CHARACTERIZATION OF THE CONSUMPTION HABITS OF HOUSEHOLD PRODUCTS THAT PROTECT THE ENVIRONMENT

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ABSTRACT

This paper is a partial advance of the research that seeks to determine the consumption habits of household appliances that are friendly to the environment, in Bogota households. It begins with a documentary review of the laws, decrees, and norms, where the state's concern for a conscious consumption of resources in the generation of energy from renewable and non-renewable. In the research of primary sources, when analysing international cases of Australia, Poland, Turkey, and Romania, through fieldwork and a review of databases established a census of Bogota families living in single-family homes. The results of the analysis categories be recorded in a statistical model, and then built a corrected linear regression of said results is carried out with the databases of the National Department of Statistics. In the second stage of the investigation, it´s created a document that consolidates the levels of the return via savings and investment versus expense.

Keywords: energy saving, renewable and non-renewable energy, home appliances, international experiences, case study.

1 INTRODUCTION

Water and energy subsidies have sparked interesting debates. Some defend them as part of measures to bring basic services to low-income sectors, such as the free vital consumption of water for the most vulnerable households. Others consider that subsidizing these services sends a perverse signal, by stimulating inefficient uses and jeopardizing the finances of the companies that supply them.

As part of the mining-energy program, the Development Plan includes a program for the rational and efficient use of energy, which aims, among other things, to encourage the replacement of old light bulbs and household appliances by more efficient ones. Between a quarter and a half of the monthly consumption of electrical energy goes to the fridge; and increases the family budget. The electric shower only wins in cold cities like Bogotá and Pasto, when you do not use a gas heater.

The vast majority of households (including those with a refrigerator) are in strata one, two, and three, where energy is subsidized. More than half of the fridges in these homes are over fifteen years old, made from materials that damage the ozone layer and are highly energy inefficient. An old, medium-sized refrigerator consumes on average around 90 kilowatt hours per month; in contrast, a new refrigerator of the same size could consume less than a third of this energy. The savings would be on the monthly bill of each home.

2 RESEARCH PROBLEM

Traditional fossil fuel energy systems present several critical problems for the planet, among the most relevant, are three. The pollution it generates, which is exhaustible, and the high price of use that is being transfer to the final consumer. Hoyos et al. [1] pose the need for integration of renewable clean energy with traditional systems of electricity production in

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search of lower prices for users and reduce the negative impact on the environ body. Collective awareness and education in the early years have generated widespread social concern about caring for the environment, states have enacted laws to the same, and mass consumer companies are in the trend of eco-labelling. Among the clean renewable energies is solar energy, National Aeronautics and Space Administration (NASA) [2] estimates that the sun is approximately half its life, and it has approximately five billion years of life remaining, hence it can be said that the solar energy is renewable. "It is calculated that between 2040 and 2050 solar energy begins an upward race, to the point of reaching sixty percent of the global matrix by the year 2100" [3, p. 68]. Therefore, the following research question arises.

2.1 Problem question

How is the financial behaviour of the consumption of household appliances, which are friendly to the environment in the city of Bogotá?

3 OVERALL OBJECTIVE

Establish the consumption habits of environmentally responsible household electrical products in the middle strata of the city of Bogotá.

4 SPECIFIC OBJECTIVES

1. Establish a timeline of regulations related to environmental protection.
2. Design and apply a statistical model between consumption and pollution, in "Departamento Nacional de Estadistica", in Spanish (DANE) databases in the last 5 years. Validating it by applying an instrument in fieldwork.
3. Analyse renewable alternative clean energy systems, which would be implemented in Bogotá to publicize the advantages (economic, ecological, and social) of investing in systems that protect and conserve the environment.

5 THEORETICAL FRAMEWORK

Investigating the history and use of energy, through a journey from the discovery and use of fire to other more recent advances in which a form of energy has always been used so that it can be carried out, is expressed according to Oviedo-Salazar et al. [4]. Who have currently tried to find other energy sources that can replace oil, that it is a non-renewable energy source and is not friendly with the ambient. On the other hand, in this article mention some types of energies. Since ancient times the Greeks and Romans used solar energy to operate different devices used daily. Likewise, Alexandre Edmond Becquerel discovered photovoltaic energy in the year of 1938, and it are used in countries that do not have networks of electricity transport, among others we also have wind energy that has been used since the beginning of humanity. Not least, the Biomass being obtained through direct combustion with materials from nature, of equal importance the geothermal energy that is used today to Generating energy for many daily tasks. Finally, the hydraulic and the sea, whose source is water and are widely used today, is stable and effective, helping to reduce the presence of CO_2 in the air.

González Arias [5] mentions that it is important to define the concept of energy since we can interpret it in different ways. One of them is when we refer to the fact that a person is very energetic. The other is that correspond to physical science in which an intuitive notion is attributed. We must not forget energy relates to magnitudes corresponding to length, time, volume, and hardness. On the other hand, we find the measurements; one of them is the indirect one that allows evaluating the magnitude from an analytical expression and not

directly through some instrument. According to the Iberoamerican Education magazine published by the author [5] indicates that some types of energy such as kinetics, gravitational potential, electrostatic potential, energy at rest in others, in which it has different analytical expressions and magnitudes for its measures. On the other hand, it is important to analyze that it does not make sense to speak of energy simply without being related to other terms such as the ones mentioned above. We have a double meaning of the term energy; it being used to both designate a specific type of it, be it kinetic or magnetic, among others. As well as being able to indicate the place where the different types of energy come from or are stored, such as the wind energy obtained from the wind or the use of the kinetic energy of the air mass such as solar energy that is renewable and is obtained from electromagnetic radiation from the sun.

6 METHODOLOGY

Based on the level of deepening: basic fundamental and descriptive. Based on data management, it will be exploratory-type quantitative. The analysis of the variables will be correlational. A cross-sectional investigation where the current moment elapses, with primary sources, of a qualitative type where the researcher will interpret the results as he says [6] and secondary sources of a qualitative type, an exploratory study, applied in its entirety in the countryside. After selecting the population of the universe, which becomes the subject of the investigation, the writing of the case helps to measure and characterize the consumption habits of environmentally friendly household appliances in Bogota households in strata 3 and 4.

For National Statistics Department (DANE-SDP) of its initials in Spanish [7] the total households in Bogotá (without the locality of Sumapaz) are 1,977,166. According to the Alcaldia Mayor de Bogotá [8], the localities that have the highest number of homes in strata 3 and 4 are Fontibón, Engativá, Barrios Unidos, Teusaquillo, half of Kennedy, and half of Rafael Uribe, for a total of 633,531 households. One of the goals of the research is to propose to households the possibility of starting alternative energy unit systems, for this. The population is reduced to Bogota households in strata 3 and 4 who live in house-type housing units, to the Secretaria Distital de Planeacion [9] 28.9% of families live at home, this reduces the population to 183,090 households.

7 MAIN DISCOVERIES

The excessive use of energy represents a negative and irreversible climate acceleration for the planet and the economy, as indicated Alagöz et al. [10]. Where they reveal that high economic growth in developing countries requires a certain level of energy, this leads to greater demands on the use of electricity, since living standards rise with the increase in GDP and GDP per capita, thus being one of the most important parameters. Causing an increase in the demand for electricity for industry, lighting and household appliances and raising the current deficit due to dependence on energy imports, which being heavily based on oil, natural gas, and coal.

8 STATE OF THE ART

It is important to make an idea and reflection, as is the case Emodi et al. [11] who express that the impact generated by climate change with the demand for electricity in Australia leads to analyze various factors. Such as global warming due to increased temperature, therefore, contributes to increased energy consumption, another concept is the use of heating since a country like Australia decreases and increases the cooling system. Various efforts has made to combat climate change and as a measure, the closure of companies that handle fossil fuels

by renewable energy and must take low-carbon technologies. In Victoria, Australia, there was a blackout, due to the prolonged and intense heat, therefore, there was a need to use the air conditioning and due to this, a discharge occurred in the circuit. Occasions like these would not happen if the use of coal to generate energy were avoids given that it makes the country the worst emitter of CO_2 per capita among developed countries. For Mirasgedis [12], they indicated that economic growth can have a strong effect due to the demand for heating and cooling, leading to an increase in installed capacity. Studies carried out in the USA found that, if it increases by 5c, it could cause economic damages of 35 billion dollars in the residential and commercial sectors, since in the countries of central and northern Europe they will experience decreasing temperatures due to global warming. Socioeconomic variables such as population are indicators that uses to estimate an increase or decrease in energy consumption over time.

On the other hand, according to Juroszek and Juroszek [13] the importance of heating in Poland can be highlighted, highlighting that this country has large quantities of lignite and bituminous coal deposits, being a cheap and easy resource to acquire, but do not take into account that the costs are high both in money and for the environment. This research is be done to answer different questions that lead them to conclude if a DE carbonization process is possible in Poland, by implementing cleaner and more environmentally friendly energy. To verify this hypothesis, the authors interviewed a group of people with specific questionnaires to obtain this information. With which concludes that coal is the mineral chosen as the best source of primary energy, this is because over the years it is been used as a tradition and culture that is not easy to change overnight. That is why it is determined that the use of coal will continue since there is not enough experience and infrastructure to migrating to other means of energy production: However, some people are willing to receive training in other alternative topics that will allow them to accelerate DE carbonization through technology.

The study carried out in Turkey aims to form a linear optimization model that reduces Turkey's current deficit to sustainable levels through energy generation with investments in solar panels, obtaining improvements in quality and decreasing system costs, reaching lower levels compared to other energy generation sources with the purpose of not only reducing current deficits but also decreasing energy dependency, contributing to economic growth, and reducing energy costs. For its part Ozdemir and Ozdemir [14] indicates the need we have worldwide to contribute to energy savings, taking into account that 40% of the world's annual energy consumption corresponds to its use in residential buildings and of this total value 94.4% is used for HVAC (heating, ventilation, and air conditioning) systems.

Based on the ideas presented, in this sense Emir and Bekun [15] expose how Romania is considered as the twelfth largest country in Europe, this country maintained a period of decline in 1989 where its economic growth was unfavorable; for the year 2000 the economy was recovering rapidly, in 2008 Romania ranked 39th in the world in energy consumption. Romania is one of the countries blessed with natural resources, such as oil, natural gas, carbon, uranium, renewable energy sources, hydroelectric power, and wind energy sources scattered throughout the country. Between 2000 and 2008, energy consumption has grown from 36,374 to 39,658 thousand tons of oil, which shows that the different energy sources are insufficient for the nation's total consumption. As part of the Kyoto protocol, Romania joined forces with the EU strategy to improve carbon emissions by uses of renewable energy resources. The Kyoto protocol emphasizes a reduction of carbon dioxide and even more positively a growth in the economy, where a significant relationship between economic growth and CO_2. Which implies that economic growth increases carbon emissions. Industrial

and economic production decrease a long-term equilibrium in which energy-driven economic growth happens.

9 MAIN RESULTS

9.1 Timeline of energy laws and regulations in Colombia 2013–2019

According to the objectives, Figs 1 and 2 show the laws and regulations in Colombia.

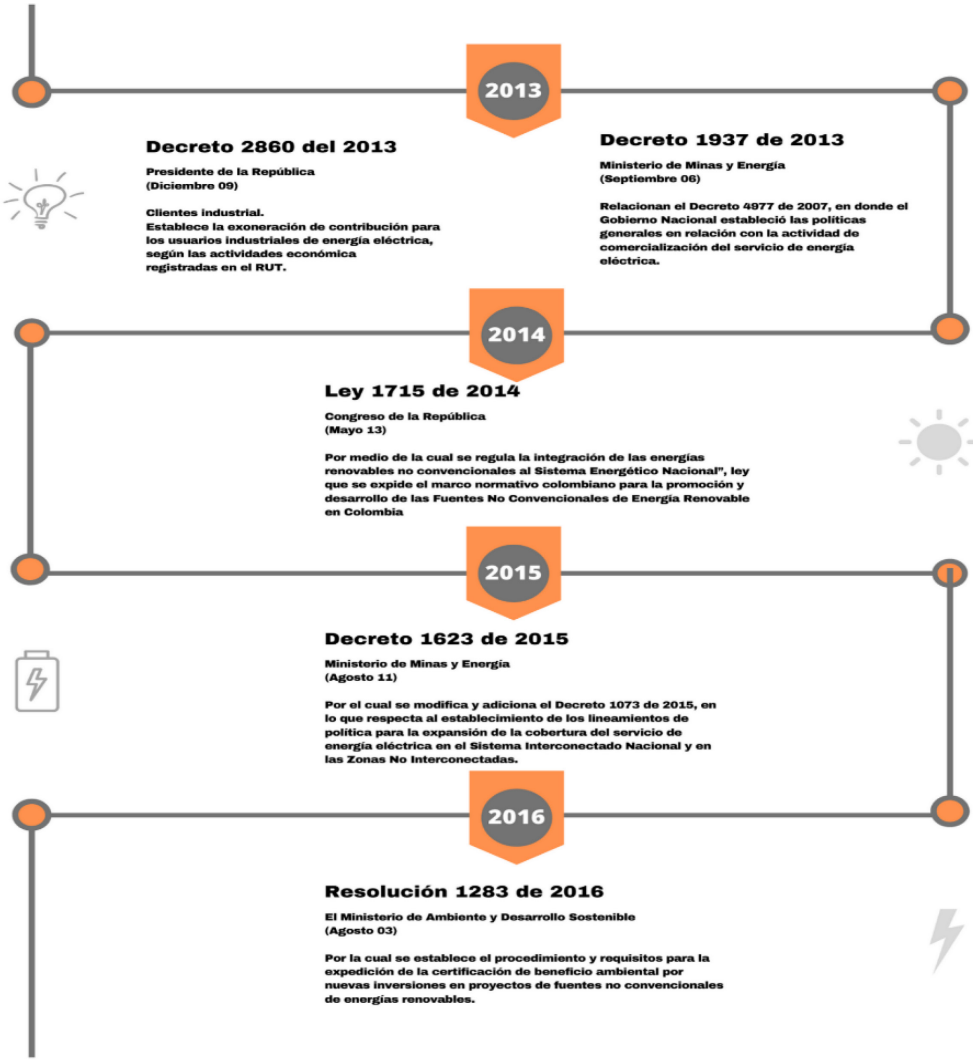

Figure 1: Timeline of the most relevant regulations and laws about energy in Colombia during the years 2013 to 2016.

Figure 2: Timeline of the most relevant regulations and laws about energy in Colombia during the years 2017 to 2019.

9.2 Design and apply a statistical model between consumption and pollution

This statistical work is done on a set of cross-sectional data in which a linear regression would be modeled to explain the dependent or endogenous variable, in this case the Opportunity cost in renewable energy systems according to the behavior of the explanatory variables such as spending on home appliances, mobile devices and computer equipment.

There will be cross-sectional data taken from groups of families where very short periods of time elapse in data collection. These data are collected under the random sampling system.

The model will consist of the following variables:

- COPSER (opportunity cost in renewable energy systems): Output variable or endogenous type.

- GELEC (expenditure on household appliances): Explanatory variable or exogenous type.
- GDM (expenditure on mobile devices): Explanatory variable or exogenous type.
- GEC (expenditure on computer equipment): Explanatory variable or exogenous type.

Given the number of variables that can explain the COPSER in this model, a Multiple Linear Regression will be applied, which is presented as a generalized population regression function FRP mentioned in Gujarati and Porter [16] where it is expressed in an example for three variables of as follows:

$$Y\_i = \beta\_1 + \beta\_2 X\_2i + \beta\_3 X\_3i + \mu\_i, \quad (1)$$

where Y is the dependent variable, X_2 and X_3 the explanatory (or regressive) variables, μ is the stochastic disturbance term, and i is the ith observation.

For the case of this work, it is necessary to work a model with 4 variables, in this way the model would be presented in a generalized way as:

$$Y\_i = \beta\_1 + \beta\_2 X\_2i + \beta\_3 X\_3i + \beta\_4 X\_4i + \mu\_i. \quad (2)$$

The linear regression procedure will require the ordinary least squares (OLS) method to estimate the parameters. Since the data will be obtained from a sample, the sample regression function (FRM) [16].

Opting for a multiple linear regression model has advantages that highlight the following:

It is more useful for a Ceteris Paribus analysis, allowing explicit control of the various factors that simultaneously affect the dependent variable.

Since multiple regression models can accommodate several explanatory variables that can correlated, causality can be inferred in cases where simple regression analysis could be misleading.

A greater part of the variation can be explained; therefore, the analysis provided by this model allows better prediction models of the dependent variable.

An additional benefit of your analysis is that you can incorporate general relationships functionally.

This characteristic of the multiple linear regression will allow this research work to determine the significance of each exogenous variable (GELEC, GDM and GEC) of this model and its explanatory capacity with respect to the endogenous variable (COPSER).

The second part aims to analyse how willing the average consumer is to acquire a renewable energy system given the conditions of its costs with respect to their investment in other types of devices and their energy expenditure. Take it into account that since it is an endogenous variable of a binomial type and of qualitative order. It is necessary to carry out a transformation of this variable by means of a logistic operator that leads to obtaining a probability that implies the inclusion of a 0 or 1 In this way, the conversion from qualitative to quantitative is achieved to achieve a linear regression model structure. In this part, the consumer's decision acquires a binary connotation in its measurement, making the model become three quantitative exogenous variables and one qualitative endogenous variable.

According to Wooldridge et al. [17], a case that often occurs in practice is to explain an event by means of a binary response, where the dependent variable takes only two values: zero or one, for this Y = 1 is specified for represent one of the answers and Y = 0 for the other.

Starting from a generalized model of multiple linear regression

$$Y = \beta\_0 + \beta\_1 X\_1 + \cdots \; [\![+ \beta]\!] \; \_k X\_k + \mu. \quad (3)$$

When Y can take only two values, β_j cannot be interpreted as the change in Y in response to a unit increase in X_j, keeping all other values fixed: Y changes from 0 to 1 and from 1 to 0. However, the β_j still have useful interpretations. If it is assumed that the null conditional mean assumption is fulfilled, E (μ | x_ (1,)…, x_k) = 0, so we obtain,

$$E (y | x) = \beta\_0 + \beta\_1 X\_1 + \cdots \; 〚+ \beta〛 \_k X\_k, \tag{4}$$

where x is a shorthand notation for all explanatory variables.

The key point is that when Y is a binary variable that takes values 0 and 1, it is always true that P (y = 1 | x) = E (y | x): the probability of "success" – that is, the probability that y = 1 – is the same as the expected value of y. Thus the following important equation is given:

$$P (y = 1 | x) = \beta\_0 + \beta\_1 X\_1 + \cdots \; 〚+ \beta〛 \_k X\_k, \tag{5}$$

which says that the probability of success, say p (x) = P (y = 1 | x), is a linear function of the X_j. Eqn (5) is an example of a binary response, and P (y = 1 | x) is also called the "response probability". Since the sum of the probabilities of being unity, P (y = 0 | x) = 1 – P (y = 1 | x) is also a linear function of the X_j.

Already in a third part, a procedure be carried out that allows predicting the probability of foster care or use of a renewable energy system in homes, based on a classification of output variables. In this phase, we are starting from a linear model to make the prediction with a variable converted by the logistic operator known as "Logit", applying the inverse of the function obtained to calculate the probability. These method knowns as the logistic regression model.

In this third part, the nature of the qualitative response models follows since the regressed one is a binary or dichotomous variable.

Gujarati and Porter [16] expresses the "Logit" model or logistics distribution function in the form:

$$P\_i = 1 / (1 + e \wedge (\; 〚–Z〛 \_i)), \tag{6}$$

which can also presented as:

$$P\_i = e \wedge Z / (1 + e \wedge Z), \tag{7}$$

where

$$Z\_i = \beta\_1 + \beta\_2 X\_i. \tag{8}$$

As Z_i is within a range of –∞ to +∞, P_i is within a range of 0 to 1 and P_i is not linearly related to Z_i. Satisfying these requirements creates an estimation problem since P_i is non-linear not only in X but also in the β, which means that the parameters cannot be estimated with the usual OLS procedure. The way, therefore, to solve the problem is to linearize the function.

If the probability of hosting a renewable energy system is P_i, then 〚(1 – P〛 _i), is the probability of not doing so.

$$1 – P\_i = 1 / (1 + e \wedge (\; 〚–Z〛 \_i)). \tag{9}$$

Therefore, you can write:

$$P\_i / ((1 – P\_i)) = (1 + e \wedge (Z\_i)) / (1 + e \wedge (\; 〚–Z〛 \_i)) = e \wedge (\; 〚–Z〛 \_i). \tag{10}$$

P_i / ((1 – P_i)) is a probability ratio where if the natural logarithm of eqn (10) is finally taken,

$$L\_i = \ln[f_0](P\_i / (1 - P\_i)) = Z\_i. \quad (11)$$

Thus, the natural logarithm L_i of the probability ratio obtained, which is not only linear in L_i but also in the parameters. L is called "Logit" where it is finally presented as follows:

$$L\_i = \ln[f_0](P\_i / (1 - P\_i)) = \beta\_1 + \beta\_2 X\_i. \quad (12)$$

The characteristics of the Logit model allow us to consider the following:

- As P goes from 0 to 1 the Logit goes from $-\infty$ to $+\infty$
- Although L is linear in X, the probabilities themselves are not.
- In the illustration of the model, two X regressors have been used; you can have as many of them as the underlying model contains them.
- If L is positive, it indicates that as the value of the regressors increases, the chances that the regressed is 1 increase. This situation removes this possibility from 1 if L were to become negative.

9.3 Analyse renewable alternative clean energy systems

Figs 3–5 represent the interest of community to reduce the levels of energy rates.

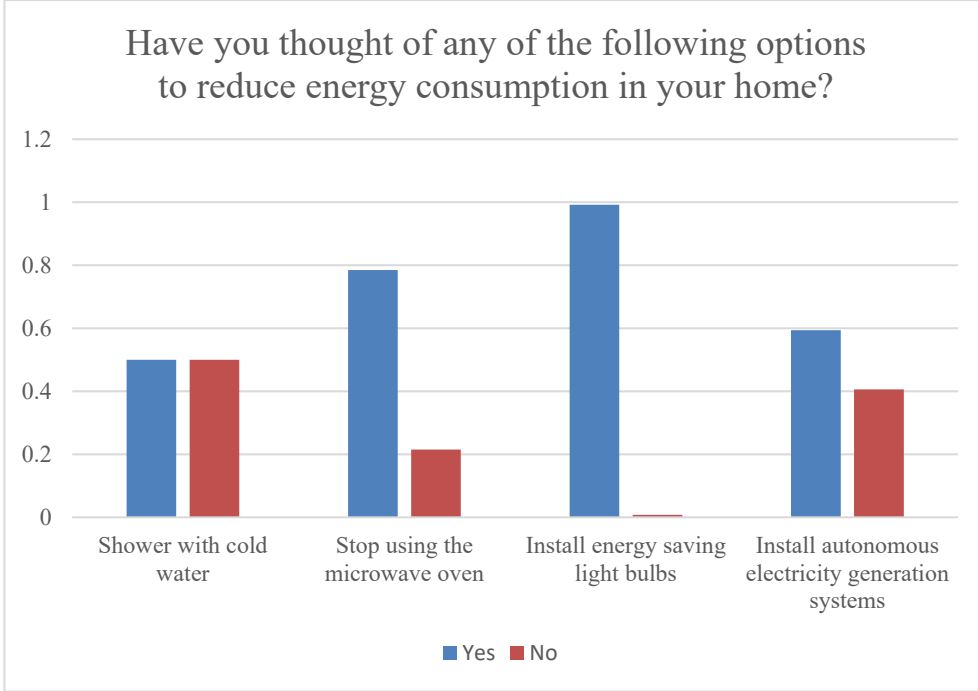

Figure 3: Self-energy saving at home.

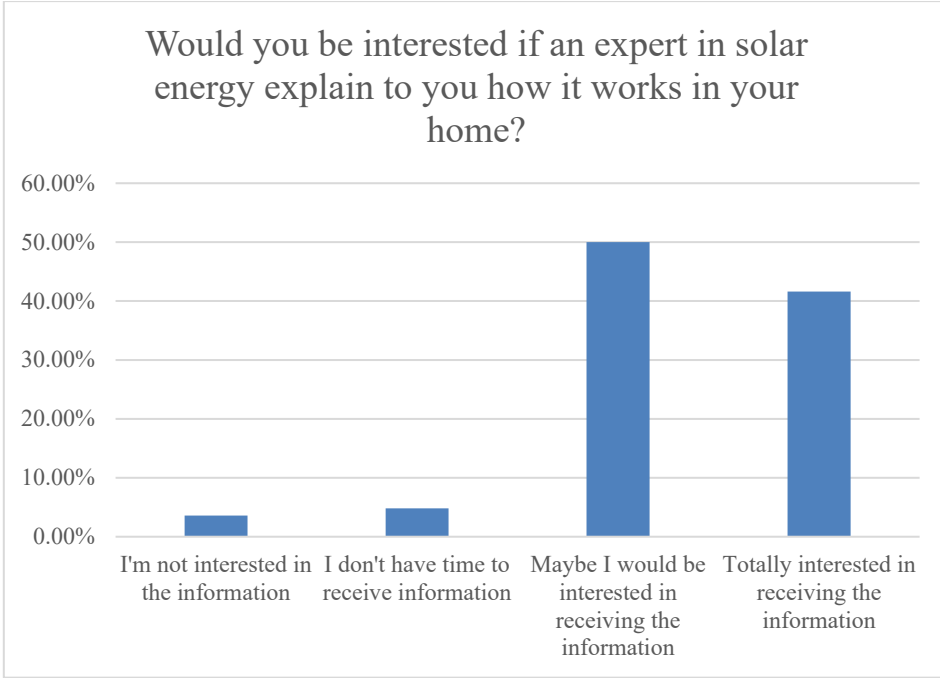

Figure 4: Interested to know how work solar energy.

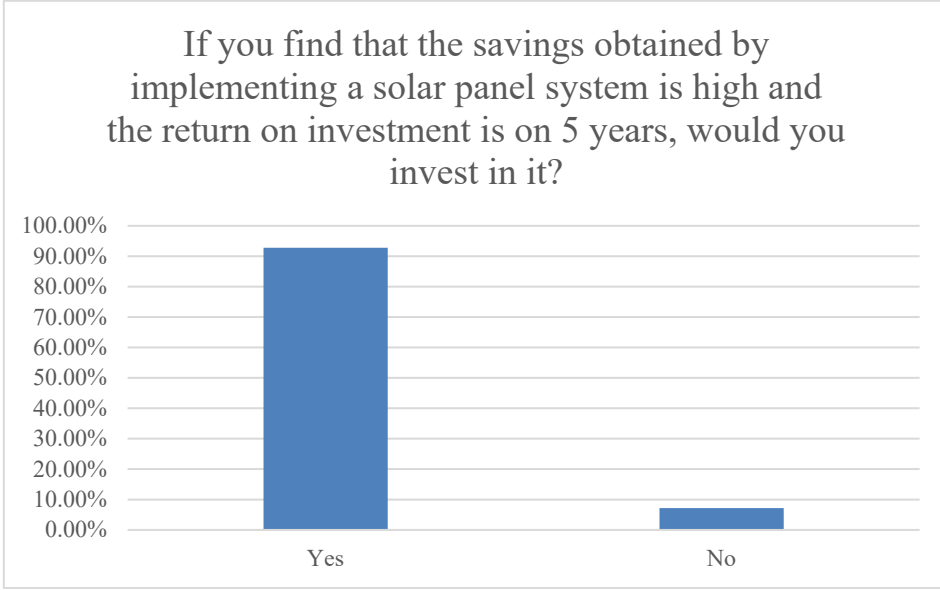

Figure 5: Possibility of installing solar panels in the houses.

10 CONCLUSIONS AND DISCUSSIONS

To the question: Have you considered modernizing your appliances to help protect the environment? It observed that the majority of the surveyed people are interested in generating a positive change for the environment, with the modernization of their household appliances, being 73.9% of the respondents, which is a considered a favorable percentage versus the 26.1% that indicate they are not interested in changing their appliances.

Measure the interest in energy saving and help the environment within the group of respondents, where relativity is shown when saving energy, since according to Fig. 6, most people disconnect their cell phone chargers when they do not use them and equally way they usually turn off the light. However, regarding the use of the television there is a significant number of people who sometimes leave the television on just to have noise, corresponding to 34% of the respondents. Therefore, it is concluded in the need to educate people in a more adequate use of their household appliances, favoring energy saving and care for the environment.

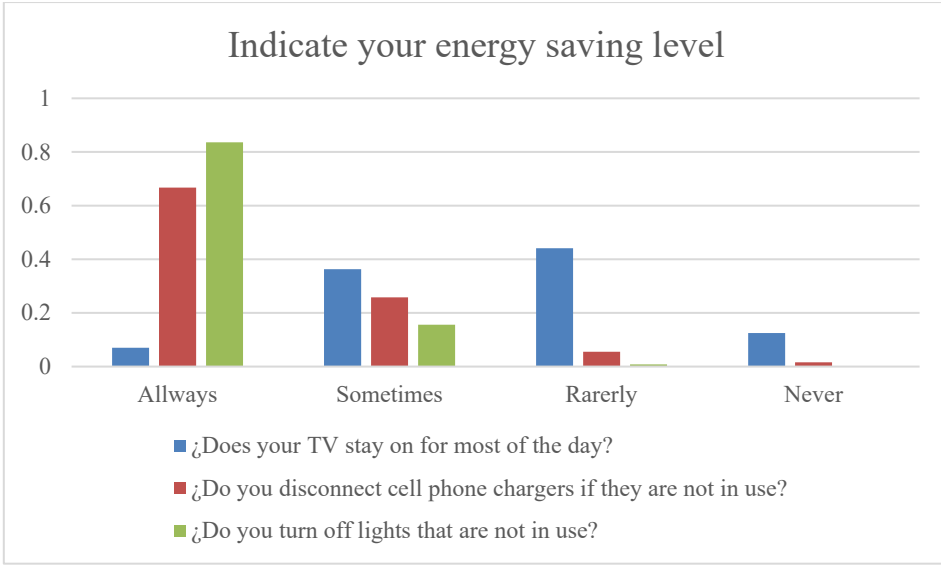

Figure 6: Energy saving at home.

The need to generate electric energy and raise awareness in society of its use is a descriptive investigation that allows a review of the most important characteristics or features of the situation or object of study. The face-to-face survey will be the measurement instrument with which the information is collected.

This type of measurement makes it possible to carry out a clear and achievable approach to identify the type of population that the survey is aimed at as well as the limitations, thoughts, tastes and whether they agree or disagree according to the objective of the survey. According to the proposed research project, it is possible to carry out a social comparison against the consumerism of electronic elements that households currently have, according to the results generated in the survey, it is possible to generate viable alternatives that contribute to caring for the environment through of electrical energy.

To carry out this dynamic, a form applies with 10 closed questions that will allow obtaining the necessary information from a population of stratum three and four in the city of Bogotá. To achieve the measurement and objectives of the research project, the information has tabulated to demonstrate the perspectives of the respondents regarding the topic of alternative clean energy research.

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