irregularly between seasons. Besides, the manufacture of photovoltaic panels involves high technology requiring a great deal of research and development. Therefore, the investment in this technology is expensive at the beginning.

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Furthermore, the electricity generation is not potential, which means it is not required for high electricity needs such as the industrial sector. Another important disfavour is the prices of PV solar kits which are expensive. Take Algeria as an example, a solar panel of 280 watts commanded 15.000 DZD, the batteries and inverters cost 50.000 DZD for each one.

Besides, the life cycle of batteries is short (5 to 8 years) and the oversupply of renewable electricity generated could not be sold by consumers in Algeria, because the prices are not fixed yet by the state and the smart grids are not developed.

To conclude, it stands to be mentioned that the excessive consumption of this type of renewable energy destroys the electricity system. That is why we cannot ignore mix-energetic. On the other hand, in the case of a malfunction or breakdown, it is possible to switch to traditional electricity.

Actually, it became very important to present the solution for making the installation of PV solar energy easier and profitable. In this manner, the state must reduce the prices of PV solar energy kits and fix the price belonging to purchasing the renewable electricity produced by consumers as it applies in foreign countries, taking Egypt as an example. Then, the prices of electricity issued from fossil fuels may be raised to push consumers who live in terrestrial homes to install the PV solar.

The key limitation of this paper is that the results are based on a limited geographical area (Algiers and Tizi Ouzou). Furthermore, most respondents are not fully aware of the importance of the green product, due to the lack of information about the importance of the PV solar energy.

5. CONCLUSION

Green marketing is one of the most addressed matters in the business of this era. The current study is based on a questionnaire addressed to some consumers of electricity in Algeria, who live in the earthiest houses which can make the installation of photovoltaic solar energy possible.

Therefore this research attempted to identify and describe the numerous factors that influence customers on this subject.

One of the important findings of this study is that the respondents from Tizi Ouzou have more willingness to install PV solar system compared to Algiers respondents

This study also suggested measuring the awareness of respondents before and after the survey. It can be concluded that even with a significant rate of 52.38% toward the willingness to install the PV solar energy in their home; this type of renewable energy doesn’t make an important financial profit after checking a virtual house simulation in Algiers.

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