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Are men more aware of the use of photovoltaic solar energy in Algeria than women? Gender based inquiry to fight climate change

Dr. Chems Eddine Boukhedimi[1]
[1]University of Tizi Ouzou, Department of commerce. Marketing Management. Algeria

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Abstract

This study aims to assess the impact of the men on the awareness toward the use of PV solar energy in Algeria. This type of research examines the awareness and knowledge of consumers with the ecological concerns and fighting climate change by reducing CO2 generated by the use of conventional energy. The method explored in this paper is quantitative through an online and face-to-face survey conducted between March, 2022 and May 2023. It should be outlined that respondents should live in land houses which are more accurate for installing photovoltaic solar energy. In addition to that, the respondents should have an income in order to cover the cost of photovoltaic solar kit. Then, the results were analyzed through SPSS software V26 by exploring the two sample t-test.

It has been demonstrated that the LEVENE test is superior to the significant level (p value: 0.855 > 0.05), which means that the variances are homogeneous. The results indicate that the independence between the awareness toward the use of PV solar energy and the gender of respondents is ensured (sig t-test: 0.781), it assumes that both men, and women from the participants are aware to use the photovoltaic solar energy.
Keywords: Consumer behavior- Green marketing- Photovoltaic solar energy- two sample t-test-Algeria - SPSS.

Introduction

Expressly, humanity's incessant need for energy grows over time and is directly linked to development due to the remarkable use of new electronic devices (Pequeno, de Matos Marques and dos Santos, 2019). Global warming and climate change are the most challenging issues in the world. However, the main reason causing global warming is the CO2 based greenhouse gases (GHGs) as a result of human beings' fossil energy consumption (Shuai, et al, 2015). Wind and solar energy are not yet developed enough to be a complete and flexible backup (Strielkowski et al, 2021) However, Photovoltaic solar energy is commonly discussed in renewable electricity projects especially for the residential sector to decline fossil fuels and fight against global warming, (Boukhedimi, Zerouti and Nedil, 2023). In this sense, the excessive consumption of fossil fuels can cause environmental problems such as extraction and use and may generate future problems in social issues when this resource runs out, another system that causes serious problems is the use of hydroelectric flooding nearby areas expelling inhabitants around them, loss of fauna and flora disrupting the ecosystem (Pequeno, de Matos Marques and dos Santos, 2019). Based on above, it is necessary to switch progressively for other safe energies, and the PV solar energy is the most accurate for householders.

In turn Photovoltaic solar energy is generated with sunlight, making this conversion of light to electricity, and this photovoltaic cell is made of a semiconductor material, one of those responsible for this effect (Pinho & Galdino, 2014). Hence, studies focusing on assessing consumers' willingness to utilize solar energy are scarce in the country Irfan et al (2021),

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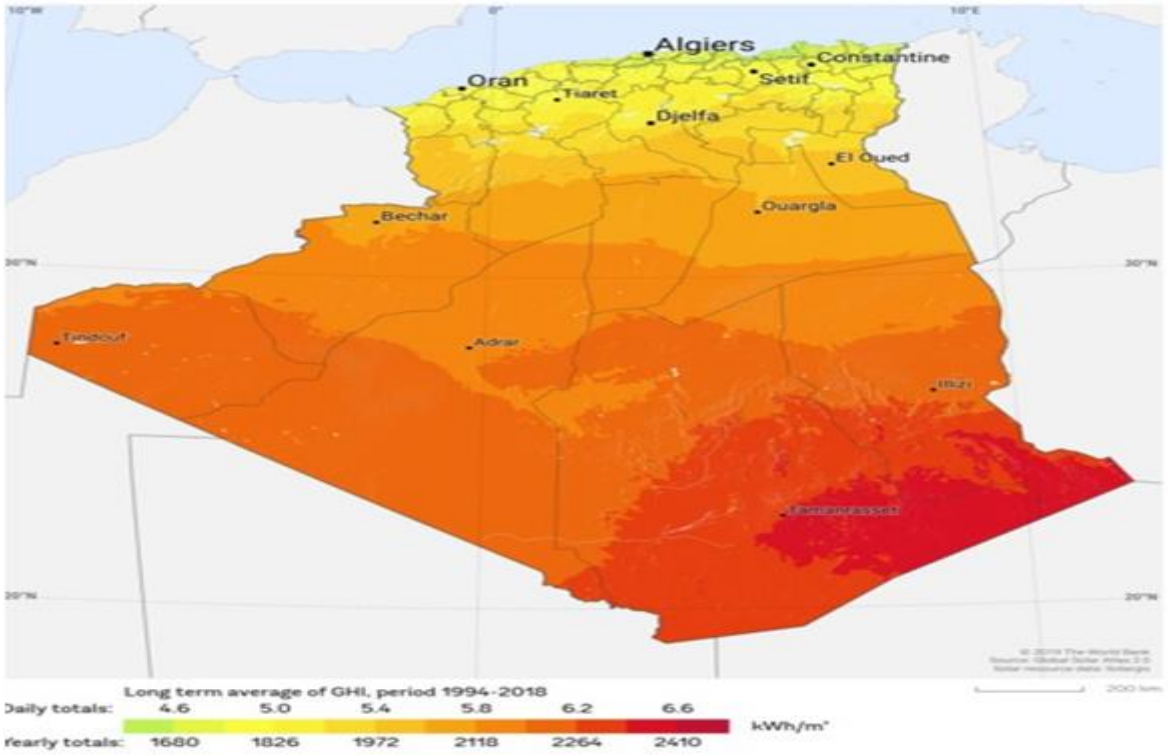
Algeria ranks among the top five natural gas-producing countries in the world, and among the top ten countries in the world for oil production. It plays a key role in global energy markets as a major producer and exporter of these products (Zaid et al, 2017).In addition to that, the solar sunshine duration exceeds 2000 hours annually on the entire of Algeria (Solargis, 2022).In other words, Algeria has a daily average of solar radiation more than 5 kWh/m2, which is the highest in the world Slimane, Mahi and Henni, 2022). Moreover, the highest radiation value is 6.4 kWh/ m2 per day in the southeast region. Although, 4.6 kWh/ m2 is the lowest per day (Haffaf & Lakdja, 2022; Global solar atlas, 2022). Therefore, Algeria has an advantage, in front of other countries.

Figure1. Map of Global horizontal irradiation in Algeria



Source: Solargis (2021)

Overall, the aim of the current study is to test gender acceptance and willingness to use PV solar home system in Algeria will be examined on this paper.

1.1. Geographical and astronomical location of Algeria

1.1.1. Geographical location: Algeria is geographically situated in the northwest of the continent of Africa, bordered to the north by the Mediterranean Sea, to the east by Tunisia and Libya, to the south by, Niger, Mali and Mauritania, and to the west by Morocco and Western Sahara.

1.1.2Area and dimensions:

Algeria is ranked among the top ten largest countries in the World (2,381,741 km2). It extends from north to south over a length of 1,900 km and from east to west over a distance of 1829 km and 1200 km of coastline.

1.1.3 Astronomical location: Algeria is located between latitudes 19° and 37° north, and between longitudes 12° east and 09° west.

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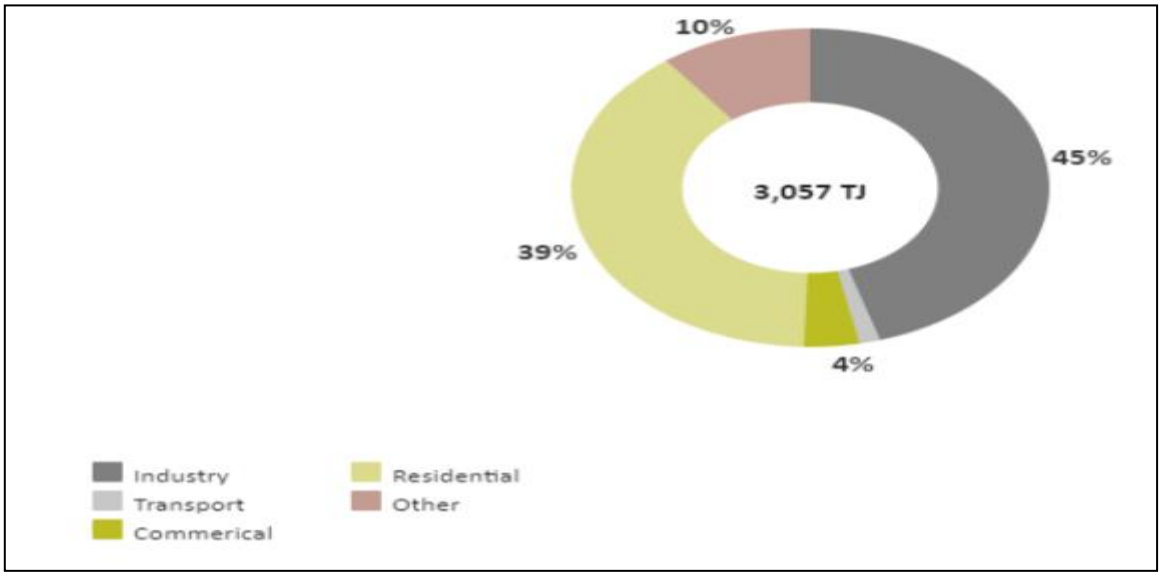
1.2. Renewal energy consumption in Algeria

Based on the statistics published by international renewable energy agency (IRENA), the final consumption in 2018 was 3.057 TJ, and the dominant sectors were the industry and residential with the aggregate of 78 % as mentioned in the figure below:

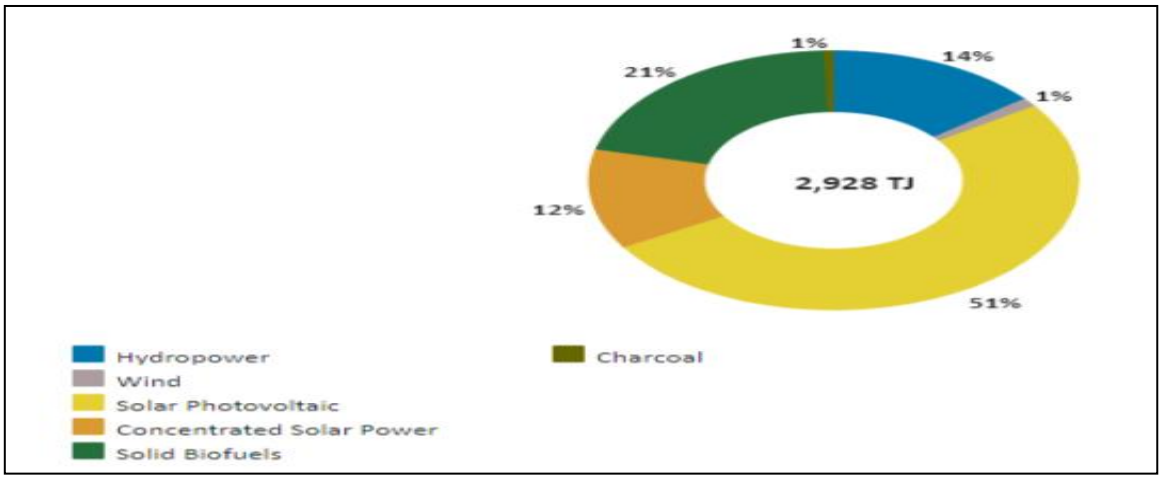
Figure2. Final Renewal energy consumption per sector in Algeria in 2018



Source: Irena (2019)

Furthermore, as per figure 3, the final consumption in 2019 has dropped by (- 4.22 %) compared to 2018, and the type most used was solar photovoltaic (51 %), followed with solid biofuels, hydropower and concentrated solar power receptively.

Figure3. Final Renewal energy consumption per type in Algeria in 2019



Source: Irena (2019)

2. Literature review

Numerous studies have showed an interest to the behavior of electricity consumers toward the possibility of using the solar PV energy (Zhou et al; 2017; Wittenberg, Blöbaum, and Matthies; 2018; Pequeno et al, 2019;

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Irfan et al, 2021; Salimi, Hosseinpour,& Borhani, 2022; Ardila, et al; 2022; Boukhedimi, Zerouti and Nedil, 2023; Boukhedimi, 2024)

In a paper entitled "Acceptance and willingness to pay for solar home system: Survey evidence from northern area of Pakistan". Zhou et al (2017) revealed that solar energy was not developed in Pakistan in that time. As for study findings, 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 adoption.

Wittenberg, Blöbaum, and Matthies (2018) provided a study for a decision to adopt for household solar PV in Germany. They concluded that environmental and energy-saving causes impact on consumers' decision to hold PV solar in their houses rooftop.

Pequeno et al (2019) conducted an empirical study in an attempt to attract more public for photovoltaic solar energy research. It was concluded that photovoltaic solar energy is promising; its environmental effects are limited in its production. Also, its power generation is clean, does not emit CO2. Further, the researchers addressed questionnaires to 13 participants in order to provide knowledge to people and answer frequent questions about this energy source. The lack of information sets off consumer insecurity, generating barriers to this energy source. The question was directed to 13 people, where 7 did not know about photovoltaic solar energy and 4 were aware of it. Two disagreed that it could solve problems due to its high cost. Furthermore, it shows how much knowledge and investment is necessitated to develop this technology in Brazil. Ultimately, Brazil has sufficient solar irradiation capacity to invest in this source, reduce CO2 emissions, barriers due to the lack of strong incentives to reduce system costs, environmental impacts of energy and reinforcing the lack of knowledge are imperative to push ahead on this issue.

Focusing on the study of Irfan et al (2021), it aimed to determine the effect of factors on consumers' willingness to utilize solar energy for household purposes in China. The current research was performed on questionnaire data of 355 households in the four cities, namely Changsha, Hengyang, Yueyang, and Zhuzhou (Hunan province), and using Structural Equation Modeling (SEM) to assess and scrutinize the formulated suppositions. The results suggested that the intention factors, i.e., (perception about self-effectiveness, awareness of solar energy, environmental concern, and belief of solar energy benefits impart positively on consumers' willingness to utilize solar energy. However, cost of solar energy has a negative influence. Particularly, perception of neighbors' participation has an insignificant impact.

Salimi, Hosseinpour,&Borhani (2022) noted that the initial capital cost of solar energy development is still expensive compared to fossil fuel technologies. Moreover, the lack of awareness among people and users about solar energy breaks the development of PV solar energy in the UAE. Besides, in a paper entitled "Modeling the technological adoption of solar energy neighborhoods: The case of Chile". Ardila, et al (2022) 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.

Using McNemar test, the Chi square test, Boukhedimi, Zerouti and Nedil (2023) attempted to examine the nexus between the demographic factors and the exploration of Photovoltaic solar energy among 42 participants in two cities Algiers and Tizi Ouzou (Algeria). The research was performed with online and face-to-face survey. The findings of the study revealed that the most of respondents are aware of the use of renewable energies. In addition to that, the city of living was the only factor that impacts on the solar PV using

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decision. Furthermore, according to the feasibility study suggested in this study, the result showed that there is no profitability that belongs to the use of photovoltaic solar energy in houses for the residential sector.

In another study, the aim of the doctoral thesis of Boukhedimi (2024) was to check the ecological awareness of the Algerian consumers, and measure their willingness to install the PV solar energy. Additionally, an examination of the impact of socio-demographic factors on the taking into consideration the ecological and societal aspects of electricity consumption place between March and July 2022 among 50 participants was discussed. Also, the current project attempted to check the differentiation in average solar irradiation between the northern, high plateau, sub-Saharan and Saharan regions in Algeria. The last aim was to determine the profitability of installation of the PV solar system in Tizi-ouzou province. In this sense, Mc Nemar test, the Chi square test, one way ANOVA test and feasibility study were performed the achieve study objectives.

The findings suggested that 46% of respondents; have an interest to install the solar PV system, and the demographic factors do not have a significant impact on whether electricity consumers consider the ecological and societal aspects of electricity consumption. Additionally, the existence of significant differentiation in average of solar irradiation between the northern, high plateau, sub-Saharan and Saharan regions in Algeria was confirmed. Moreover, assuming the exploitation of 3 kWh of PV solar energy per day, without batteries, resulted in an acquisition cost of 215,000 DZD, with a duration that exceeds 73 years to recover the amount of money invested. Therefore, it was concluded that the installation of the PV solar system is not profitable at all.

3. Materials and Methods

3.1. Method of Sampling

This study used both online and face-to-face survey as a branch of the quantitative approach. A total of 63 questionnaires were handed out and 58 received between March, 2022 and May 2023, providing a response rate of 92.06%. It should be mentioned that respondents have to live in land houses which are more suitable for installing photovoltaic solar energy. Additionally, the respondents should have an income in order to cover the cost of photovoltaic solar kit. Moreover,

This paper has empirically tested the impact of the gender variable on their ecological awareness, by including the intention to use PV solar home system in Algeria , which tend to measure the acceptance of gender respondents regarding this issue which is one of the basic elements of this the theory of planned behavior developed by (Ajzen, 1991). From statistical overview, it is important to note that the data were analyzed using SPSS software (Version 26), and the independent-samples t-test was explored to ensure the examination of study hypotheses.

Hence, the final sample size (n) was 58, and the findings might be generalized across the population (N), because the central limit theory (CLT) demonstrates that the sample is representative once the number of the sample population (n) is equal or superior to 30 (Chang et al, 2006; Polya, 1920; Johnson, 2004; Tomothy, 2005; Berenson et al, 2012; Naval, 2013; El sherif, 2021; Sriram, 2023).

3.2. Hypotheses

H1. Men are more aware than women regarding their willingness to explore the PV solar home system in Algeria.
H2. The Algerian women have more acceptance than men in terms of using the PV solar home system.
H3. Both men and women are aware with the use of the PV solar home system in Algeria.

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4. Result & discussion

As stated by Al Jeraisy (2008), there are obvious differences between women's behaviour and men's in various situations. To meet the aim of the study is to assess the ecological awareness of men and women. Therefore, the two sample t-test is used to examine the hypotheses.

4.1 Reliability test

The interpretation of alpha varies statistically from 0.0 to 1.0. (George & Mallery, 2003; Cohen, Manion and Morrison, 2007). However, the value is accepted when going from 0‹6 to 0‹7 (Hulin, Netemeyer, and Cudeck, 2001). In this way, the study questionnaire is reliable (0.77).

Table1. Cronbach alpha test

Cronbach alpha coefficient	Items
0.77	24

Source: Survey data

4.2. Descriptive statistics

Referring to the results illustrated in the table 1, it has been indicated that the sample size of the study is 58 respondents, 36 of them were collected by an online survey, and others (n = 22) using face-to-face questionnaires. Additionally, 3 missed online questionnaires, and 2 unfilled face-to-face survey questionnaires were determined.

Table2. Survey sample size

Questionnaires distributed online	Questionnaires collected online	Questionnaires distributed face-to-face	Questionnaires collected face-to-face	Final sample size
39	**36**	**24**	**22**	**58**

Source: Survey data

As per table 3, most of the participates were men (n=43; $\bar{x}$=1.441), with some concentrations of the values around the arithmetic mean (Standard deviation: 0.302 near to 0).

Table3. Descriptive statistics for the gender of the study sample.

	Frequency (n)	Mean ($\bar{x}$)	Standard deviation (σ)
Men	43	1.441	0.302
Women	15	1.466	0.281

Source: Survey data

Overall, It has been determined that the LEVENE test is superior to the significant level (p value: 0.855 > 0.05), which implies that the variances are homogeneous. The results indicate that the independence between the awareness toward the use of PV solar energy and the gender of respondents is ensured (sig t-test: 0.781), it means that both men, and women from the participants are aware to use the photovoltaic solar energy. Therefore, the first and the second hypotheses are rejected, while the last one is confirmed.

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Table 4 Study result

	Hypotheses	Result
t-test's result ***(sig:* 0.781**)	H1	**Rejected**
	H1	**Rejected**
	H1	**Accepted**

Source: Survey data

Conclusion-

The focus of this paper is on the analysis of gender difference with the acceptance of using the PV solar home system in Algeria. This study involved 43 men and 15 women, through online and face-to-face questionnaires during March 2022 and May 2023. As a result, both men, and women are agreeing to use the photovoltaic solar energy.

In line with the study limit, the number of women in the current survey was limited to 15 participants. Therefore, it is recommended that future research may have to be expanded with the involvement of women, even though men are more accurate to invest compared to women. However, it is important to note that the findings of the present paper could be considered useful to scientific research by including the results obtained.

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