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Feasibility Analysis of the Import of Photovoltaic Solar Panels to Cuenca

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Dedication

This thesis is dedicated to my father, Anibal Ricardo Jácome Avilés, a fundamental pillar for the construction of my professional life in this long journey, since he instilled in me such important values as responsibility and the desire to overcome difficulties at any time. I feel a deep admiration for him and his virtues, achievements and passion to do things, which make him my guide, always keeping in mind that, from an early age, he pushed me to be a successful man. Similarly, I want to dedicate the thesis to my mother, Maria Augusta Quito Moscoso. Her love, affection and support throughout my personal and professional training have been essential. Without a doubt, she is the engine that drives me to go ahead and overcome adversity. Finally, I want to thank my grandparents and family in general for their love and teachings that will be etched in my memory forever.

Ricardo Esteban Jácome Quito

Dedication

In a very special way and with great affection, I want to dedicate this thesis to my parents, Inés Lucia Espinoza Carrera and Fernando Narciso Ordoñez Molina who, apart from giving me life, have taught me values that shaped me as a person. I want to thank them for all the love, support and advice that have helped me face all kinds of difficulties and that will accompany me throughout my life. I want to thank my grandparents for representing kindness and unconditional affection, showing me the importance of family union and also for showing me that they will always support us.

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Ricardo Esteban Jácome Quito

Ricardo Javier Ordóñez Espinoza

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Abstract

The energetic matrix transformation proposed by the government and the increase on the number of households in Cuenca, motivate the exploration in a market that has not been fully exploited. The import of photovoltaic solar panels can offer an alternative to provide nationwide electricity and sell the surplus to other countries in order to achieve an energetic independence.

Introduction

The purpose of the project is to focus on complementing the energy matrix transformation (proposed by the Ecuadorian government) through investment and construction of hydroelectric plants. In this way, the objectives are: to generate income for the country through energy sell to other countries; to contribute to the environmental care (an important topic worldwide) and to boost the technological development. This is directly linked to foreign trade, an important field of the career.

The Ecuadorian government has stablished as a goal, the energetic and productive matrix transformation in a complementary way, as mentioned in the 2008 current constitution. The Ecuadorian constitution establishes that those changes should be made respecting the environment through renewable and clean energetic production in order to reduce the dependence on fossil fuels.

Furthermore, the current government pretends to use the energy surplus (generated by the hydroelectric plants built in the government years) to sell it to Colombia and Peru. On the other hand, the government has boosted projects that increase the level of electricity consumption (implementation of induction cookers and electric cars) and as a result, the amount of energy surplus for sell could be reduced. In this way, the important thing is to find out the feasibility of the photovoltaic solar panels import to Cuenca, in order to reduce the energetic consumption in households.

Chapter 1: Definition of the guidelines, requirements and conditions for the solar panels import.

1.1 Renewable Energy - History and Growth

"Renewable or alternative energies are the ones that when employed, do not significantly alter the environment, are cyclically recoverable in relatively short periods of time, and unlike the so-called conventional energy, do not originate in the natural resources mining (which are finite and non-renewable)."(Garcia, 2002) The progression of energy needs has been a factor that increased throughout history, due to the constant desire of many people to progress and innovate at all times. Since the beginning of the Industrial Revolution, energy emerges as a key factor in the daily activities of human beings. Similarly, man begins to use energy sources classified as flexible in the sense that they are not constrained by geographical conditions or natural phenomena. Fossil fuels are required to produce energy, leaving aside water and wind mills (limited use) in an era where energy transportation is presented as something unknown, complex and therefore expensive. (Garcia, 2002)

During 1970, the drilling of petroleum covered 40% of energy demand in the industrialized countries, a factor to consider due to the oil crisis that occurred during those years when fossil fuels stopped being economical. This cost increase encouraged governments to consider new ways to augment supply for the population, with an intensive search for cost-effective energy sources and alternative energy which at that time were considered unproductive. Nevertheless, these options had to be taken into consideration as a possibility to recover from the

fuel crisis and steer the economy back to recovery. The rejection coming from society towards those technologies that polluted the environment, caused a positive effect and awareness on the consequences that the bad practices of industries that did not take the necessary measures to reduce the environmental impact, could cause in the future. (Garcia, 2002)

In this sense, the idea of the implementation of renewable energy comes to light as the most appealing alternative in the efforts coming from countries in order to stop the crisis, also driven by the growth of the population worldwide (constantly increasing the energy demand). In addition, it is public that oil reserves will eventually be depleted, so governments of that time started to lay the groundwork for big changes in the future with the inclusion of different types of renewable energy.

1.1.1 Solar energy

"The sun is a giant incandescent sphere, located at 150 million kilometers from Earth, with a mass 334,000 times bigger than our planet, that emits energy for approximately 5,000 million years, which manifests before us basically in the form of light and heat" (Garcia, 2002). In this context, it should be noted that Solar energy is radiated directly and it is not absorbed or transformed significantly, providing the inhabitants of Earth light and heat and received in the form of electromagnetic waves. Only half of the solar energy that impinges on the atmosphere reaches the surface of the planet since upper layers remove much of the ultraviolet radiation and a part of it is reflected into space while water vapor and other atmospheric components absorbs another. If radiation came directly, it would definitely affect human life in large proportions as it

is happening today where these layers are wearing down each time and radiation increases. (Garcia, 2002)

"Solar energy is the origin of almost all sources of currently available energy, with the exception perhaps of nuclear and geothermal forms. Fossil fuels are solar energy stored as chemical energy (hydro, wind or biomass are also types of solar energy)." (Garcia, 2002) Therefore, it is clear that solar energy is vital mainly because it is going to be present at all times, unlike fossil fuels that at some point will run out and also it does not damage the environment (which is consistent to the trends of recent years in favor of environmental protection). There is a considerable growth on the demand of products whose manufacturing causes less impact to the environment than those that deteriorate it every day.

1.1.2 Photovoltaic Systems

A photovoltaic system is defined as a generating source of electrical power, where cells that are sensitive to sunlight transform solar energy into an electrical current and a continual electric flow that can be assembled anywhere. It is important to realize that these systems do not require any fuel to operate and its maintenance is minimum as they are solid state devices without moving parts. Similarly, they do not produce any noise or toxic emissions that threaten the environment so their use has increased. (Garcia, 2002)

According to the experience on photovoltaic rural electrification, the results show that the performance of PV systems is not always satisfactory; however, study in existing facilities

clearly demonstrates that the solar component (photovoltaic panel) will rarely fail. (Garcia, 2002) This is a favorable argument that increases the confidence of people in solar panels and encourages their use and acceptance.

1.1.3 Main benefits

- Photovoltaic systems have a high degree of reliability due to the absence of moving parts (simplicity in design) that reduces operating costs and maintenance. The modules that integrate the systems are sealed in a solid state, which can be operated in a wide variety of environmental conditions and easy to transport and install. (Garcia, 2002)

- The solar modules or photovoltaic panels can be used for large periods as its operation ensures that there will not be a significant loss in conversion efficiency, enabling a high energy availability for an uninterrupted power supply. (Garcia, 2002) This helps to ensure that long-term solar panels can become more profitable as opposed to paying a monthly amount of money for electricity consumption.

- As they receive solar energy (amounts vary depending on location), photovoltaic systems do not depend on fuel supplies, so in those isolated areas in Cuenca with fuel access difficulties, people can be reassured that the system will work without any problem, eliminating associated fuel costs and availability. (Garcia, 2002) While statistics from the Regulation Agency and Electricity Control (which will be presented later) indicate that in 2016 the areas covered by electricity have increased, there are still

isolated areas that do not have this service, so solar energy is a very advantageous solution.

- As it is a modular system, its generating capacity can gradually expand with demand without affecting the system. (Garcia, 2002)

- The use of photovoltaic systems removes the vulnerability that electricity grids usually have, simplifying the selection of places for the equipment installation (they can be located in the spaces that demand them). (Garcia, 2002)

1.1.4 Individual Photovoltaic System

Individual systems have a common scheme, comprised of:

- **Photovoltaic generator:** composed of one or more interconnected photovoltaic modules to form a unit that generates continuous current (CC).

- **Accumulator:** stores energy produced by the generator and provides electric current in hours without light or in cloudy days. It is the element that requires a higher maintenance because it ensures efficiency and durability.

- **Battery:** composed of several vessels (two nominal volts). Its grille material is a lead alloy that makes it resistant to climate change and external factors.

- **Charge Regulator:** to prevent excessive shock or a battery overloading and its simplicity makes it easy to maintain.

- **Loads:** lamps, radio, television, computers.

- **Wiring:** cables, switches, connecting boxes

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- **Inverter:** Continuous/Alternative Current/ (AC/DC), which converts 12 or 24 volts stored in the battery into 230 volts AC Current (García, 2002) (Arisa)

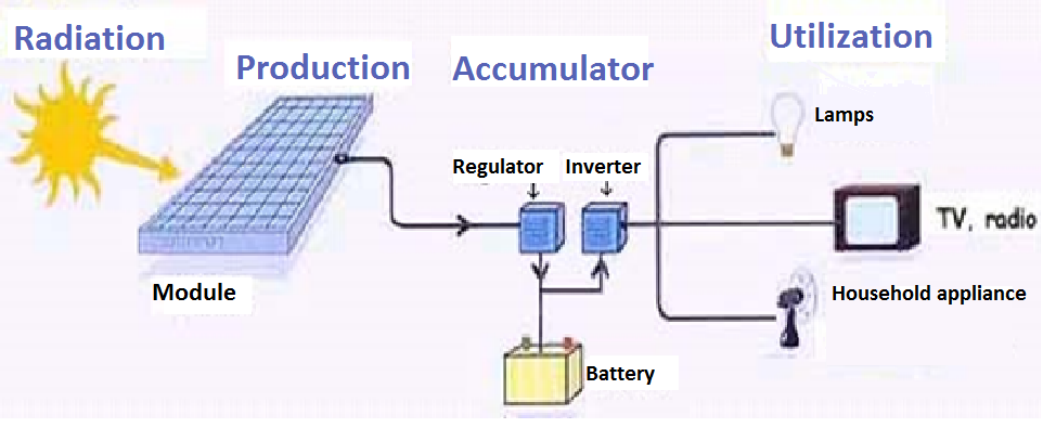

Illustration 1:Photovoltaic system operation

Source: (Arisa, 2015)

1.1.5 Photovoltaic Solar energy

"The sun produces an enormous amount of energy: approximately 1.1 by 1020 kilowatts/hour every second (1 kilowatt/hour is the energy required to light a 100-watt light bulb for 10 hours.)" The outside atmosphere intercepts approximately half of a billionth part of the energy generated by the Sun, or approximately 1.5 trillion (1.500.000.000.000.000.000) kilowatt/hours a year. However, due to reflection, scattering and absorption caused by the atmosphere gases, only 47% of this energy, or approximately 0.7 trillion (700.000.000.000.000.000) kilowatt/hours reaches the surface of Earth." (Arisa)

In order to implement solar energy in an active and beneficial way for humanity, there are two technical achievements: thermal and photovoltaic conversion. For this thesis purposes, photovoltaic or direct conversion of solar energy into electrical energy, is going to be explained in depth. Such a transformation is done through solar cells, which act as semiconductors which generate electricity. (García, 2002)

"The basis of photovoltaic solar energy is the photoelectric or photovoltaic effect, which consists on the light conversion into electricity. This process is achieved through some materials with the property of absorbing photons and emitting electrons. When these free electrons are captured, an electric current that can be used as electricity is the final result "(AMT Solar, 2012).

In 1839, the French physicist Edmundo Bequerel was the first person to observe the photoelectric effect in a real way. However, it was in 1954 when the first photovoltaic module

was developed at Bell Laboratories and it was treated like a scientific experiment since its cost was too high to be used on a larger scale. In subsequent years, factors such as globalization and the internationalization of enterprises have led to lower the production costs of these modules, allowing a large-scale use in benefit of the population worldwide.

1.1.6 Solar panels

"For the photovoltaic cells, a semiconductor grid receives a special chemical treatment to form an electric field, one side positive and the other negative." When solar light affects the cell, the electrons are displaced from the semiconductor material. If electricity conductors are placed on both positive and negative sides of the grid, an electric circuit is created and the electrons can then be captured in form of electricity. This electricity can be used to supply power, for example, to light a bulb. The combination of several electrically connected cells that are mounted on a structure that supports the frame, is called a photovoltaic module. Several modules can be connected one with another to form a solar grid field. "The modules produce electricity in continuous current; these can be connected in series or parallel to get the voltage that is required." (AMT Solar, 2012)

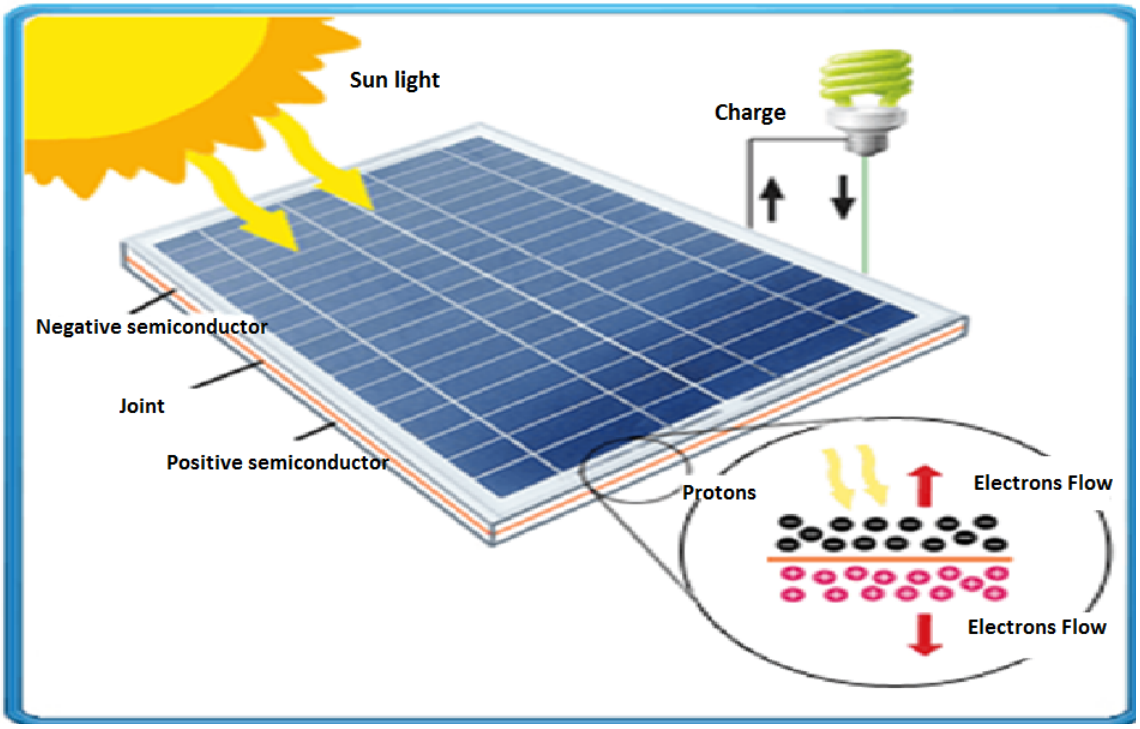

Illustration 2: Solar panel operation

Source: (Damia Solar, s.f.)

A **solar cell** is a small plate made out of crystalline silicon that turns the light emitted from the sun into electricity due to its composition. That is why a solar panel is a large plate where there are many solar cells together. If a solar cell converts solar energy into electricity, a solar panel becomes much more powerful than a single solar cell. Cells are connected to each other in series. (Technological Area)

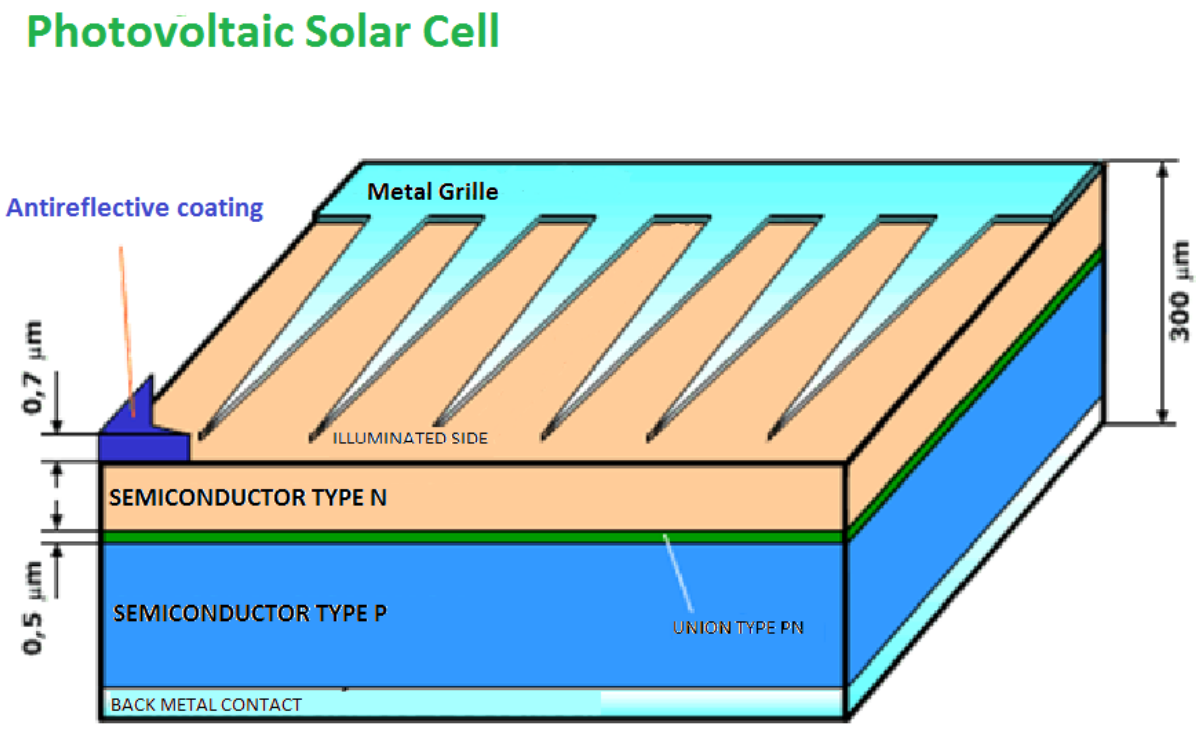

Illustration 3: Photovoltaic Solar Cell

Source: (Universidad de Jaén, s.f.)

Apart from the benefits and advantages of the photovoltaic systems, the main advantage of using a solar panel lies in the fact that it produces clean, renewable energy, without the need of using fossil resources or nuclear energy. As it can be seen in Ecuador, there have been major problems as a result of oil drilling, causing serious damage to population and environment through the release of toxic gases to the atmosphere. In the same way, photovoltaic systems help save energy through the installation of a renewable system that allows cost optimizations and moving away from depending on companies that supply energy. (Technology Area)

Among the disadvantages that have been found, it can be mentioned that even though its energy is clean and renewable, its manufacturing still depends on non-clean energy, since silicon or gallium arsenide have to be extracted and then processed to be placed on the panel. Another disadvantage is that the panel relies on climate, so if it is installed in a place that does not receive much sunlight, it will not be so efficient. Its cost or size can become an obstacle; however, in places that lack a basic electrical infrastructure, the panel will be much more profitable to contribute with the environment in the long term. Locally, in those rural parishes with energy supply problems, solar panels are a great alternative to be taken into account.

Today, solar panels are mainly used on the roof of households in order to supply power to appliances, electronic devices, lighting, heating the water and all other functions that allow the supply of electricity. "Solar panels are also used for satellites. This is known as space-based solar energy. Satellites carry aboard solar panels that absorb the sunlight and generate electricity that can be used for the operation of the same satellite or also to transmit that energy to Earth. A solar powered satellite station can send the collected energy from the Sun to the Earth in the form of microwaves or lasers to areas where there is, for example, a shortage of energy." (Technological Area)

Panels are protected on the outside with tempered glass which makes it resistant to different weather conditions, adding a simple installation, maintenance and taking into account that the panel does not include any moving parts. Cells and contacts are encapsulated in a strong synthetic resin, accomplishing good reliability and a long-life span of 25 years or more. In the same sense, if a cell fails, it does not affect the operation of the other cells, and the intensity or voltage can be easily adjusted by increasing or suppressing cells. (Arisa)

The watt peak (Wp) is the power unit of the photovoltaic solar panel that represents the panel maximum electrical power. It is used as a suffix of unit in the international system and focuses on cells or solar cells that form the panels, where the conditions of the electricity production depend on external factors. The Watt Peak (Wp) is a value obtained under ideal conditions of DC power that is measured when the panels are radiated by sunlight, creating a 1000 W power under standard temperature conditions (25 degrees Celsius). (Sebastian)

Currently, PV systems are used in low-power products (1 WP) such as calculators, watches, cell applications in satellites and even in space missions (15Wp - 20KWp,) including the provision of energy for households, commercial establishments, isolated communities, lighting, battery chargers, emergency telephones on roads, etc. (Garcia, 2002)

1.1.7 Importance Today

Since the beginning, man has been characterized by using all the tools offered by nature in order to have greater benefits and to survive. Water, sun, wind, fire, among others, have been the means that man has conducted in favor of crops and to take care of animals. Throughout time, the same methods have been used with the inclusion of fossil fuels, not only to subsist, but as an important income for countries worldwide. Nevertheless, fossil fuels are mainly responsible for carbon dioxide emissions that contribute to increase the greenhouse effect and threaten the stability of the planet climate, so governments worldwide must change the repetitive past model, where the resources were exploited regardless of the environmental impact and the consequent damage to nature and future generations.

On the other hand, energy consumption continues to grow on a large scale, driven by the development and growth of several emerging nations and the increase of the world population, which will reach 9,100 million by 2050. For obvious reasons, this implies higher energy consumption as explained in the chart below, where "Mtoe" is a unit of energy that represents the millions tons equivalent of oil:

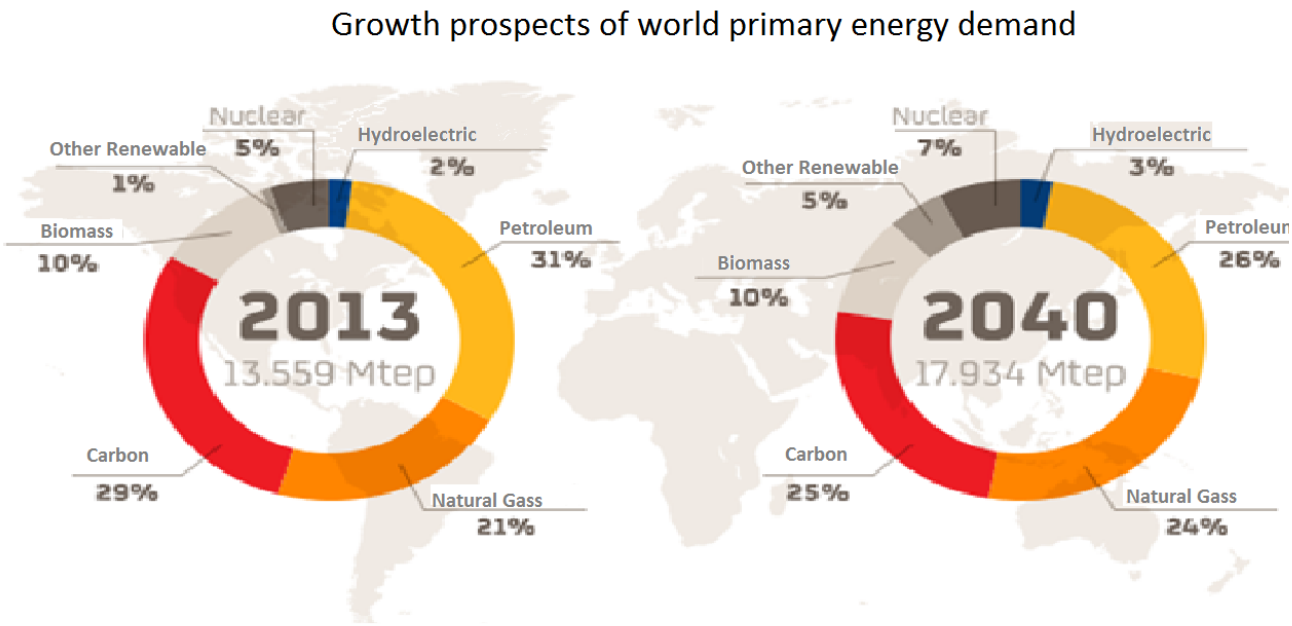

Illustration 4: Growth prospects of world primary energy demand

Source: (International Energy Agency and D. Secretariat technical of Repsol, 2013)

In the preceding graphic it can be seen that the highest concentration around the world in 2013 was located in oil, coal and natural gas, percentages that according to forecasts, by 2040 will not vary too much. On the other hand, renewable energies have a 3% growth from one year to another, so it is clear that fossil fuels will continue to dominate worldwide. However, these

resources are going to run out at some point, so there is a drive to maximize the renewable energy use.

It is important to mention that in recent years, population worldwide has increased (6000 million people currently) according to the United Nations reports, with projections up to 8,500 million by 2025 and 9,100 million by 2050. Consequently, energy consumption will continue to increase in the next years, but it must be taken into account that the two figures are not increasing at the same level. As it can be seen in the following graphic, the tons consumption of primary energies in 2013 surpassed the world population and is similar to per capita consumption.

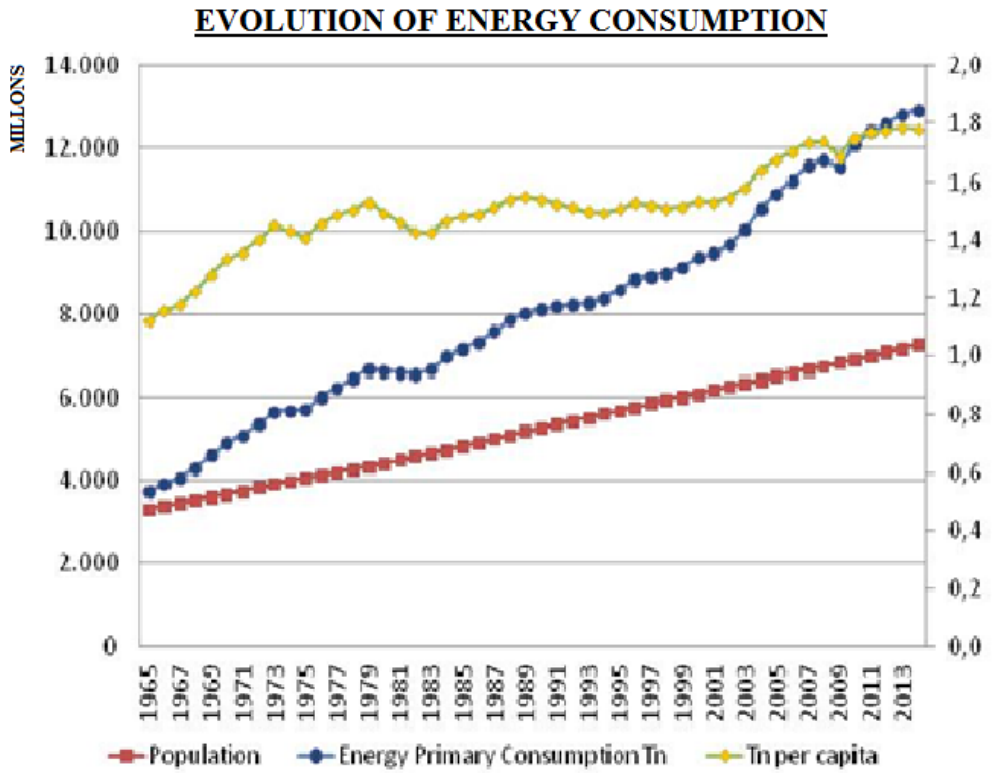

Illustration 5: Evolution of Energy Consumption

Source: (Energy BP, s.f.)

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Undoubtedly, this is a matter of concern for the environment because as it can be seen in the previous graphics, the most recurring energy sources are and will continue to be for some years, those that mostly affect the planet. In this sense, renewable energies are becoming a vital matter of discussion among governments mainly because “in order to satisfy the greed of energy worldwide, an additional 550 Million-ton Equivalent of Petroleum have to be produced each year

considering the increase in energy consumption and also old facilities replacements. Meeting the urgent need, curbing the amount of emissions to an acceptable maximum means that 75% of these new 550 Mtoe per year must come from non-polluting energy sources, or in absolute terms, 400 Mtoe non-polluting energy per year".

According to the studies that have been carried out, the following amounts have to be considered: 100 Mtoe energy per biomass, 15 Mtoe energy by hydroelectricity, 2 Mtoe geothermal energy and 50 Mtoe solar and wind energy to have a total of 167 Mtoe additional renewable energy per year, which represents the 40% that would have to be produced by renewable energy means to avoid the environmental collapse (Hipernova). It is clear that the mere fact of seeking to use renewable energy will not be enough to stop the overheating produced in the environment and that has become increasingly evident over time. That being said, a government impulse is necessary in different countries in order to raise awareness and reduce energy consumption for a common benefit.

According to a report published by the European Commission in 2011, world production of photovoltaic energy has reached a volume of 23.5 gigawatts (GW), 500 times higher than the production by 1990. The report mentions that Photovoltaic energy is one of the industries that has grown during the most recent years, where the European Union was the leader in photovoltaic installations until 2010. Today, the scene has dramatically changed, as China has become the main solar cells and modules manufacturer, followed by Taiwan, Germany and Japan. First Solar (US, Germany, Malaysia, Vietnam), Q-Cells (Germany and Malaysia), REC (Norway and Singapore) and Solar World (Germany and USA) are among the largest manufacturers in the world. (Greener Life, 2011)

"The report also shows that solar module prices have experienced a dramatic reduction of nearly 50 percent in the last three years. Analysts predict that investments in photovoltaic technology could double from 35-40 million euros in 2010 to more than 70 million in 2015, while they expect consumer prices will continue to decline"(Green Living, 2011). In addition, the constant claims coming from society and non-governmental organizations looking forward to take care of the planet, make the future scenario for photovoltaic energy very favorable, consequently with a demand increase for solar panels that solve several problems throughout its use.

1.2 State boost

Ecuadorian President Rafael Correa said Ecuador will have the "most efficient and friendliest energy matrix in the world", as 95% of the energy will be produced from water thanks to the different mega projects built by the administration (Andes, 2016). Due to the impulse in the energy field given by the current government as part of the productive matrix development, the government is seeking to export the energy surplus so that Ecuador can have higher incomes rather than depending on oil, which has been the basis of the national economy for many years.

Throughout history, Ecuador has been characterized as a primary producing and exporting country, where oil, banana, cacao, flowers and other products without added value have allowed the country to subsist. However, the rise of emerging economies such as China, the signing of multiple free trade agreements and liberalization of trade, the internationalization of enterprises and other factors, force the country to be more competitive in order to integrate the world order.

That is why, the government developed the Good Living National Plan (2013-2017), which defines it as "the way of living that allows happiness and permanence of cultural and environmental diversity; harmony, equality, equity and solidarity. It is not looking for opulence or infinite economic growth". Within the National Plan objectives, there is a drive for the transformation of the productive matrix and strategic sectors (that include the energy matrix) where society seeks to be in harmony with nature, recognizing and promoting its rights and guaranteeing a healthy and sustainable environment. All of the above is established in the Constitution of Ecuador (the first to recognize the rights of nature) including the human activities approach within the biophysical limits of ecosystems and a great responsibility towards future generations. (National Plan of Good Living, 2013)

Similarly, the National Plan within its fifth chapter explains about environmental sustainability and mentions that, although the main source of wealth depends on petroleum drilling, it is a challenge to develop non-polluting industries which respect the rights of nature and the right of the inhabitants to live in a healthy environment. In this sense, solar panels comply with these specifications and appear as a great alternative to be driven as part of the strategic sectors during the transformation of the productive grid.

In addition, "the transformation of the productive matrix must settle in the impulse to the strategic fields, in the redefinition of the offer to export goods and services oriented towards the productive diversification based on adding value to them, in the exports impulse and its expansion in products and destinations, in its replacement of imports, in the inclusion of actors, in the production deconcentration in order to improve competitiveness in the different economic fields" (Good Living National Plan, 2013). It can be seen that the Government is seeking a

radical change in the way the country has been managed throughout history, not only by conviction, but also by present and future needs.

1.2.1 Energy: Central Axis of the Productive System

"Energy is the blood flow of the productive system and that is why it is important to increase the representativeness of the energy obtained from renewable sources, strengthen the non-renewable national energy stock and establish a proper management of energy demand, in order to achieve sustainability in time and minimize the energy supply risk for the systemic productivity." Following this line, the Government has invested a lot of money in the construction of the hydroelectric power plants to supply the growing demand for energy and also to export the surplus in order to create a new income for the country. If the use of solar panels is implemented, starting in Cuenca and gradually expanding to the rest of Ecuador, the country is going to have a greater surplus that can be sold to neighboring countries, providing a great economic respite.

As pointed out previously, the energy demand around the world is constantly growing at a higher rate, outpacing the growth of the population worldwide. Ecuador is no exception since, according to the data submitted under the National Plan, between 1990 and 2011, per capita energy demand incremented to a 2% annual average rate, while the population registered a 1.94% annual growth. Making a reference trend, for the 2013-2030 period has been projected a 2.1% annual average increase in energy demand; slightly lower than the 1990-2011 period, which is explained by a lower rate of population growth (1.3%). (Good Living National Plan, 2013)

In order to achieve both economic and environmental sustainability, the new worldwide trend is based on the use of renewable energy sources to generate electricity and supply a demand that grows on a large scale. That is why Ecuador, in the past six years, has tried to cover the energy demand with renewable energy, mainly on hydroelectric dams and trying to reduce the use of petroleum and natural gas resources.

Ecuador's projections by 2030 are based on taking the necessary measures to "deepen equity in access and affordability of energy products and services, as well as in saving, efficient use of consumer energy and in the progressive substitution considering criteria of economic efficiency and environmental sustainability, with emphasis on freight transportation and electrification in the industrial and residential sectors."(Good Living National Plan, 2013). In addition, the concern coming from the government is evident not only because of the great drop in oil prices in recent years, but also because of the decline in production fields, including the risk of a future oil shortage linked to the consequent search for alternative energy resources.

"By 2030, the electricity supply will be complemented by the implementation of small power generation projects with renewable sources - such as photovoltaic, wind, biomass and hydroelectricity - in areas close to consumers and participatory management schemes of the Decentralized Autonomous Governments, community organizations and the private sector. These projects make renewable energies available for productive uses and the interconnected system, which creates local employment, optimizes the use of natural resources, diversifies the territories in the generation of electricity and reduces technical losses during the transmission of electricity" (Good Living National Plan, 2013). Besides giving a boost to the implementation of

renewable energies, the government seeks to include the different social sectors to be part of the change and adjust to the environmental reality that the world faces, where it is necessary to be aware of the consequences and at the same time benefit the economy and general welfare of Ecuador. Population is essential to successful planning and change must be started by each of the inhabitants, trying to contribute to the environment.

All of the extraction activities carried out in Ecuador throughout history have caused serious environmental damage that led to air pollution, extinction of several species of animals and plants, destruction of habitats and many other negative factors which are contrary to both the Constitution, that ensures the rights of citizens to live in a healthy environment, and the National Plan which focuses primarily on "the production transformation under an eco-efficient model with a greater economic, social and environmental value". In this sense, the conservation and sustainable use of the natural heritage and its natural resources, the insertion of environmentally clean technologies, the application of energy efficiency and a greater participation of renewable energies are being promoted, as well as the prevention, control and the mitigation of pollution and sustainable production, consumption and post-consumption."(Good Living National Plan, 2013)

That said, the main objective is to promote greater efficiency and participation of renewable and sustainable energy as a measure to prevent the environment pollution, with several control mechanisms, incentives, prevention of damages and a constant application of technologies which have quality standards to measure their efficiency and the positive impact degree on nature. All of this must be accompanied by mass awareness campaigns so that citizens

start to prevent the destruction of nature and a greater awareness of the energy use, so that demand does not continue to grow at the previously indicated rate.

1.2.2 Energy Matrix

Ecuador is a self-sufficient country in global energy terms, so surplus energy can be exported to other countries. However, Ecuador imports secondary energy (diesel, naphtha, liquefied petroleum gas, gasoline) due to the growing deficiency that exists and also to satisfy the domestic demand. Projections point to a decline in oil reserves at levels up to 110 million barrels (barrel of oil equivalent to energy released during the burning of a crude oil barrel) by 2020; the increasing rhythm of energy demand indicates that, by the same year, demand would equal supply.

Similarly, studies show that between 1990 and 2012, the renewable energy use rate has declined, while non-renewable energy rate has increased in large numbers, and this is mainly due to "the growing participation of the transportation sector in the use of fossil fuels. This sector accounts 56% of the total energy use in the country (MICSE, 2012). In the field of transportation, 85% of energy consumption refers to gasoline and diesel. Other high energy consumption sectors are residential, with a 16% consumption, and industrial, which consumes 11%. In the case of households, 56% represents the liquefied petroleum gas consumption (LPG); In addition, this sector accounts for the 92% of the national LPG consumption. In the case of the industries, 37% corresponds to diesel and fuel consumption; this sector represents only 11% of the national energy consumption. "Good Living National Plan, 2013)

56% of household consumption coming from liquefied petroleum gas, is what is intended to be replaced with the implementation of photovoltaic solar panels, contributing to the environment by having a clean energy that does not affect nature, as well as allowing the government to export more quantities of energy from hydroelectric plants that will no longer be consumed locally.

"Distribution electricity losses have declined from 22.3% in 2006 to 14.7% in 2011, equivalent to more than USD 100 million savings per year (MICSE, 2012) and the percentage of households in the urban areas with electric service has increased from 97.9% in 2008 to 98.3% in 2012, consequently exceeding the proposed goal for 2013 in the 2009-2013 National Plan"(Good Living National Plan, 2013). Inequality in the provision of public electricity service is still evident in the poorest quintiles and in the rural areas that would benefit from the implementation of the panels. That is why, within the goals set in the National Plan, it is firstly to reach a 60% renewable installed capacity by 2017 (in 2012 it was 43.7%) and, secondly, to increase the installed capacity for electricity generation, from 5454.4 MW in 2012 to 8741 MW in 2017.

According to the information published by the Vice-Presidency, "during the six years of government management, $ 14.398 million have been invested in strategic sectors, so that Ecuador is transformed from being an energy-importing country to an exporter country and a productive industrialized matrix of services. In 2016, the major hydroelectric projects will be implemented: Coca Codo Sinclair, Blower, Toachi Pilatón, Minas San Francisco, Delsitanisagua, Manduriaco, Quijos, Mazar-Dudas. The first wind farm, Villanoco, is already in operation and looking forward to implementing solar plants as other sources of renewable energy. "That is a historic milestone," said Coordinating Minister Rafael Poveda.

On the other hand, it is pointed out that about $ 4.5 billion have been invested to replace the use of polluting fuels by 93% and seeking to double the energy capacity to 7,480 MW (Vice-Presidency of Ecuador). Similarly, Rafael Correa has highlighted the importance of the Pacific Refinery, vital to cover the fuel deficit in the domestic market without having to resort to petroleum import, thanks to an investment close to 12 billion dollars. (Vice-Presidency of the Republic of Ecuador)

The following chart shows statistics indicating that the efforts are starting to show positive results, since 51,78% renewable energy production exceeds consumption of fossil fuels to 13.638,89 gigawatt hour (GwH), in benefit of Ecuadorian residents (regulating electric, 2016).

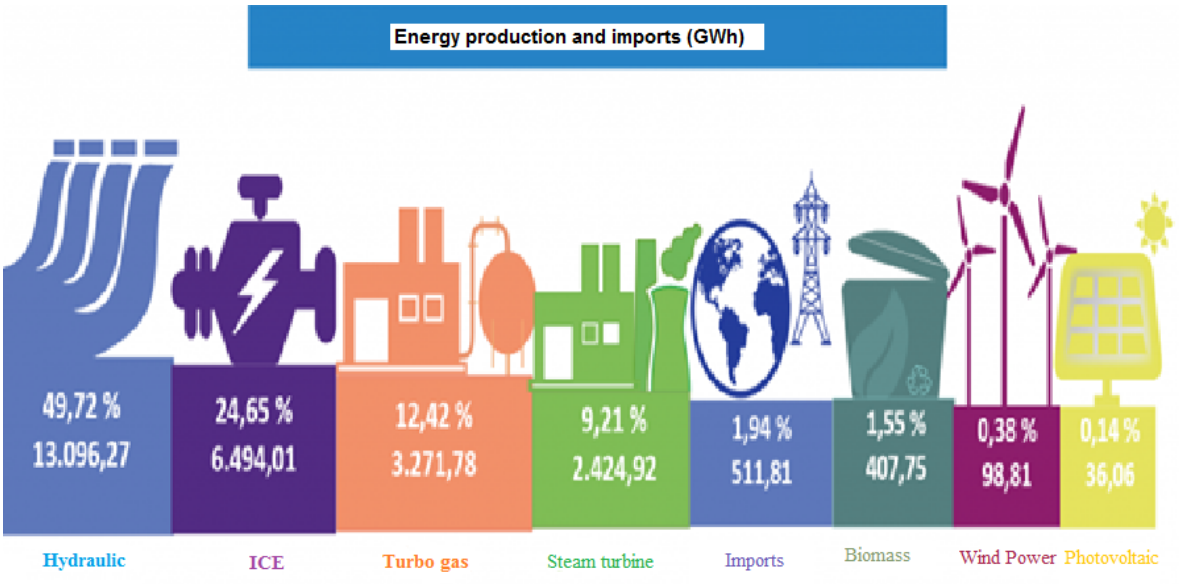


Illustration 6: Energy production and imports

Source: (Arconel, 2015)

Currently, Ecuador is a world leader, appearing as fifth in energy security according to a report from the Vancouver University, standing out for the efforts in the field of the construction of eight hydropower projects.

In concordance to the data presented by ARCONEL in the workshop “strengthening of basic statistics as support to the development sustainable objectives", by 2015, Ecuador exceeded the 97% coverage of electric energy supply" (Electric Regulation, 2016). This shows that Ecuador has had a great reception to this initiative from the government, where the figures endorse a positive change leaving aside the traditional form of consumption and coverage of energy in the country.

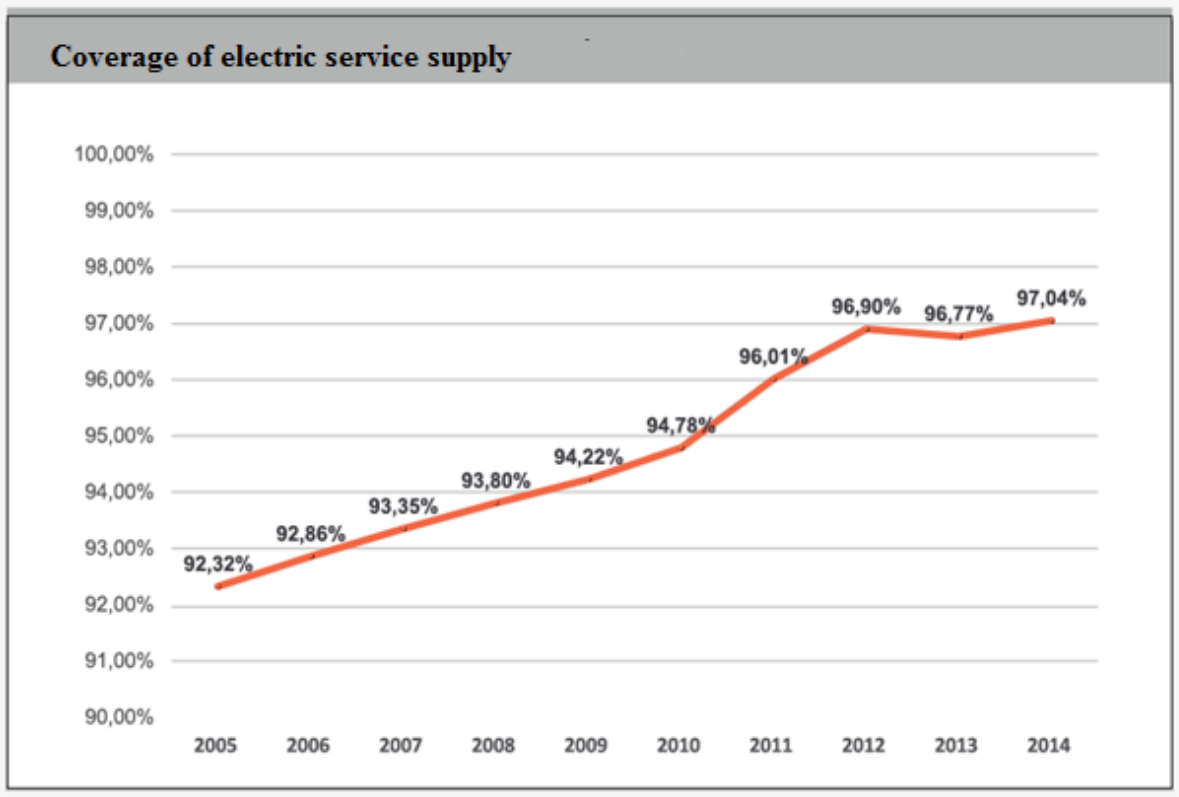


Illustration 7: Coverage of electric service supply

Figure 7: (Arconel, 2015)

Chapter 2: Market study in Cuenca Canton.

2.1. Energy Consumption in Ecuador.

Energy consumption in the country revolves around power flow that occurs through the interconnected national system(S.N.I.), from not built-in power systems and power interconnections with Peru and Colombia.

According to the total gross energy distributed nationally, 51.55% corresponds to energy produced by renewable sources, 46.52% to energy from non-renewable sources and 1.93% to energy imports.

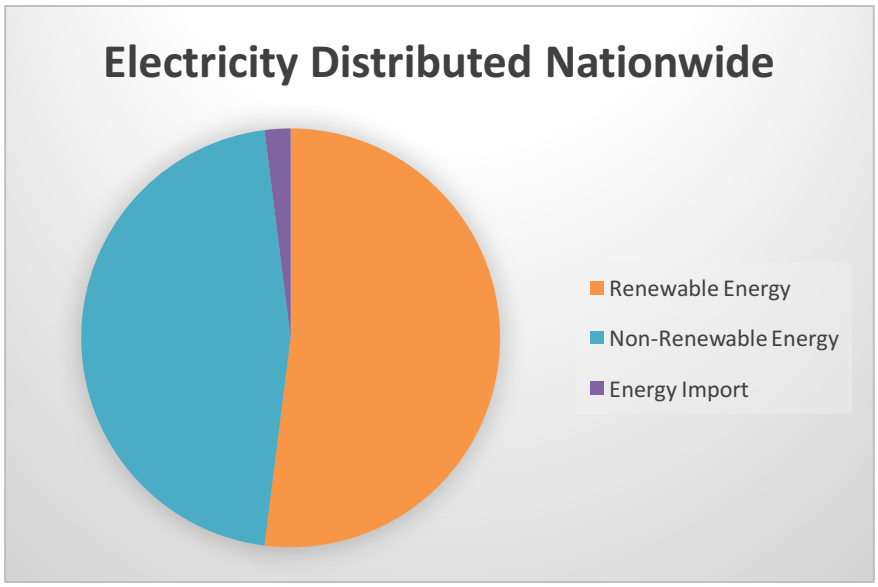


Illustration 8: Energy Distributed Nationwide

Source: (2015 Arconel)

The production of electricity is based on the contribution coming from the hydroelectric, thermoelectric, wind and photovoltaic Central. According to information based on the National Agency for Regulation and Control of Electricity (ARCONEL), it establishes that electricity production from 2015 belongs to: hydroelectric power plants (49.49%), thermoelectric (46.52%), international interconnections (1.93%), biomass generation (bagasse) (1.54%), wind-farms (0.37%) and photovoltaic plants (0.14%).

Energy Type	Type of Plant	Rated Power		Effective output	
		MW	%	MW	%
Renewable	Wind power	21,15	0,35%	21,15	0,38%
	Hydraulic	26,41	0,44%	26,37	0,47%
	Photovoltaic	2412,86	40,15%	2401,3	43,20%
	Thermal steam turbine	144,3	2,40%	136,4	2,45%
Total Renewable		**2604,72**	**43,34%**	**2585,22**	**46,51%**
Non-Renewable	Thermal ICE	1860,69	30,96%	1547,38	27,84%
	Thermal Turbo Gas	1086,69	18,07%	978	17,59%
	Thermal steam turbine	1086,24	7,62%	448,24	8,06%
Total non-renewable		**458,24**	**56,66%**	**2973,62**	**53,46%**
Total		6009,84	100%	5558,84	100%

Chart 1:Energy Production in Ecuador

Source: (2015 Arconel)

Among major non-renewable and renewable power generation sources, wind and photovoltaic plants have a minority participation with 0.38% and 0.47% respectively, followed by biomass power plants (fuel from renewable sources (bagasse) with 2.45%, while MCI are thermal plants which have a greater participation in terms of non-renewable sources, with a

27.84% effective power.) Finally, hydroelectric power plants are the most representative within the range of renewable energy with 43,20%. This total of effective power, at country level, would translate into 92.89% if it is directly related to the generated production through renewable sources.

Photovoltaic Energy in Ecuador

The country has 14 public companies generating power from photovoltaic systems. Mainly, they are located in the South of the country (Loja), starting its operations in 2014 and an investment of approximately 700 million dollars.

Energy Consumption

By 2015, the provinces with the largest per capita energy consumption (i.e. over 1000 Kw/h / hab) were Guayas, Galápagos, Pichincha, El Oro, Azuay and Santa Elena. The per capita consumption indicator at the province and national level is calculated by using the customers power consumption regulated by the distribution of companies and the population projected by the "INEC" by 2016. Azuay has a 1.151,75 Kw/h per capita consumption.

In recent years, there has been an increase in electricity demand. The increased demand is concentrated on the coast: 57.20%, in regards to 39.81% (mountain range), while Azuay recorded a 933,40 GW/h increase during 2015.

Energy-saving

Within the main energy-saving practices during 2014, turning off the lights after leaving a room was the most popular (95,08%). In terms of energy-saving devices, 23.47% of the participants claim to have an energy-saver appliance, while 1.90% have solar panels. (National Institute of Statistics and Censuses, 2014)

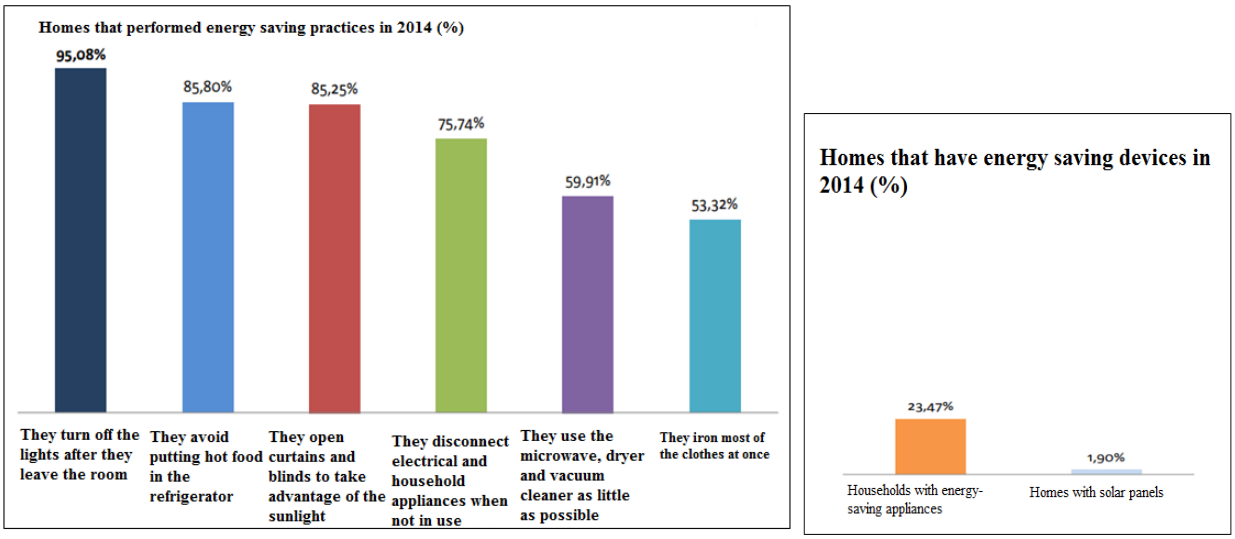


Illustration 9: Energy saving practices

Source: (National Institute of Statistics and Censuses, 2014)

2.2 Energy Imports

During the 2009-2011 period, energy resulting from dryness in the main power plants basins was imported. In addition, during the 2012-2015 period, an important reduction due to the implementation of several non-renewable and renewable generation projects was evident.

During the same period, it is recorded that 98% of the imports are contributed by Colombia and the remaining 2% by Peru, with a $10.49 average price from Colombia and $5.49 from Peru. (Arconel, 2015)

Company	Type of Transaction	2010	2011	2012	2013	2014	2015
Colombia	O. Amount	794.51	1294.59	236.03	662.34	824.02	457.24
Total Colombia		**794.51**	**1294.59**	**236.03**	**662.34**	**824.02**	**457.24**
Perú	Contratos	-	-	-	-	-	54.57
	O. Amount	78.39		2.17		12.72	
Total Perú		78.39		2.17		12.72	

Chart 2:Energy Imports

Source: (2015 Arconel)

2.3 Market Study

SOLAR PANELS: TECHNICAL STUDY

Objectives	-To learn about energy-saving habits. -To calculate the Kw/m power consumption average -To know the opinion about solar panels
Universe: (N)	- B Socio-economic household level: 38.129
Sample (n):	-200 surveys: 35% in the urban area and 65% in the rural area -Error Range: 7%
Survey method:	- Face-to-face

2.4 Methodology

Determination of the sample size:

To calculate the sample size, the following formula is often used:

$$n = \frac{N\sigma^2 Z^2}{(N-1)e^2 + \sigma^2 Z^2}$$

Where:

N = population size. 38.129 households, B socio-economic level (National Institute of Statistics and Censuses, 2014).

n = sample size.

Standard deviation of the population which, generally uses a 0.5 constant value.

Z = level of confidence, which usually takes about a 95% confidence.

e = acceptable limit of sampling error, value that is at the discretion of the interviewer (in this case 7%).

Being the given sample: 200 surveys among urban area (35%) and rural areas (65%) with a 7% error range. (Fernández)

Elaboration of the survey:

Once these aspects were taken into account and after fulfilling the study objectives, the questions were raised. The objectives were: to know the saving-energy habits, Kw/month power consumption average within households and the opinion about solar panels, mainly taking into consideration perception, knowledge and acceptance:

- **Energy-saving habits (Target 1):** To achieve the proposed objective, questions on energy-saving habits were aimed in order to know if the families consider them important and if they put them into practice. (Questions 3,4,5,6).

- **Energy-consumption (Target 2):** To comply with the following objective, questions about electric power service were raised in order to know if the kw/

month household consumption average and the monthly payment made to receive such service are known by the owners. (Questions 7,8).

- **Opinion about solar panels (Target 3):** Finally, to accomplish the main objective, questions about the degree of knowledge, acceptance, and interest on the solar panels were aimed. (Questions 9,10,11,12,13,14).

Surveys:

A total of 70 surveys were implemented in Cuenca (urban area), while in the rural area 170 surveys were applied and divided between: Ricaurte (23), Baños (22), Paccha (22), San Joaquin (22), Sayausí (22) and Nulti (21).

Quality control:

Within the tabulation process, the first step after the surveys is quality control, where a randomly survey sample is selected according to the different obtained segments (in the study). This selection is checked again in order to validate certain questions and see if the information matches the data. (Fernández)

Review, Codification and digitalization:

Within the review, the obtained information is checked to see if it is complete and consistent and if the surveys were applied correctly. The next step is the digitalization of surveys in a software specifically made for it. The last step is to encode each variable of the survey; for example, changes to numerical codes and all the data obtained to facilitate the review and the data processing. (Fernandez)

Processing:

Processing is done in a software designed for the study, which allows to cross and analyze relevant variables within the research objectives previously established. (Fernández)

2.5 Survey

SURVEY

Good morning my name is …, This time we are performing a study about electricity consumption, please help me with a few minutes of your time to answer some questions.

1. Place

Nulti	☐
Cuenca	☐
Ricaurte	☐
Baños	☐
Sayausí	☐
San Joaquín	☐

2. Are you the head of the household?

Yes	☐	1 **Continue**
No	☐	2 **Ask to contact the head of the household, otherwise finish**

ENERGY-SAVING

3. On a scale from 1 to 5, where 1 is nothing important and 5 is very important, how important is your home energy-saving?

1	2	3	4	5
Not important	Less important	Regularly important	Important	Very important

4. From the list below, tell me if you practice any of the following energy-saving habits in your home?

Do you disconnect appliances or electrical appliances when they are not in use?			
Do you use energy-saving lights in your home?			
Do you turn off the lights when you leave a room?			
Do you avoid putting hot food in the refrigerator?			
Do you open curtains and blinds to take advantage of the sunlight?			
Do you use the microwave, dryer and vacuum cleaner as little as possible?			
Do you iron most of the clothes at once?			
Do you have energy-saving appliances?			
Do you have solar panels?			

5. On average, how many hours a day are lights turned on from Monday to Friday at home?

_____

6. _ On average, how many hours a day are lights turned on during the weekend?

ENERGY SERVICE

7. Speaking of electricity service, how much do you pay for the service monthly?

$_____

Do you know the monthly average consumption in Kw/h? Ask to show the CENTROSUR invoice

Kw _____

ABOUT SOLAR PANELS

8. Do you know what the photovoltaic solar panels are?

Yes ☐ 1 **Explain**_____

No ☐ 2

9. I am going to read you the definition of a photovoltaic solar panel and its general characteristics, so that you can give me your opinion of this system.

It is a renewable energy generation system, which consists of the sunlight conversion into electricity. It does not consume fuel as it obtains its energy from the Sun, which means that in the long term they are more viable and stable.

On the other hand, the environmental impact is practically null because it does not produce pollution.

Photovoltaic systems do not produce any annoying sounds when they are in operation and have a long useful life (more than 20 years).

10. How attractive do you think this renewable energy system is? To qualify, use a scale from 1 to 5 where 1 is nothing attractive and 5 very attractive

1	2	3	4	5
Not attractive	**Less attractive**	**Regularly attractive**	**Attractive**	**Very attractive**

10.1 Answers 1- 2 -3: ask why

11. How beneficial do you consider this renewable energy system for your home? To qualify use a scale from 1 to 5, where 1 is nothing beneficial and 5 very beneficial

1	2	3	4	5
Not beneficial	**Less beneficial**	**Regularly beneficial**	**Beneficial**	**Very Beneficial**

11.1. Answers 1- 2 -3: ask why

_____

12. How interested would you be in purchasing a photovoltaic solar panel system for your home?

1	2	3	4	5
Not interested Continue	**Less interested Continue**	**Regularly interested Continue**	**Interested Go to Q14**	**Very interested Go to Q14**

12.1. Answers 1- 2 -3: ask why

_____

IN Q13.1 IF THE ANSWER RELATES TO ECONOMIC REASONS ASK: How much do you think this system should cost? $_____ GO TO Q15

13. How much would you be willing to pay for this energy system?

$_____

SOCIOECONOMIC LEVEL

What is your level of education?
What is the level of education of the head of household?

	Level of Education of the interviewed	**Level of Education of the head of household**
No studies	1	1
Incomplete Primary School	2	2
Complete Primary School	3	3
Incomplete Secondary School	4	4
Complete Secondary School	5	5

Technical (3-year career)	6	6
Incomplete University	7	7
Complete University	8	8
Postgraduate	9	9

What is your occupation?
What is the occupation of the head of household?

	Occupation of the interviewed	**Occupation of the head of household**
On their own		
Small farmer	1	1
Big farmer	2	2
Self-employed (worker without upper degree)	3	3
Businessman (up to 5 employees)	4	4
Businessman (more than 5 employees)	5	5
Professional accountant (With a superior degree: Doctor, Lawyer, Architect)	6	6
By others		
Responsible: up to 5 employees	7	7

Responsible: more than 5 employees	8	8
Salaried professional (Doctor, Lawyer, Architect,)	9	9
Intermediate Command (Section Chief, Supervisor)	10	10
Other office employees (Secretary, Accountant, Assistant)	11	11
Other out-of-office employees (Dispatchers, messengers)	12	12
Skilled manual worker (Carpenter, plumber)	13	13
Unskilled manual worker (Pawns, Day laborers)	14	14

No working

Retired / Pensioner /	15	15
Student	16	16
Unemployed	17	17
Housewife	18	18
Other inactive	19	19

Interviewed name: _____
Age: _____ Gender: Male (1) Female (2)
Telephone number_____ (OBLIGATORY)
Address_____
_
Interviewer: _____

Prepared by: (Jácome & Ordóñez, 2016)

2.6 Market Study Results

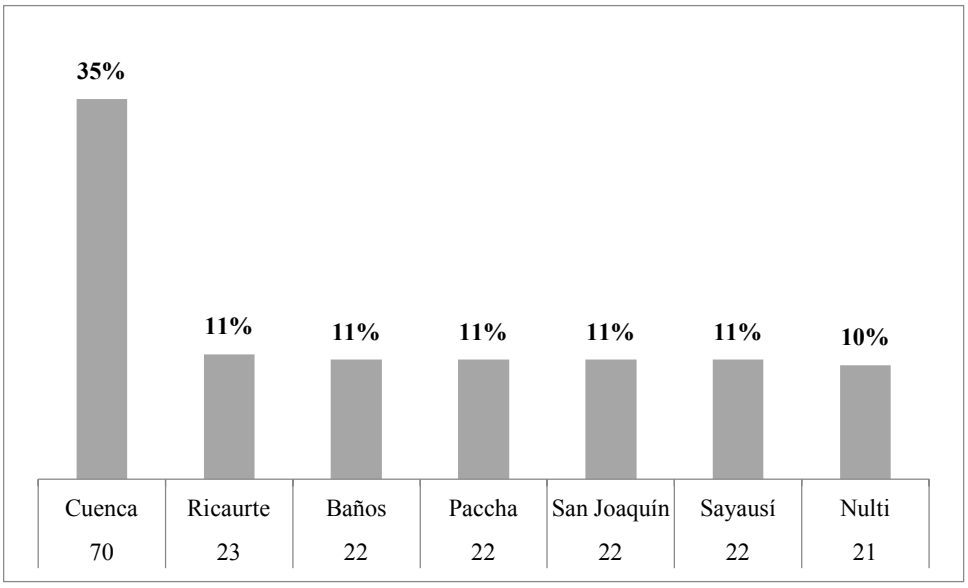


Illustration 10:Market study sample.

Prepared by: (Jácome & Ordóñez, 2016)

The sample consisted of 200 surveys divided between urban and rural area. 70 surveys were applied in Cuenca, while 170 surveys were applied in the rural are: Ricaurte (23), Baños (22), Paccha (22), San Joaquin (22), Sayausí (22) and Nulti (21) surveys.

Energy-saving in households

Around 85% of the total number of respondents consider it is very important to save energy, while 15% consider that it is important.

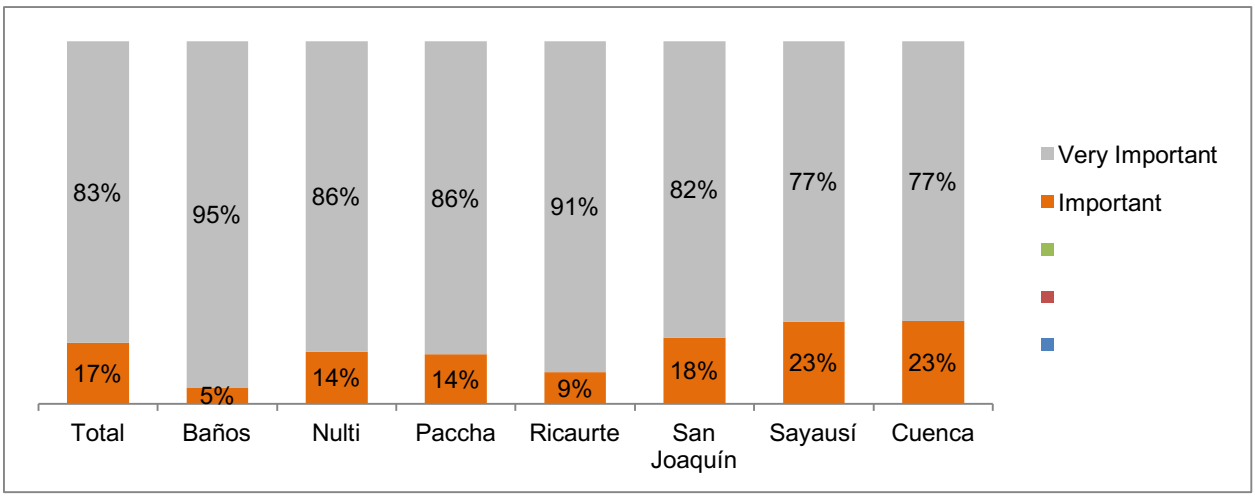


Illustration 11: Energy-saving in households

Prepared by: (Jácome & Ordóñez, 2016)

Energy-saving habits

In terms of energy-saving practices, every household consider it is important to have some habits. It can be seen that San Joaquin (67%) represents the parish with the most energy-saving habits, while Baños (50%) is on the opposite side.

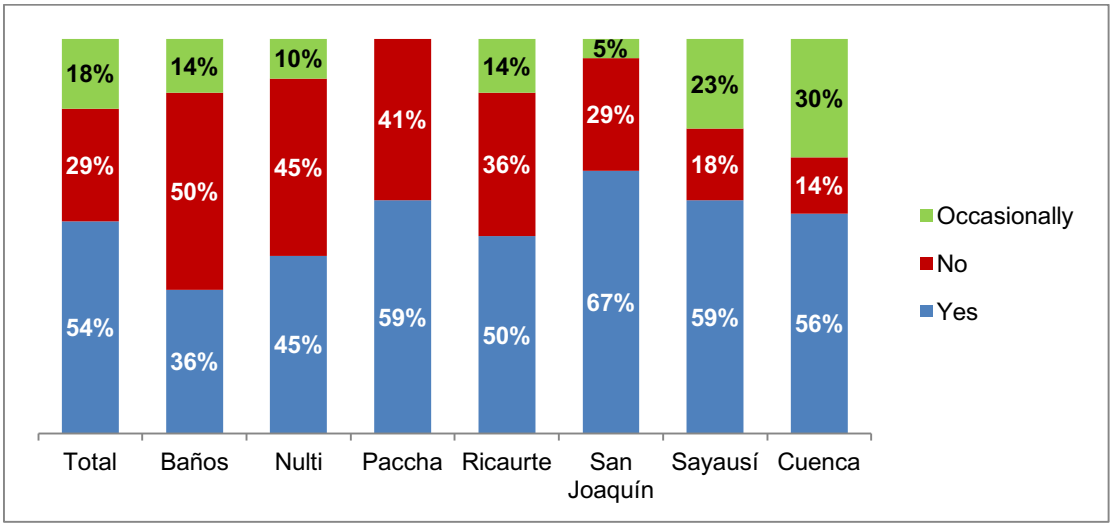


Illustration 12: Energy-saving habits

Prepared by: (Jácome & Ordóñez, 2016)

The main energy-saving practices are:

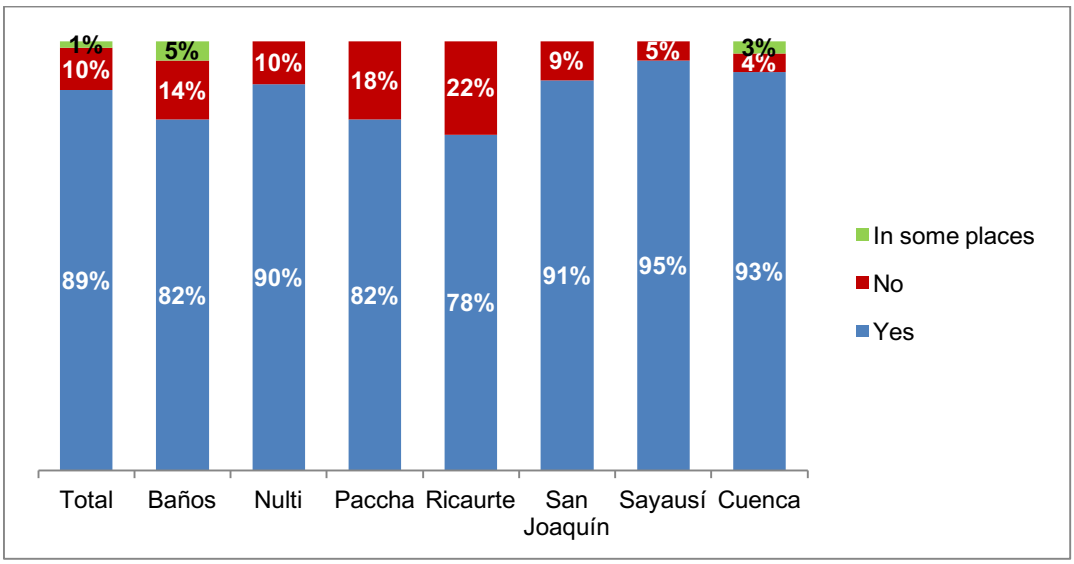


Illustration 13: Saving spotlights use

Prepared by: (Jácome & Ordóñez, 2016)

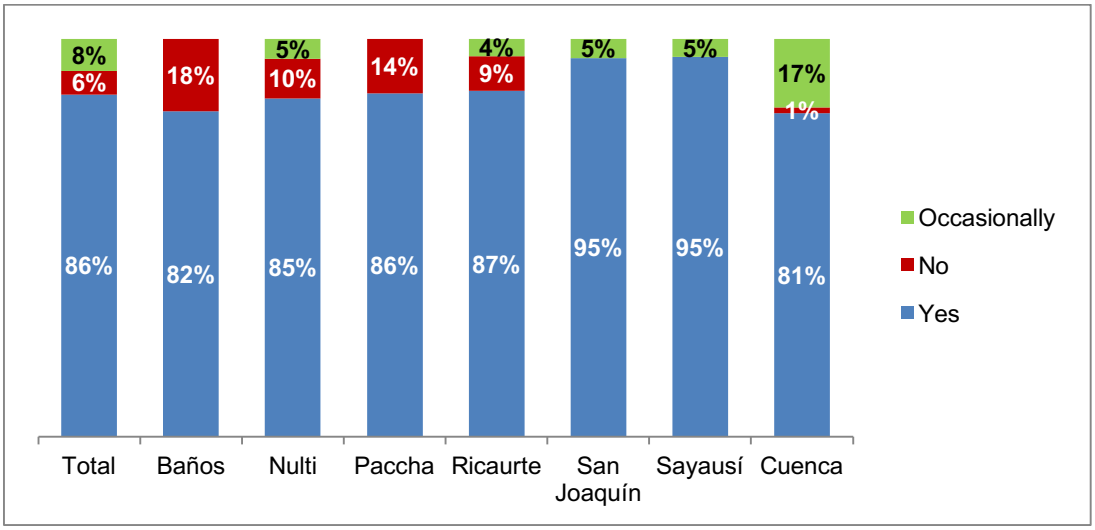


Illustration 14: Do you turn off lights when leaving a room?

Prepared by: (Jácome & Ordóñez, 2016)

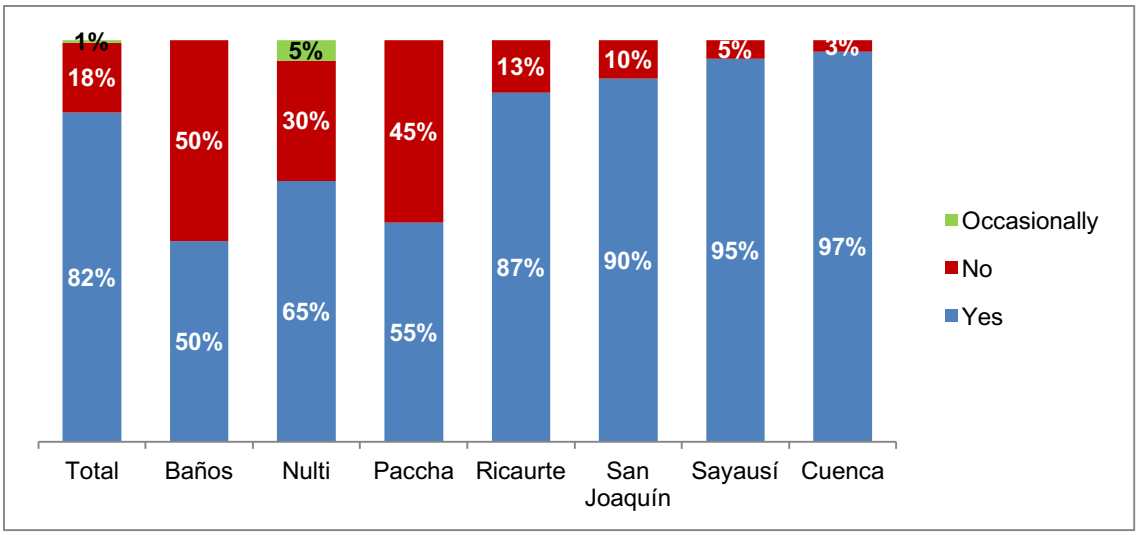


Illustration 15: Do you refrain from placing hot food in the refrigerator?

Prepared by: (Jácome & Ordóñez, 2016)

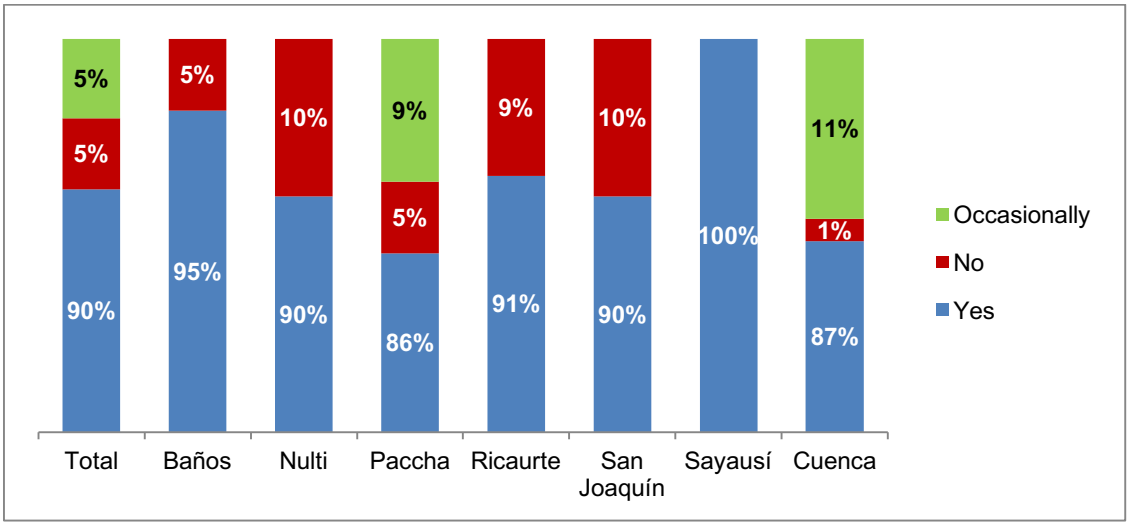


Illustration 16: Do you open blinds and curtains to take advantage of the sunlight?

Prepared by: (Jácome & Ordóñez, 2016)

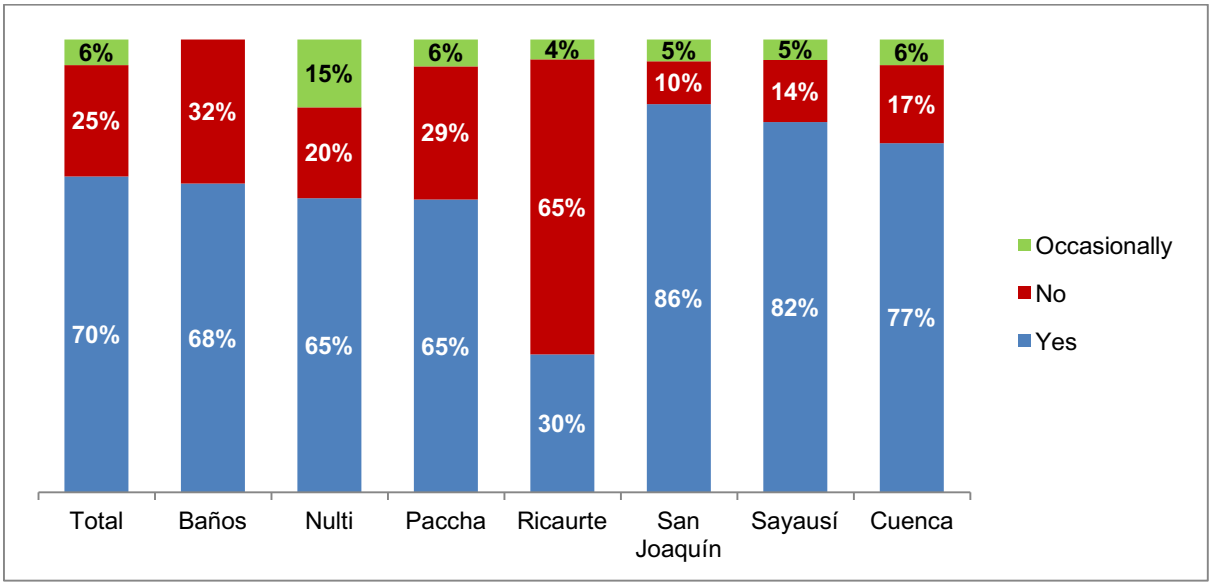


Illustration 17: ¿Are the microwave, dryer and vacuum cleaner used minimally?

Prepared by: (Jácome & Ordóñez, 2016)

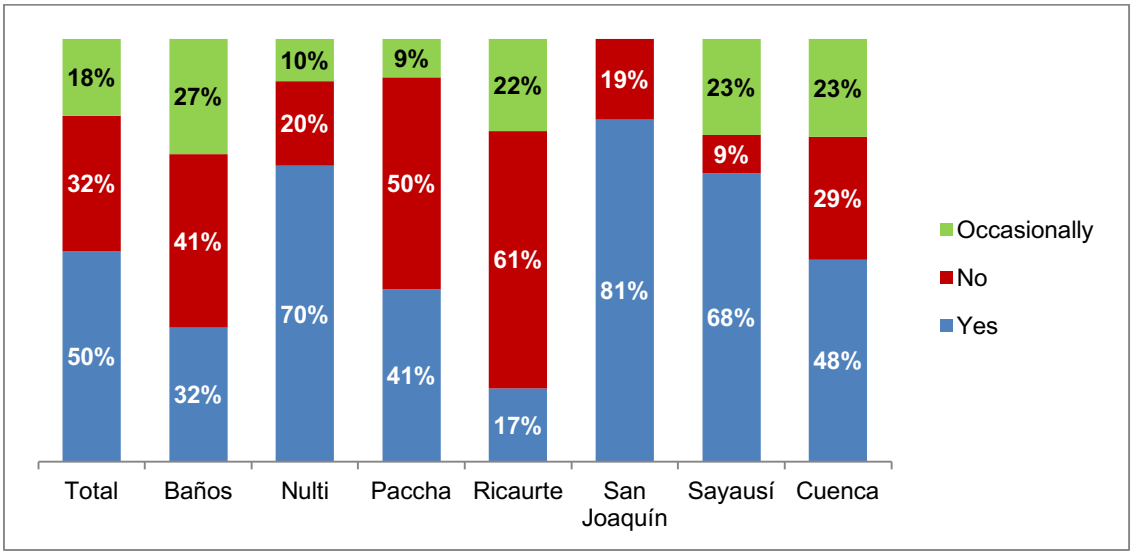


Illustration 18: Do you iron the most amount of clothes at a single time?

Prepared by: (Jácome & Ordóñez, 2016)

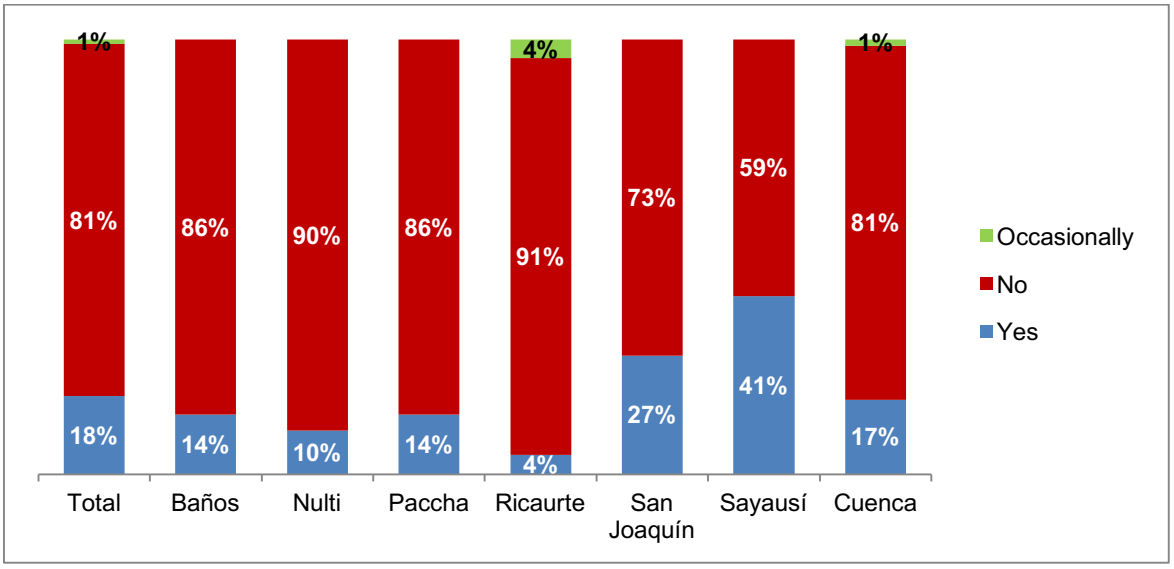


Illustration 19: Do have energy-saving appliances?

Prepared by: (Jácome & Ordóñez, 2016)

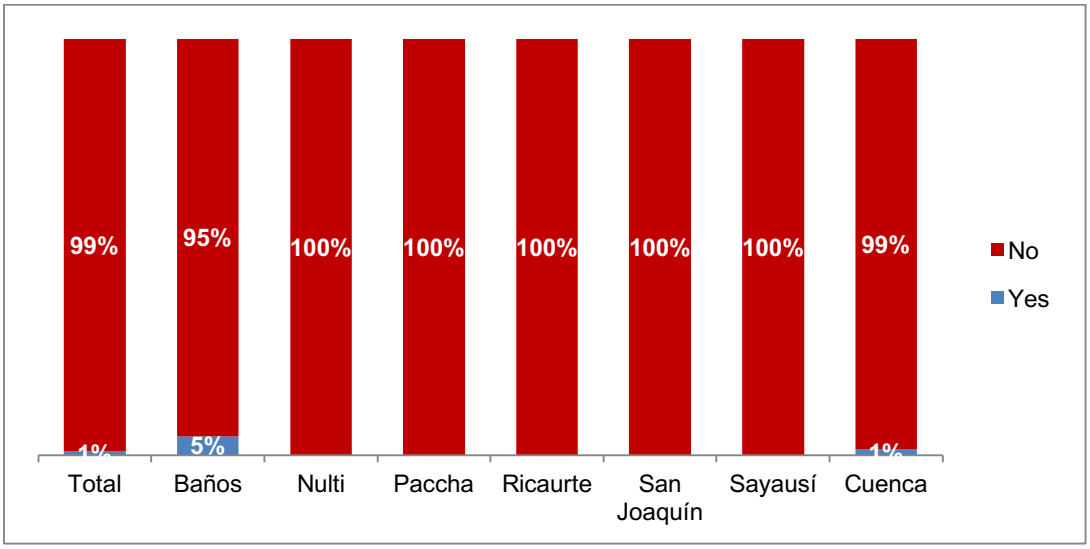


Illustration 20: Do you have solar panels?

Prepared by: (Jácome & Ordóñez, 2016)

Out the total number of participants,100% answered they do not have solar panels. Only in Baños and Cuenca, people own solar panels (6%).

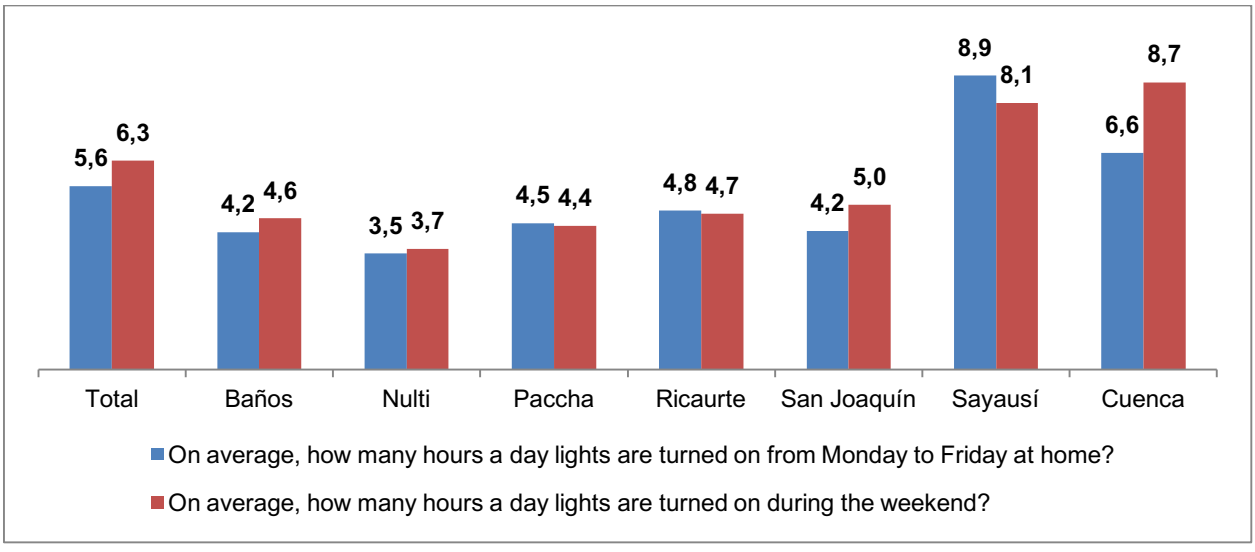


Illustration 21: Electric consumption in hours

Prepared by: (Jácome & Ordóñez, 2016)

It can be mentioned that the average, from Monday to Friday, is 5.6 hours, while the average during the weekend is 6.3 hours. Sayausí is the most representative parish from Monday to Friday (8.9 hours), while Cuenca represents the highest digit during the weekend (8.7 hours).

Talking about electric power service, how much do you pay for the service monthly?

The majority of participants pay on average $28. Ricaurte has a $34.74 monthly average.

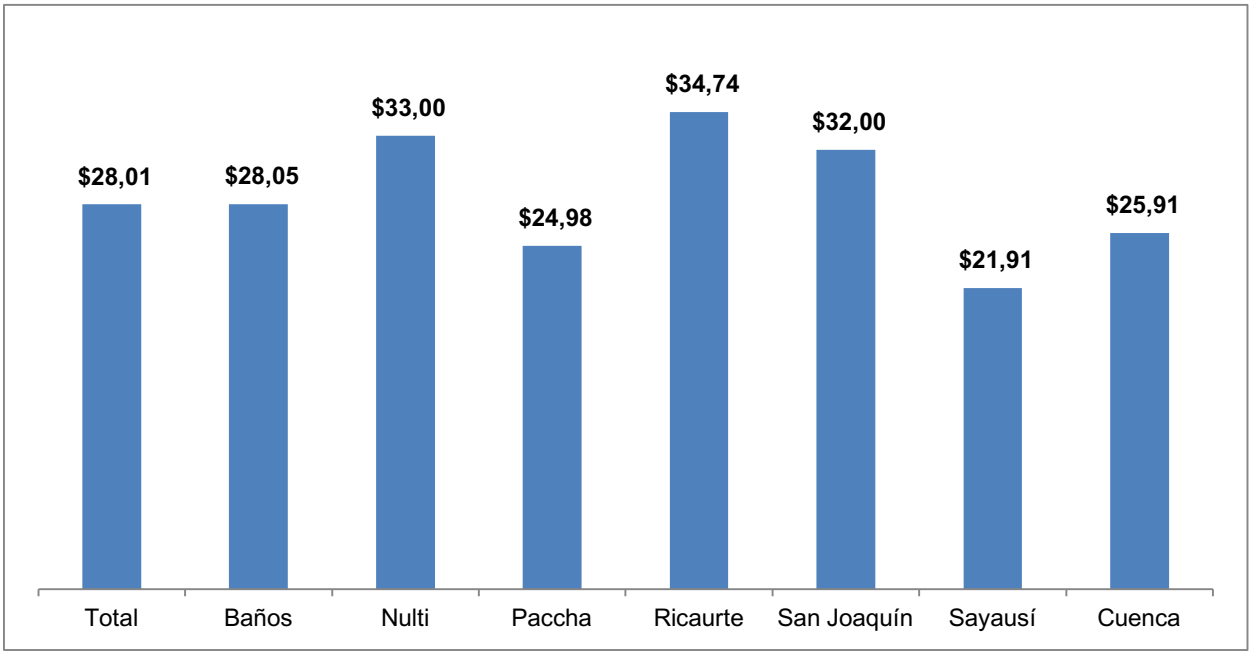


Illustration 22:Monthly payment for the service

Prepared by: (Jácome & Ordóñez, 2016)

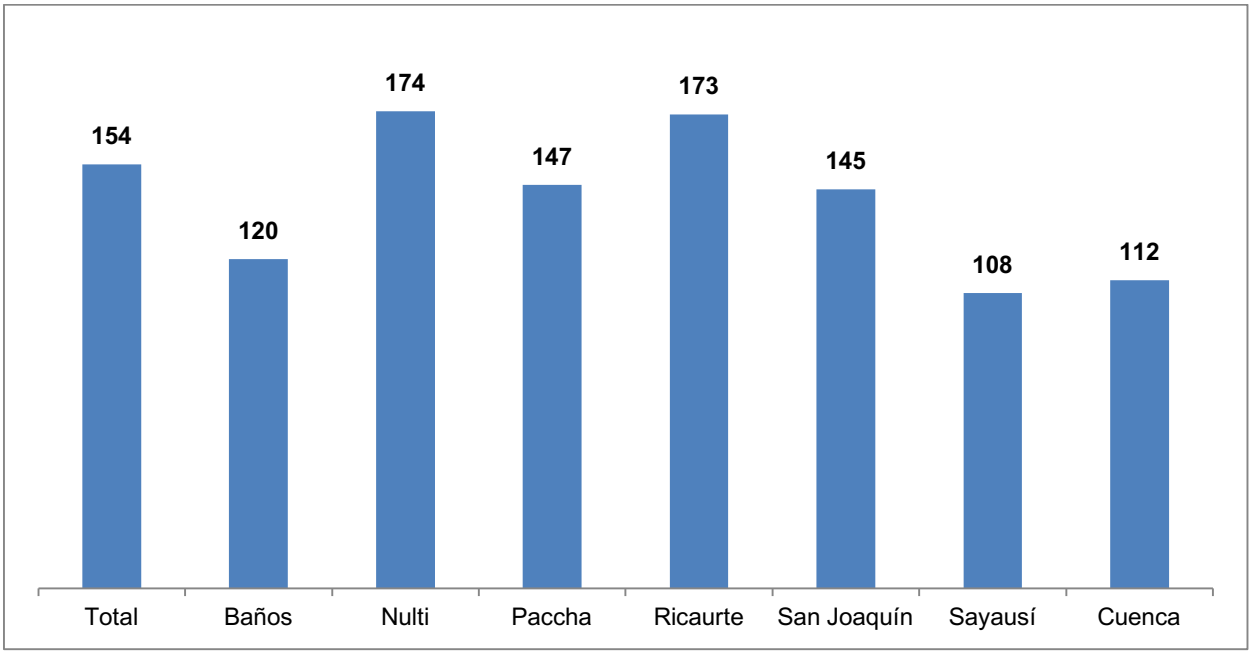


Illustration 23:Consumption average Kw/month

Prepared by: (Jácome & Ordóñez, 2016)

The consumption average is 154 kw/month. However, Nulti (174 kw/h) and Ricaurte (173 kw/h) have a higher energy consumption.

Knowledge about photovoltaic solar panels

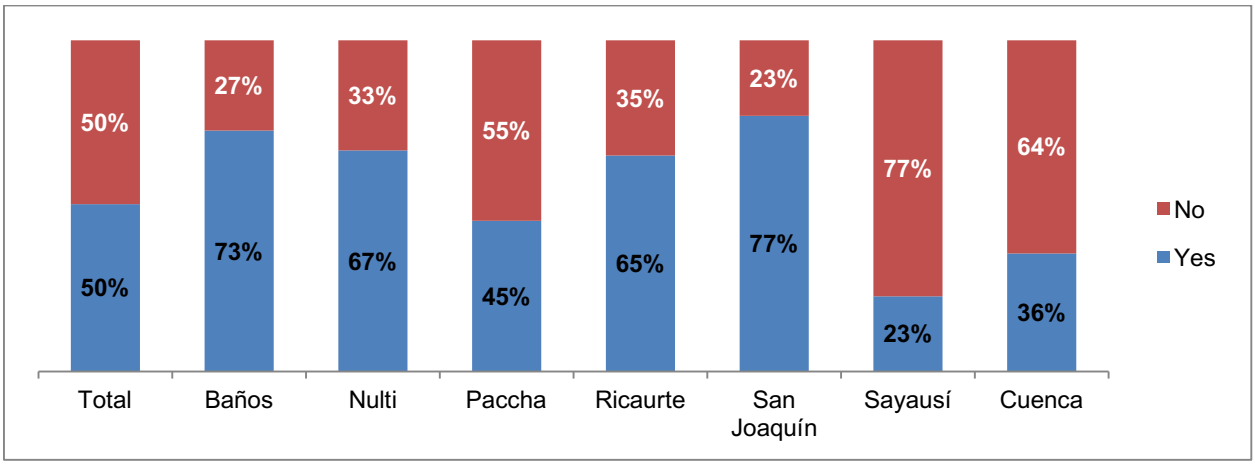


Illustration 24::Knowledge about photovoltaic solar panels

Prepared by: (Jácome & Ordóñez, 2016)

As it is shown, 50% of the participants know about solar panels, while 50% do not have any idea. In San Joaquin (77%) and Baños (73%) most people know what they are and it is important to mention that in Cuenca there is less knowledge about the subject.

	Total	Baños	Nulti	Paccha	Ricaurte	San Joaquín	Sayausí	Cuenca
Uses the sunlight and produces energy	59%	94%	86%	40%	33%	18%	100%	64%
Deveices that receive solar energy	29%	0%	14%	50%	27%	59%	0%	36%
Energy without pollution and economic	11%	6%	0%	10%	40%	18%	0%	0%
Swimming pool heater	1%	0%	0%	0%	0%	6%	0%	0%

Chart 3:Tabulation Results

Prepared by: (Jácome & Ordóñez, 2016)

Participants who know what solar panels are, defined them as: devices that use sunlight and produce energy (59%); while 29% defined them as appliances / plates which receive solar energy; energy without pollution and economic was also a definition given by people (11%).

It is a renewable energy generation system, which consists of the sunlight conversion into electricity, does not consume fuel as it obtains its energy from the Sun, which means that in the long term they are more viable and stable.

On the other hand, the environmental impact is practically null because it does not produce pollution. (Garcia,2002)

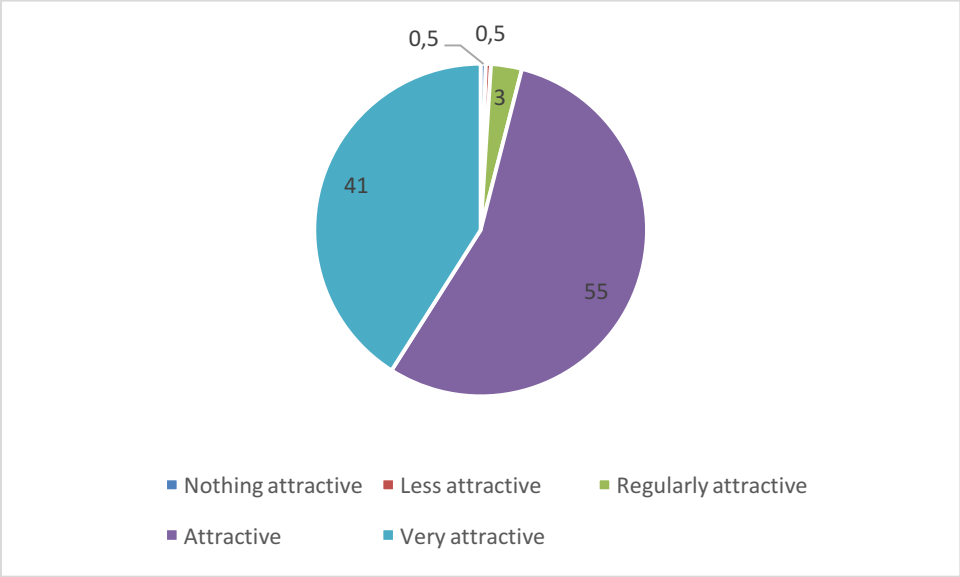


Illustration 25: How attractive do you think this renewable energy system is?

Prepared by: (Jácome & Ordóñez, 2016)

55% considers that a renewable energy system seems to be attractive and 41% considers it very attractive. In conclusion, 96% of the participants consider it as an appealing idea.

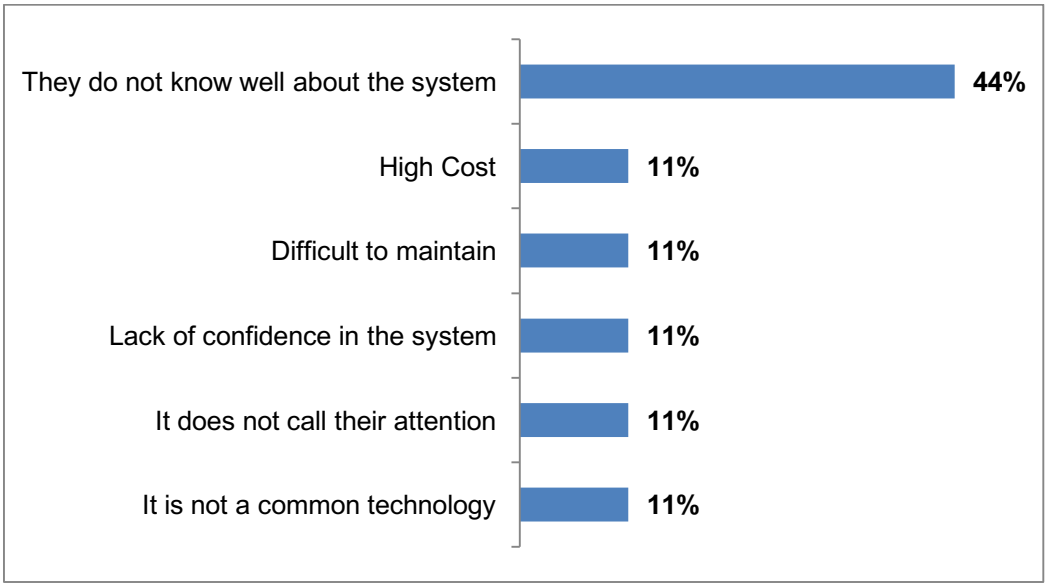


Illustration 26: Reasons for low attractiveness

Prepared by: (Jácome & Ordóñez, 2016)

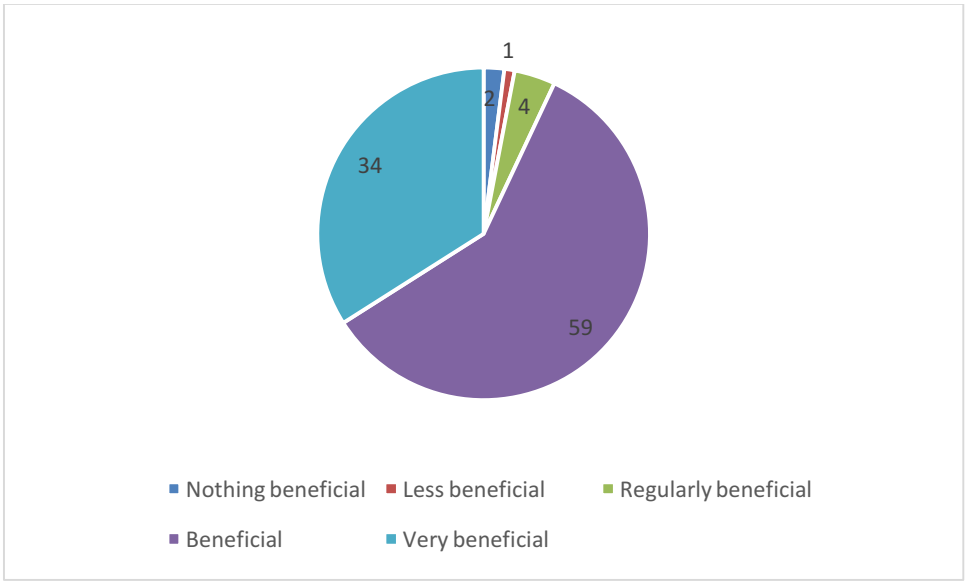


Illustration 27: How beneficial do you consider this renewable energy system for your home?

Prepared by: (Jácome & Ordóñez, 2016)

Source: Market Study

59% considers it as a beneficial idea while 34% considers it as very beneficial to own a renewable energy system for household use.

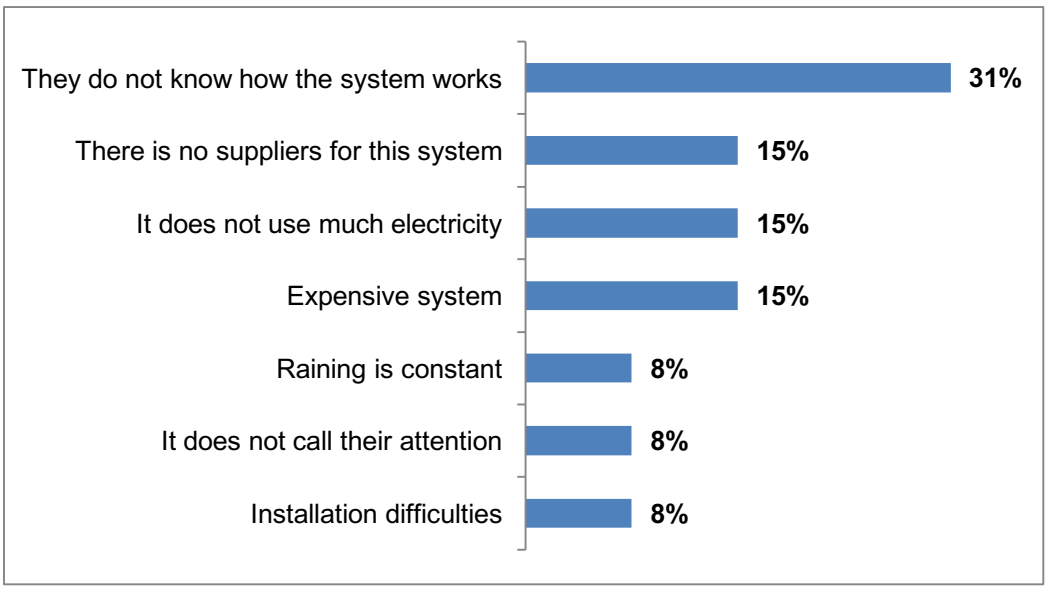


Illustration 28:Low benefit reasons

Prepared by: (Jácome & Ordóñez, 2016)

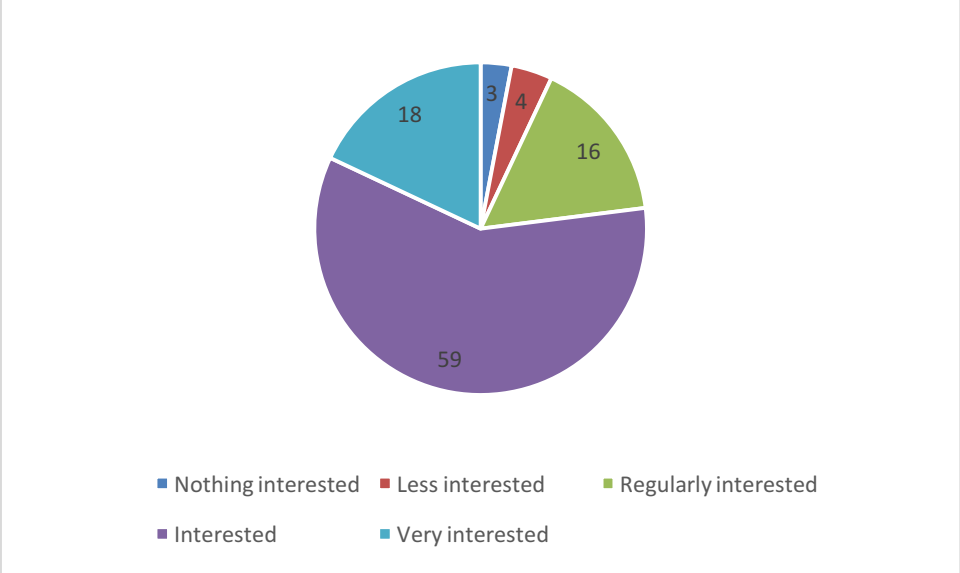


Illustration 29: How interested would you be in purchasing a photovoltaic system for your home?

Prepared by: (Jácome & Ordóñez, 2016)

As it can be seen, 77% of the participants would be interested in purchasing the system, while 7% would not be interested.

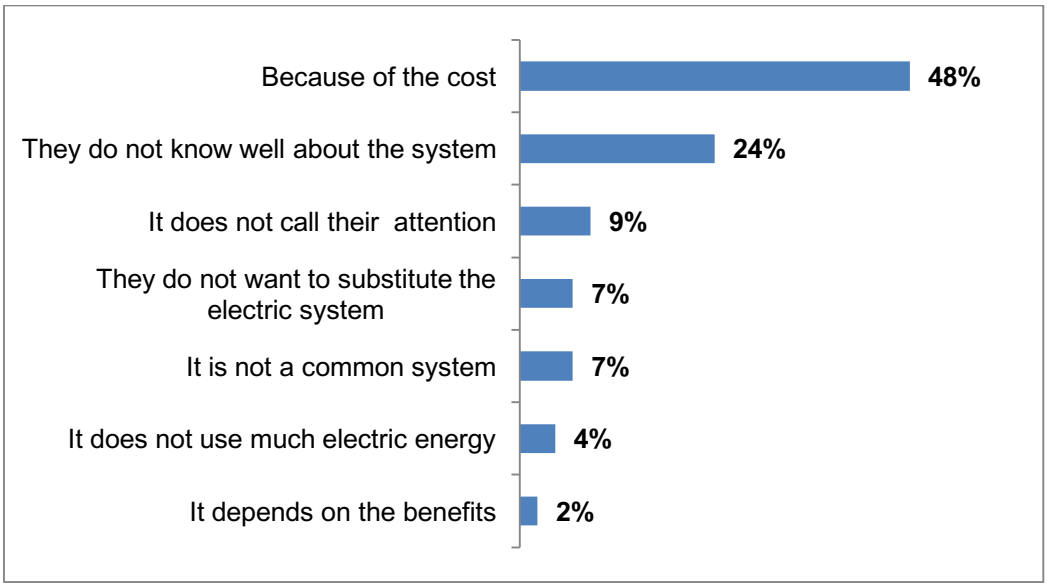


Illustration 30:Reasons for lower intent to purchase

Prepared by: (Jácome & Ordóñez, 2016)

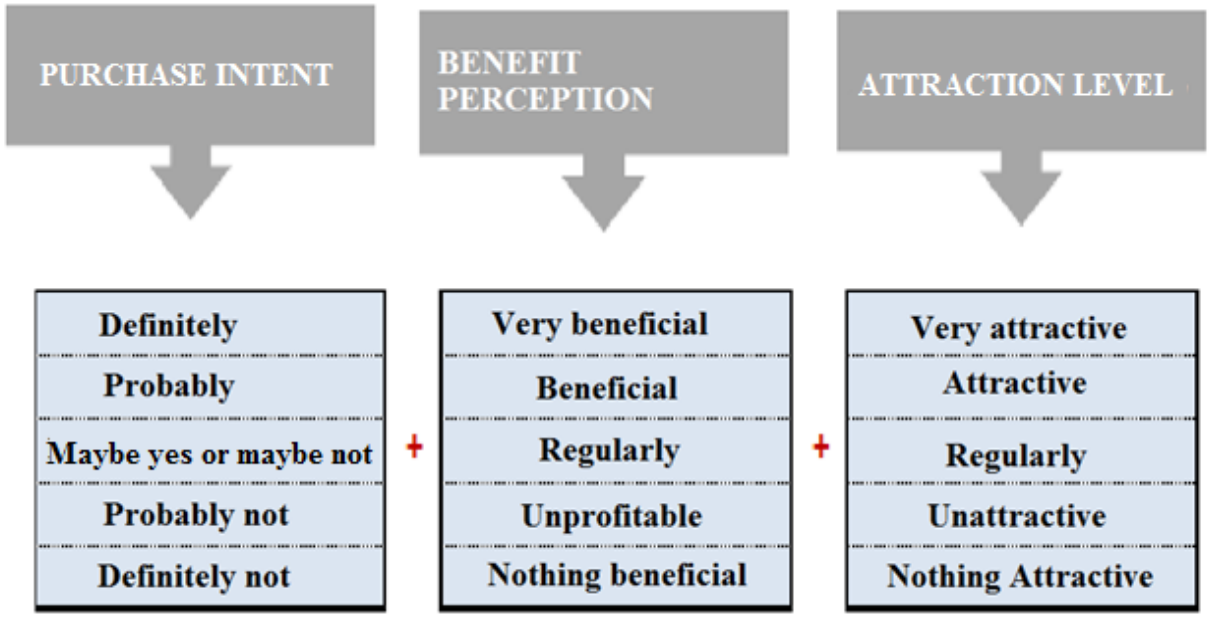
2.7 Market Demand – Concept Acceptance Index

Methodology

To determine the demand by applying the concept acceptance index, three scenarios have to be formed: optimistic, moderate, and conservative. This is a methodology taken from "Advance consultant", which considers the junction of three variables such as purchase intent, the perception of benefit and attraction level to determine the different acceptance degrees of the concept and the real success probability. (Advance consultant)

It is a renewable energy generation system, which consists of the sunlight conversion into electricity, does not consume fuel as it obtains its energy from the Sun, which means that in the long term they are more viable and stable.

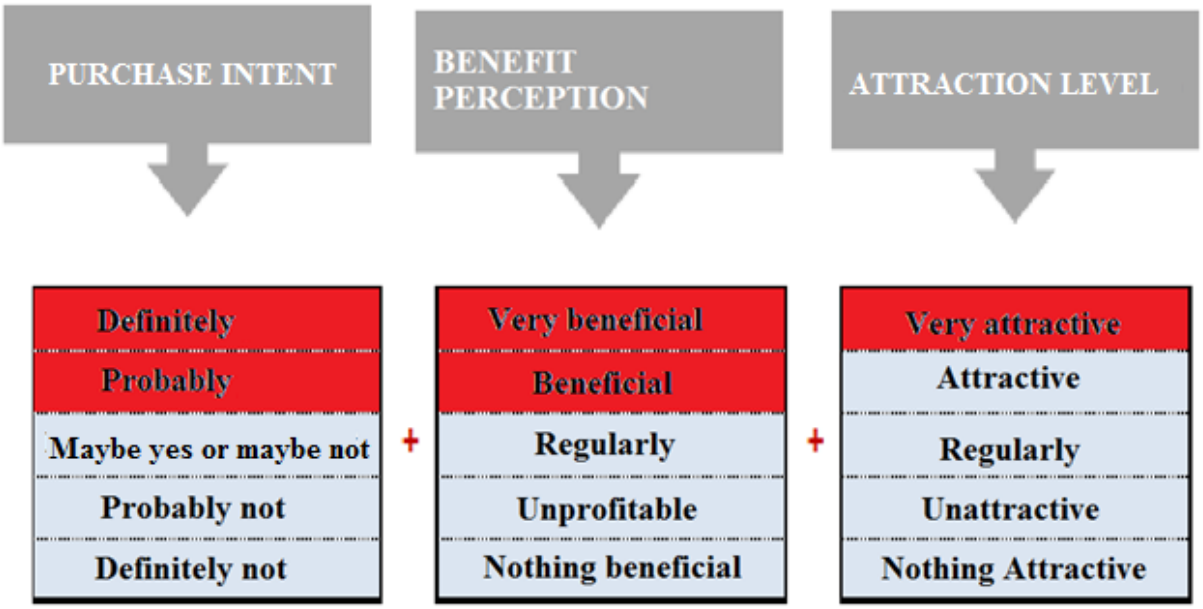
On the other hand, the environmental impact is practically null because it does not produce pollution (Garcia,2002)



Prepared by: (Jácome & Ordóñez, 2016)

Source: (Advance consultant)

Optimistic scenario

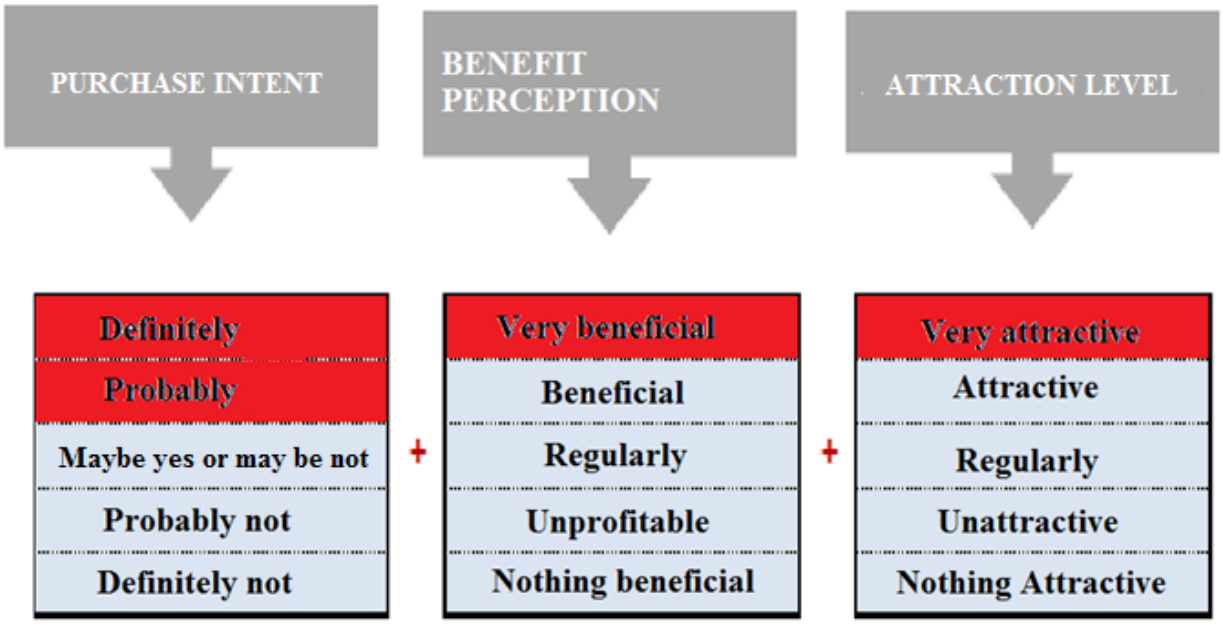


Prepared by: (Jácome & Ordóñez, 2016)

Source: (Advance consultant)

THE PREDISPOSED PEOPLE: They have a general interest in becoming potential consumers or users. They are somewhat attracted by the concept and have a positive attitude in the purchase intent and perception of benefits, while these subjects are assigned the highest attraction level.

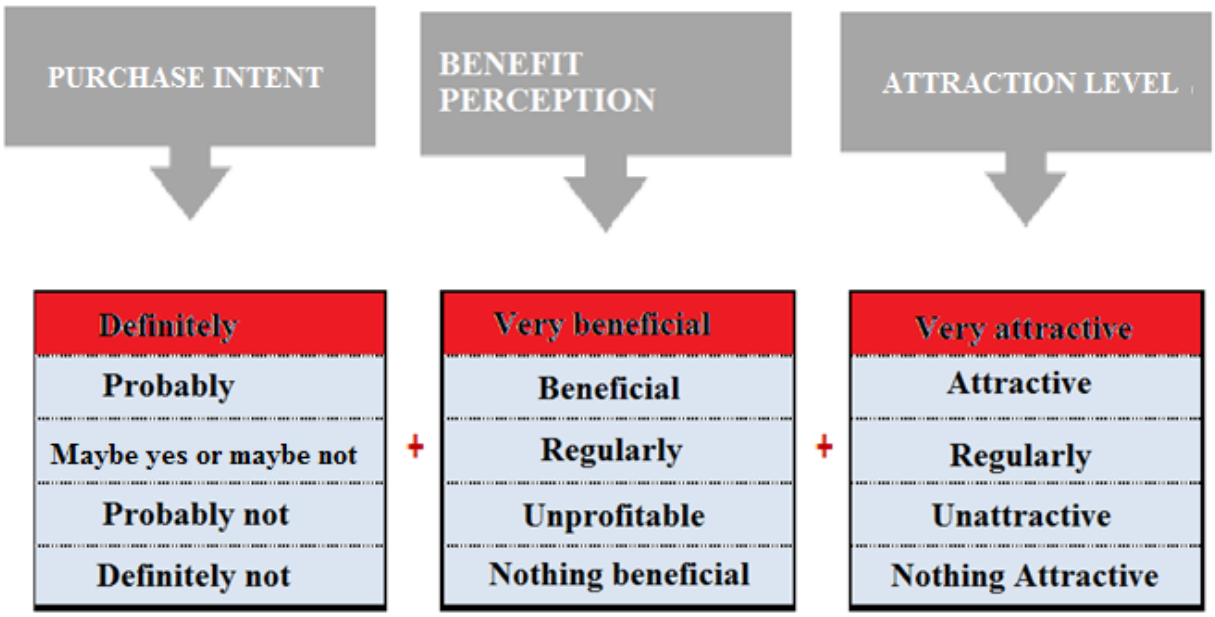
Moderate stage



Prepared by: (Jácome & Ordóñez, 2016)
Source: (Advance consultant)

THE INTERESTED PEOPLE: They are assigned with an assessment on the perception of benefit, unlike THE PREDISPOSED PEOPLE, and therefore they have a greater determination in purchasing the product or service, because of the valuation they give to the concept.

Conservative scenario



Prepared by: (Jácome & Ordóñez, 2016)

Source: (Advance consultant)

ENTHUSIASTS: They present the highest evaluation degree in the three variables. They consider the idea as something that would cover their expectations. In order to have a precise analysis to minimize risks, it is recommended to use this indicator.

Attractive / beneficial / interested		Total	Baños	Nulti	Paccha	Ricaurte	San Joaquín	Sayausí	Cuenca
How attractive is this renewable energy system? To qualify use a scale from 1 to 5, where 1 is nothing attractive and 5 very attractive.	Nothing attractive	0%	0%	0%	0%	0%	0%	0%	1%
	Less attractive	1%	0%	0%	0%	0%	0%	0%	3%
	Regularly attractive	3%	5%	5%	0%	0%	5%	14%	0%
	Attractive	55%	41%	43%	55%	78%	64%	36%	59%
	Very attractive	41%	55%	52%	45%	22%	32%	50%	37%
How beneficial is this renewable energy system for use in your home? To qualify use a scale from 1 to 5, where 1 is nothing beneficial and 5 very beneficial.	Nothing beneficial	2%	9%	0%	5%	0%	0%	0%	1%
	Less beneficial	0%	0%	0%	0%	0%	0%	0%	0%
	Regularly beneficial	4%	0%	0%	5%	0%	5%	5%	9%
	Beneficial	59%	50%	52%	55%	70%	68%	55%	61%
	Very beneficial	34%	41%	48%	36%	30%	27%	41%	29%
How interested would you be in purchasing a photovoltaic solar panel system for your home?	Nothing interested	3%	5%	0%	5%	0%	0%	5%	6%
	Less interested	4%	5%	5%	5%	0%	0%	0%	7%
	Regularly interested	16%	9%	10%	23%	0%	5%	27%	23%
	Interested	58%	59%	52%	68%	87%	77%	45%	46%
	Very interested	18%	18%	33%	0%	13%	18%	23%	19%
	Does not know	0%	5%	0%	0%	0%	0%	0%	0%

Chart 4: Concept acceptance index results

Prepared by: (Jácome & Ordóñez, 2016

Scenarios	Total	Baños	Nulti	Paccha	Ricaurte	San Joaquin	Sayausí	Cuenca
OPTIMISTIC	33%	45%	48%	36%	22%	32%	41%	26%
MODERATE	24%	27%	38%	27%	9%	23%	36%	19%
CONSERVATIVE	12%	5%	29%	0%	0%	9%	23%	14%

Chart 5:Results of the three scenarios

Prepared by: (Jácome & Ordóñez, 2016)

In the optimistic scenario that represents the 33% of the total, **12.647** people would be predisposed to purchasing solar panels. In a moderate scenario, **9060** people would be interested in purchasing the panels (24%). Finally, within a conservative scenario, 12% seem enthusiastic to the idea of purchasing this type of renewable energy system (**4.530** people).

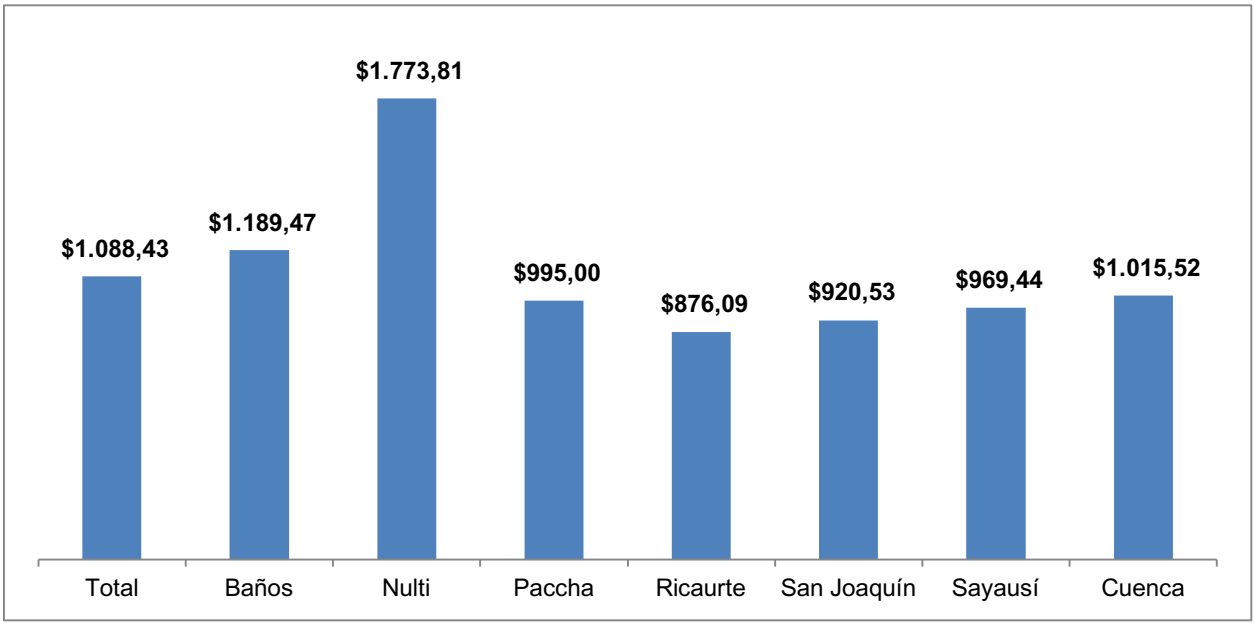


Illustration 31: How much would you be willing to pay for the photovoltaic system?

Prepared by: (Jácome & Ordóñez, 2016)

On average, they would be willing to pay $1.088,43.

2.8. Marketing strategies

Source: (Fernández)

Product- Solar panels are renewable energy systems that get energy from the Sun, being a source of energy that is already setting trends in several countries. It does not consume fuel.

Price- People would be willing to pay $1088.43. Due to the high price, they must be sold as a long term investment as the product can be used for 20 years or more. It is also important to look for sources in order to finance the purchase.

Place- In order to sell this product (sales channel) commercial agreements with credit cards could be aimed at a upper middle class (B) or upper class (A), that are willing to pay the displayed price.

Promotions- They should be directed to showing the benefits of this renewable energy system since most of the people have a general knowledge of what they are but they do not know well how they work. Media printed advertising, radio, television and the internet can be used to talk about the advantages.

It is also important to consider that 85% of the survey participants consider energy-saving in households is essential and they have a lot of habits of doing so.

- In the same way, by means of this system, energy can be provided in areas with a difficult energy supply access.
- On the other hand, the environmental impact is almost null as it does not produce pollution. It also avoids greater amounts of pollutant emissions.
- PV systems do not produce any annoying sounds while they operate and they last for 20 years or more.

2.9 Solar Panels imports

January 2013 - August 2016					
Total FOB	Total Freight	Total insurance	Total CIF	Total net weight	Total units
$1,145,627.90	$16,802.86	$2,794.43	$1,165,971.08	141442.66	279.1

Chart 6: Solar Panels Imports to Ecuador

Prepared by: (Jácome & Ordóñez, 2016)

Source: (Group)

From 2013 to 2016, 279 solar panels have been imported (power description superior to 18.5 kw but less or equal to 30 kw).

Business Name	Units Sum	CIF US$	Participation
ESLIVE S.A.	61	$52,510.54	22%
NAPORTEC S.A.	46	$555,269.86	16%
PASQUEL RUPERTO FABIAN	43	$4,365.11	15%
ALMACENES JUAN ELJURI CIA. LTDA.	29	$285,342.34	10%
GENMAQ CIA. LTDA.	22	$150,199.48	8%
DECOCINA CIA. LTDA.	15	$ 162.79	5%
VIPRENCAR S.A.	9	$5,210.61	3%
SINOHYDRO CORPORATION	8	$11,423.06	3%
SCHLUMBERGER ECUADOR S.A.	5	$13,139.04	2%
AEROAGRIPAC S.A.	3	$2,239.00	1%

Chart 7: Solar Panels main importers

Prepared by: (Jácome & Ordóñez, 2016)

Source: (Group)

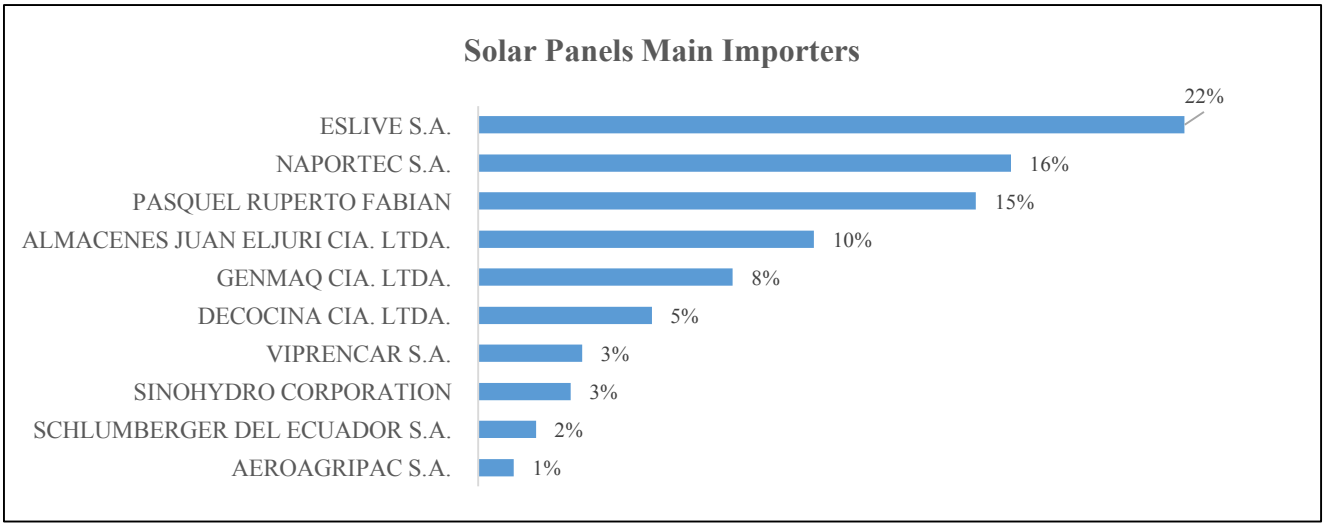


Illustration 32: Solar Panels Main Importers

Source: (Group)

In the illustration, solar panels main importers arise from 2013 to 2016, representing more than 80%. The main suppliers are: Guayaquil, Quito and Cuenca, being ESLIVE S.A. the main importer with 22%, followed by NAPORTEC S.A Pasquel Ruperto Fabián with the 16% and Almacenes Juan Eljuri with the 10%.

Top imported brands: 2013-2016

A total of 30 brands have been imported, being the main importing countries: United States with the 46% and China with the 33%, while other countries with a major participation are: Brazil, Spain, Japan, United Kingdom and Italy which represent around 21%.

Brand	Units	Participation
UNSPECIFIED	66.1	23.68%
YOUR	41	14.69%
CARRIER	40	14.33%
MWM	29	10.39%
UNBRANDED	26	9.32%
APLUS	19	6.81%
NARDI	15	5.37%
GEXIN	6	2.15%
DINGOL BRAND	3	1.07%
STAMFORD	3	1.07%
Other *[1]	31	11.11%

Chart 8: Top imported

Prepared by: (Jácome & Ordóñez, 2016)

Source: (Group)

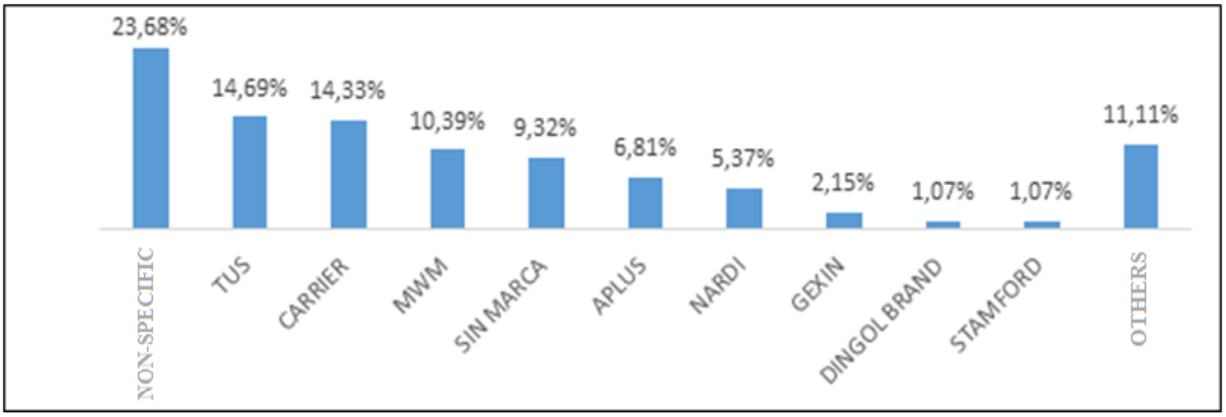


Illustration 33: Top Imported Brands

Prepared by: (Jácome & Ordóñez, 2016)

Source: (Group)

The main customs ports are: Guayaquil (84% through land and sea); Quito (14%) and Esmeraldas (2%).

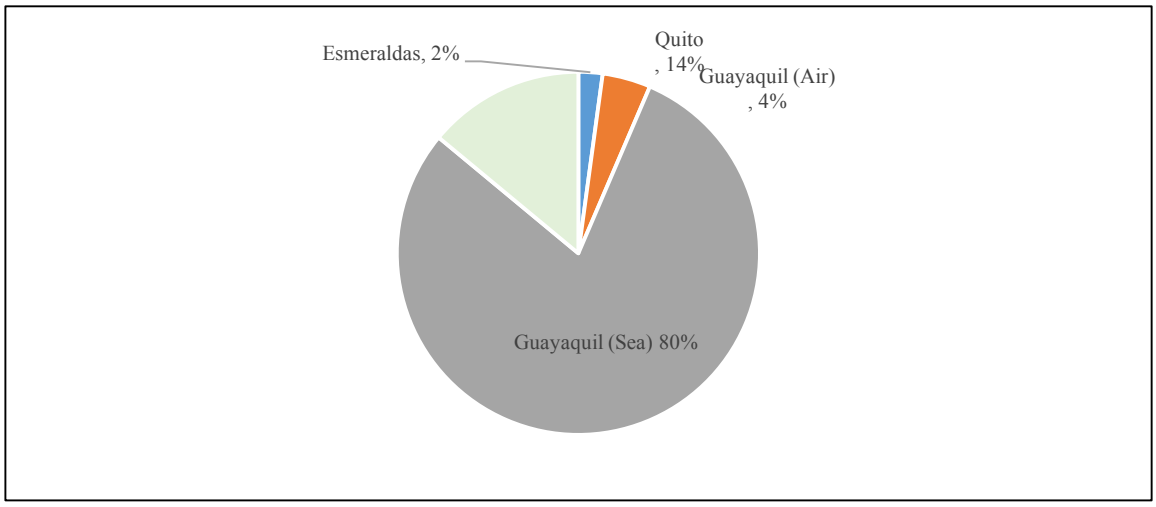


Illustration 34: Main Customs Ports

Prepared by: (Jácome & Ordóñez, 2016)

Source: (Group)

Solar panels import by company and brand

The following chart shows the imported brands by provider, where the ones with a bigger market participation (86%) between 2013 and 2016 are shown.

Business Name	Brand	Units	Total	Participation
ESLIVE S.A.	SIN ESPECEIFICAR SIN MARCA	46 15	61	22%
NAPORTEC S.A.	CARRIER SIN MARCA	40 6	46	16%
PASQUEL RUPERTO FABIAN	TEX TUS	2 41	43	16%
ALMACENES JUAN ELJURI CIA. LTDA.	MWM	29	29	10%
GENMAQ CIA. LTDA.	APLUS STAMFORD	19 3	22	8%
DECOCINA CIA. LTDA.	NARDI	15	15	5%
VIPRENCAR S.A.	DINGOL BRAND GEXIN	3 6	9	3%
SINOHYDRO CORPORATION	SIN ESPECEIFICAR SINOHYDRO	6 2	8	3%
SCHLUMBERGER DEL ECUADOR S.A.	SIN ESPECEIFICAR PETROLEUM SCHLUMBERGER	1 2 2	4	2%
AEROAGRIPAC S.A.	SIN ESPECEIFICAR	3.1	3	1.11%

Chart 9: Solar panels import by company and brand

Prepared by: (Jácome & Ordóñez, 2016)

Source: (Group)

Total imports by brand

The following chart details the total imports by brands, units, CIF value, FOB value, freight and insurance value.

Brand	Units	FOB Sum US$	Average Sum CIF	CIF Sum US$	Insurance Sum US$	Freight Sum US$
SIN ESPECIFICAR	66.1	$ 72,522.81	$ 44,406.59	$ 75,625.34	$ 389.11	$ 2,713.42
AMS	1	$ 6,297.27	$ 6,350.44	$ 6,350.44	$ 3.17	$ 50.00
APLUS	19	$ 138,890.00	$ 7,517.15	$ 142,825.80	$ 285.80	$ 3,650.00
BAKER RULLMAN	1	$ 1,720.00	$ 1,735.33	$ 1,735.33	$ 2.71	$ 12.62
BROADCROWN	1	$ 10,365.00	$ 11,253.89	$ 11,253.89	$ 45.13	$ 843.76
CARRIER	40	$ 480,000.00	$ 24,143.16	$ 482,863.13	$ 402.38	$ 2,460.75
CATERPILLAR	2	$ 242.29	$ 126.85	$ 253.69	$ 2.51	$ 8.89
CERULEAN	1	$ 76.24	$ 113.00	$ 113.00	$ 0.28	$ 36.49
DEUTZ	1	$ 4,710.32	$ 4,733.15	$ 4,733.15	$ 19.60	$ 3.23
DINGOL BRAND	3	$ 2,043.00	$ 2,091.69	$ 2,091.69	$ 20.70	$ 27.99
DOOSAN INFRACORE	1	$ 604.66	$ 674.66	$ 674.66	$ 17.11	$ 52.89
GEXIN	6	$ 2,951.00	$ 2,101.12	$ 3,118.92	$ 30.87	$ 137.04
HAIWEINENG	2	$ 1,555.00	$ 1,646.02	$ 1,646.02	$ 16.29	$ 74.72
KOHLER	2	$ 7,090.00	$ 8,044.07	$ 8,044.07	$ 63.87	$ 890.20
MAQUINARIA SANTA FE	1	$ 350.97	$ 454.50	$ 454.50	$ 4.50	$ 99.03
MARATHON	1	$ 1,396.24	$ 1,460.97	$ 1,460.97	$ 13.30	$ 51.43
MWM	29	$ 280,413.13	$ 37,476.85	$ 285,342.34	$ 1,120.22	$ 3,809.00
NARDI	15	$ 106.36	$ 10.85	$ 162.79	$ 1.61	$ 54.82
NN	2	$ 263.30	$ 271.28	$ 271.28	$ 2.11	$ 5.87
PETROLEUM	2	$ 6,400.80	$ 3,239.52	$ 6,479.03	$ 0.73	$ 77.50
SCALLONIA	1	$ 4,350.30	$ 4,399.69	$ 4,399.69	$ 49.01	$ 0.38
SCHLUMBERGER	2	$ 1,787.40	$ 912.61	$ 1,825.21	$ 0.18	$ 37.63
SHANDONG HUATONG	2	$ 12,599.02	$ 6,672.46	$ 13,344.91	$ -	$ -
SIN MARCA	26	$ 92,669.04	$ 21,969.96	$ 94,037.44	$ 174.62	$ 1,193.78
SINOHYDRO	2	$ 421.58	$ 217.00	$ 434.00	$ 0.72	$ 11.70
STAMFORD	3	$ 7,182.00	$ 2,457.89	$ 7,373.68	$ 73.01	$ 118.67
TEX	2	$ 252.00	$ 128.31	$ 256.61	$ 1.63	$ 2.98
TUS	41	$ 4,034.64	$ 1,320.46	$ 4,108.50	$ 26.14	$ 47.71
VALENTBIOSCIENCES CORPOR	1	$ 1,400.00	$ 1,605.90	$ 1,605.90	$ 15.90	$ 190.00
WEG	2	$ 2,377.88	$ 1,257.19	$ 2,514.38	$ 9.79	$ 126.71
WORLDWIDE PARTS EQUIPMEN	1	$ 555.65	$ 570.73	$ 570.73	$ 1.43	$ 13.65
Total	279.1	$ 1,145,627.90	$ 199,363.26	$ 1,165,971.09	$ 2,794.43	$ 16,802.86

Chart 10:Total imports by brand

Prepared by: (Jácome & Ordóñez, 2016)

Source: (Group)

Chapter 3: Analysis and establishment of the origin of the panels (country) and involved costs

3.1 Centrosur Data: 2012-2015

Prior to the analysis of the different suppliers, it has been relevant to back up the energy consumption data (Kw/h and dollars) in the parishes listed below to establish the household average consumption and thus determine the quantity and capacity of the photovoltaic systems to be imported. The following charts show the annual consumption in: dollars, Kw/h, the number of

households by parish, the consumption for housing both in dollars and in KW/h and the relationship between price and power consumption.

PARISH	PAYMENT	CONSUMPTION (KW)	HOUSE HOLDS	ANNUAL H. PAYMENT	ANUAL H.CONSUMPTION (KW/H)	DAILY CONSUMPTION PER HOUSEHOLD	PAYMENT (KW)
BAÑOS	701.615,15	8.209.962,00	6.915,00	101,46	1187,27	3,25	0,09
BELLAVISTA	904.834,81	10.616.439,00	6.753,00	133,99	1572,11	4,31	0,09
CAÑARIBAMBA	625.169,10	7.432.376,00	4.322,00	144,65	1719,66	4,71	0,08
EL BATÁN	1.052.846,87	12.276.866,00	7.432,00	141,66	1651,89	4,53	0,09
EL SAGRARIO	412.480,03	4.704.323,00	2.944,00	140,11	1597,94	4,38	0,09
EL VECINO	1.329.348,89	15.699.908,00	10.207,00	130,24	1538,15	4,21	0,08
GIL RAMÍREZ DÁVALOS	318.960,53	3.709.452,00	2.442,00	130,61	1519,02	4,16	0,09
HERMANO MIGUEL	297.722,17	3.634.095,00	2.459,00	121,07	1477,88	4,05	0,08
HUAYNACÁPAC	906.380,69	10.280.691,00	5.333,00	169,96	1927,75	5,28	0,09
MACHÁNGARA	589.004,08	6.818.847,00	4.037,00	145,90	1689,09	4,63	0,09
MONAY	647.028,31	7.691.205,00	5.029,00	128,66	1529,37	4,19	0,08
MULTI	383.790,20	4.260.732,00	3.101,00	123,76	1373,99	3,76	0,09
RICAURTE	706.771,04	8.542.655,00	6.634,00	106,54	1287,71	3,53	0,08
SAN BLAS	406.455,42	4.806.765,00	3.008,00	135,12	1597,99	4,38	0,08
SAN JOAQUÍN	278.814,35	3.272.961,00	2.364,00	117,94	1384,50	3,79	0,09
SAN SEBASTIÁN	1.352.684,90	15.704.129,00	9.640,00	140,32	1629,06	4,46	0,09
SAYAUSÍ	611.892,96	7.332.324,00	5.681,00	107,71	1290,67	3,54	0,08
SUCRE	932.969,91	10.350.632,00	5.375,00	173,58	1925,70	5,28	0,09
TOTORACOCHA	1.168.378,78	13.924.631,00	8.828,00	132,35	1577,33	4,32	0,08
PACCHA	212.992,22	1.842.094,00	2.099,00	101,47	877,61	2,40	0,12
YANUNCAY	2.010.078,81	23.316.014,00	14.765,00	136,14	1579,14	4,33	0,09
Total 2012	15850219,22	1844271,01	119368	2763,25	31933,82		
AVERAGE 2012	754772,34	878224,2,90	5684,19	131,58	1520,66	4,17	0,09

Chart 11:Energy consumption and payment 2012

Prepared by: (Jácome & Ordóñez, 2016)

Source: (Utta, 2016)

PARISH	PAYMENT	CONSUMPTION (KW)	HOUSEHOLDS	ANNUAL H. PAYMENT	ANNUAL H. CONSUMPTION (KW/H)	DAILY CONSUMPTION PER HOUSE HOLD	PAYMENT (KW)
BAÑOS	770.620,97	8.436.876,00	7.243,00	106,40	116483	3,191	0,09
BELAVISTA	983.766,82	10.628.511,00	6.933,00	141,90	153303	4,200	0,09
CAÑARIBAMBA	682.258,23	7.386.601,00	4.349,00	156,88	169846	4,653	0,09
EL BATÁN	1.131.459,72	12.117.516,00	7.631,00	148,27	158793	4,351	0,09
EL SAGRARIO	441.449,53	4.643.329,00	2.955,00	149,39	157135	4,305	0,10
EL VECINO	1.462.565,97	15.914.129,00	10.590,00	138,11	150275	4,117	0,09
GIL RAMÍREZ DÁVALOS	349.450,49	3.707.637,00	2.432,00	143,69	152452	4,177	0,09
HERMANO MIGUEL	330.326,96	3.632.677,00	2.456,00	134,50	147910	4,052	0,09
HUAYNACÁPAC	945.606,53	9.956.243,00	5.534,00	170,87	179910	4,929	0,09
MACHÁNGARA	629.065,02	6.752.292,00	4.291,00	146,60	157359	4,311	0,09
MONAY	729.046,25	7.932.824,00	5.159,00	141,32	153767	4,213	0,09
NULTI	383.965,33	4.099.425,00	3.217,00	119,36	126187	3,457	0,09
RICAURTE	807.944,06	8.885.252,00	7.088,00	113,99	125356	3,434	0,09
SAN BLAS	428.839,80	4.629.478,00	3.005,00	142,71	154059	4,221	0,09
SAN JOAQUÍN	335.241,76	3.392.981,00	2.500,00	134,10	135719	3,718	0,10
SAN SEBASTIÁN	1.340.513,83	14.320.748,00	10.191,00	131,54	140523	3,850	0,09
SAYAUSÍ	682.332,23	7.478.239,00	5.918,00	115,30	126364	3,462	0,09
SUCRE	919.409,05	9.590.796,00	5.446,00	168,82	176107	4,825	0,10
TOTORACOCHA	1.304.589,90	14.131.532,00	8.965,00	145,52	157630	4,319	0,09
PACCHA	163.695,96	1.833.239,00	2.002,00	81,77	915,70	2,509	0,09
YANUNCAY	2.119.059,38	22.800.406,00	15.467,00	137,01	147413	4,039	0,09
Total 2013	16.941.207,79	182.230.731,00	123.372,00	2868,01	30781,64		
AVERAGE 2013	806.724,18	8.677.653,86	5.874,86	136,57	146579	4,016	0,09

Chart 12:Energy consumption and payment 2013

Prepared by: (Jácome & Ordóñez, 2016)

Source: (Utta, 2016)

PARISH	PAYMENT	CONSUMPTION (KW/H)	HOUSEHOLDS	ANNUAL H. PAYMENT	ANNUAL H. CONSUMPTION KW/H	DAILY CONSUMPTION PER HOUSEHOLD KW	PAYMENT (KW)
BAÑOS	1609055,91	17550850	7904	203,57	2220,50	6,08	0,09
BELLAVISTA	1184395,7	11802403	7282	162,65	1620,76	4,44	0,10
CAÑARIBAMBA	738586,76	7319027	4452	165,90	1643,99	4,50	0,10
EL BATÁN	1333537,92	13399252	8033	166,01	1668,03	4,57	0,10
EL SAGRARIO	551362,1	5456483	3000	183,79	1818,83	4,98	0,10
EL VECINO	2995007,78	36042160	11172	268,08	3226,12	8,84	0,08
GIL RAMÍREZ DÁVALOS	1844011,94	17261557	2467	747,47	6996,98	19,17	0,11
HERMANO MIGUEL	846189,67	8786814	2454	344,82	3580,61	9,81	0,10
HUAYNACÁPAC	1509126,41	15988710	5822	259,21	2746,26	7,52	0,09
MACHÁNGARA	699264,8	6988524	4726	147,96	1478,74	4,05	0,10
MONAY	1474438,19	14600873	5527	266,77	2641,74	7,24	0,10
NULTI	465591,87	4445961	3540	131,52	1255,92	3,44	0,10
PACCHA	535454,31	5906882	7822	68,45	755,16	2,07	0,09
RICAURTE	957320,64	9305140	3090	309,81	3011,37	8,25	0,10
SAN BLAS	517453,2	5143694	2693	192,15	1910,02	5,23	0,10
SAN JOAQUÍN	434665,47	4236528	11119	39,09	381,02	1,04	0,10
SAN SEBASTIÁN	1904862,49	19211117	6388	298,19	3007,38	8,24	0,10
SAYAUSÍ	819192,17	8035844	5669	144,50	1417,51	3,88	0,10
SUCRE	1109557,99	10768093	9300	119,31	1157,86	3,17	0,10
TOTORACOCHA	1450635,63	14402785	16578	87,50	868,79	2,38	0,10
YANUNCAY	2412052,1	23206658	2337	1032,11	9930,11	27,21	0,10
TOTAL	25391763,05	259859355	131375	5338,886179	53337,68		
AVERAGE	1209131,57	12374255,00	6255,95	254,23	2539,89	6,96	0,10

Chart 13:Energy consumption and payment 2014

Prepared by: (Jácome & Ordóñez, 2016)

Source: (Utta, 2016)

PARISH	PAYMENT	CONSUMPTION (KW/H)	HOUSEHOLDS	ANNUAL H. PAYMENT	ANNUAL H. CONSUMPTION KW/H	DAILY CONSUMPTION PER HOUSEHOLD KW	PAYMENT (KW)
BAÑOS	1079834,67	10094157	7904	136,62	1277,09	3,50	0,11
BELLAVISTA	1219740,36	11622728	7282	167,50	1596,09	4,37	0,10
CAÑARIBAMBA	795868,78	7626808	4452	178,77	1713,12	4,69	0,10
EL BATÁN	1396549,84	13280046	8033	173,85	1653,19	4,53	0,11
EL SAGRARIO	508619,42	4692366	3000	169,54	1564,12	4,29	0,11
EL VECINO	1827103,49	17379754	11172	163,54	1555,65	4,26	0,11
GIL RAMÍREZ DÁVALOS	401601,46	3743600	2467	162,79	1517,47	4,16	0,11
HERMANO MIGUEL	396246,83	3780698	2454	161,47	1540,63	4,22	0,10
HUAYNACÁPAC	1163553,34	11099902	5822	199,85	1906,54	5,22	0,10
MACHÁNGARA	805376,18	7738078	4726	170,41	1637,34	4,49	0,10
MONAY	896351	8588670	5527	162,18	1553,95	4,26	0,10
NULTI	567858,27	5276171	3540	160,41	1490,44	4,08	0,11
PACCHA	239493,56	2815485	7822	30,62	359,94	0,99	0,09
RICAURTE	1108464,3	9943995	3090	358,73	3218,12	8,82	0,11
SAN BLAS	513169,49	4780630	2693	190,56	1775,21	4,86	0,11
SAN JOAQUÍN	485748,51	5377700	11119	43,69	483,65	1,33	0,09
SAN SEBASTIÁN	1875726,55	16922173	6388	293,63	2649,06	7,26	0,11
SAYAUSÍ	911420,51	8700638	5669	160,77	1534,77	4,20	0,10
SUCRE	1126497,22	10944220	9300	121,13	1176,80	3,22	0,10
TOTORACOCHA	1537157,52	15655775	16578	92,72	944,37	2,59	0,10
YANUNCAY	2738655,28	24096443	2337	1171,87	10310,84	28,25	0,11
TOTAL	21595036,58	204160037	131375	4470,65	41458,41	113,58	
AVERAGE	1028335,08	9721906,52	6255,95	212,89	1974,21	5,41	0,10

Chart 14:Energy consumption and payment 2015

Prepared by: (Jácome & Ordóñez, 2016)

Source: (Utta, 2016)

The graphics that are shown below indicate the consumption growth in the different parishes (2012-2015). It is important to notice that between 2012 and 2015, consumption in millions of dollars has grown by 136,24%, while energy consumption (Kw/h) has grown by 110.7% between the first and the last year, which shows the territorial expansion that Cuenca has suffered within its urban and rural area.

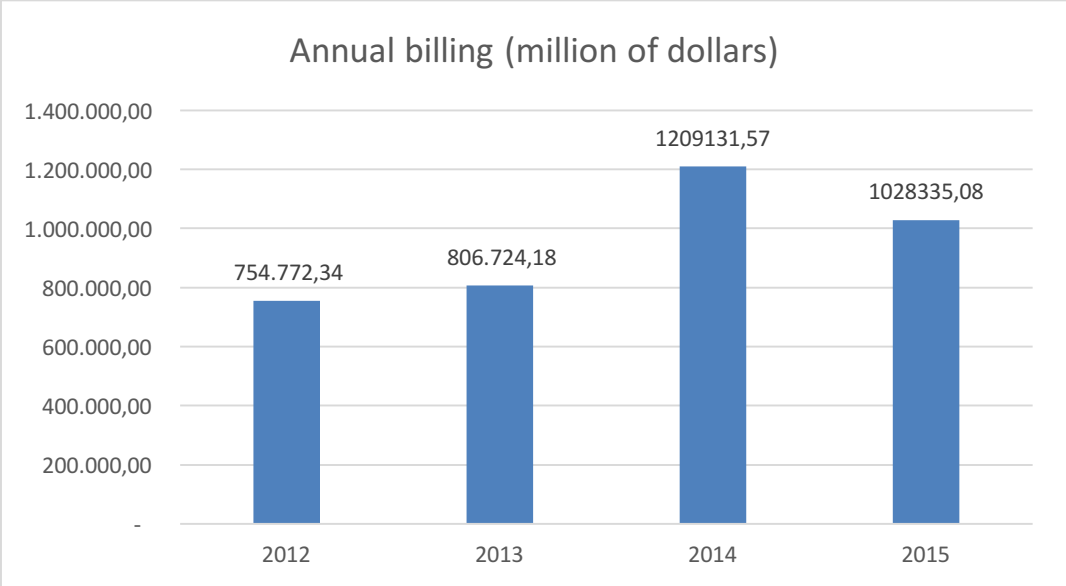


Illustration 35: Annual billing

Prepared by: (Jácome & Ordóñez, 2016)

Source: (Utta, 2016)

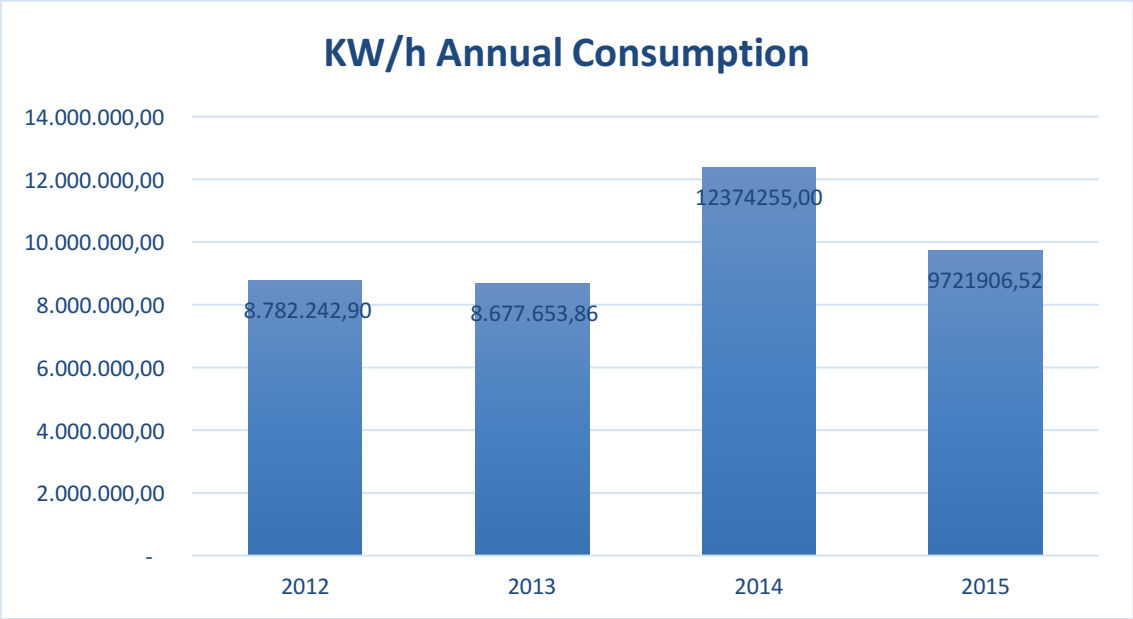


Illustration 36: kw/H Annual consumption

Prepared by: (Jácome & Ordóñez, 2016)

Source: (Utta, 2016)

The following chart shows the average of what is paid in the parishes depending on the energy consumption, where an increase of $0.01 can be seen between 2012 and 2015 (represents an increase rate of 11.11%).

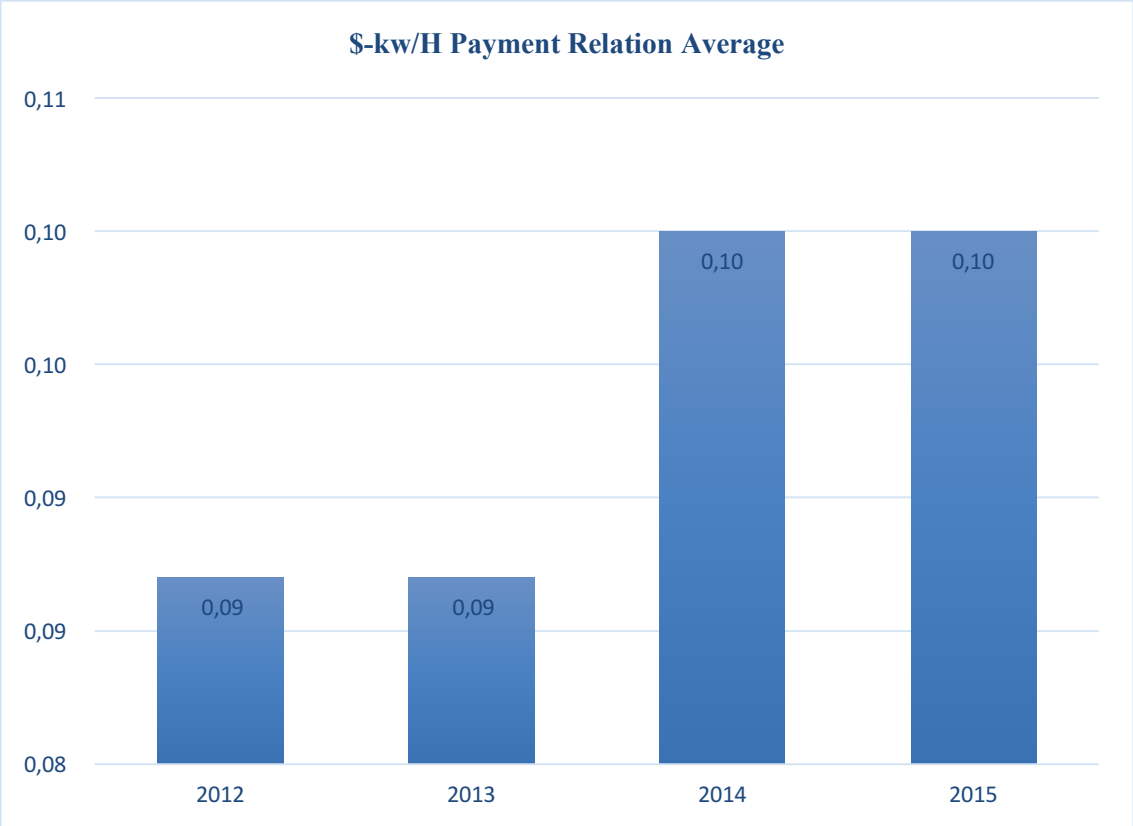


Illustration 37: Payment Relation average ($-kw/h)

Prepared by: (Jácome & Ordóñez, 2016)

Source: (Utta, 2016)

Similarly, it is important to mention the daily consumption average where it can be seen that between 2012 and 2015 KW/H household consumption doubles in the analyzed parishes. The preceding information is complemented by the latest census conducted in the country, whose data shows that Cuenca is the city that pays the mots for energy consumption reaching the monthly figure of $25 according to direct sources of the National Institute of Statistics and Censuses.

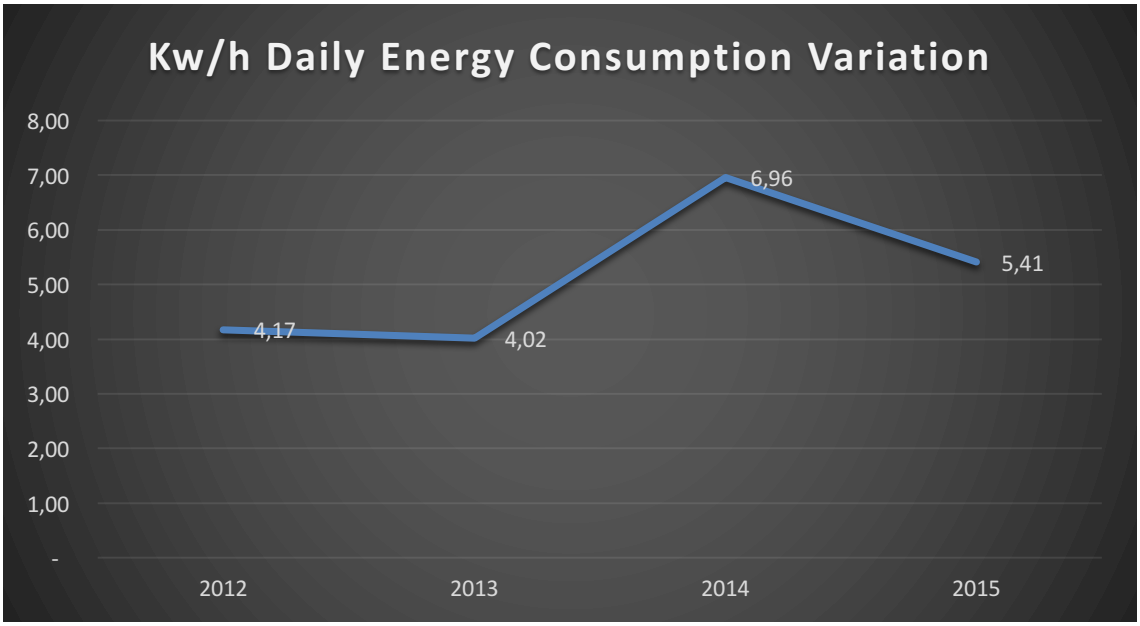


Illustration 38: Daily Energy Consumption Variation (Kw/h)

Prepared by: (Jácome & Ordóñez, 2016)

Source: (Utta, 2016)

3.2 Analysis of the different suppliers

Before making a decision on the most suitable supplier in different terms, it is advisable to describe the profile of the selected companies and then indicate the variables that have led to picking one of them.

Anern

Guangzhou Anern Energy Technology is a Chinese company that exports its products worldwide. Its website describes it as:

> A diversified company that provides scientific and technological innovation, applications in terms of energy and financial services, committed to improving life conditions and international cooperation through energy-saving

> technologies, efficient lighting and green energy solutions. As a leader in the field of renewable energy and LED lighting, Anern insists on the integration of advanced technology and professional design in each solution, mixing the best service with high quality products and having as a main objective the satisfaction of the clients. Anern offers a wide range of products, from solar lighting for streets, solar energy systems and all kinds of LED lights. The company has various allies around the world, which has allowed the export of its products to more than 50 countries in different regions. (Anern, 2016).

Solaris

Solaris Technology Industry is an American company that offers its products within their country, so shipments abroad and expenditures shall originate from by the importer. As stated on its website:

> Solaris is a company that provides tailored products, quality solar energy systems and solar panel kits for roofs throughout the country. As an innovative company, we supply solar components for residential and commercial applications and industry-leading products. Our inventory includes: solar panels, solar batteries, solar inverters, charge controllers, racking and mounting accessories, solar panel kits and a wide variety of products for homeowners and U.S. companies. (Solaris).

Hebei Mutian Solar Energy Scientech Development Ltd. Co.

Hebei Mutian Solar Energy Scientech Development is a Chinese factory that manufactures products that work with solar energy. The company is the leader in this segment with more than 50,000 successful projects in over 56 countries. Since 2006, it seeks to create innovative products with a low cost and high benefits to the consumer.

This company sends its products anywhere in the world, offers three-to-five-year warranty, and for solar panels, the warranty is extended to twenty years (they also offer technical service in all its products). The delivery of the products from China is estimated between 15 to 40 days and the packing of the goods has two modalities: packing in wooden box and packing in cartons (pallets included in both forms). The Incoterms that the company uses are ExWork (EXW) and Free On Board (FOB). (Hebei Mutian Solar Energy Scientech Development)

Nationwide Solar, Inc.

Nationwide Solar is a company domiciled in the United States, with offices in California and Oregon, which is in the photovoltaic industry since 1982, maintaining its philosophy of offering the best available products at the lowest price possible, without compromising service. The company offers custom designs that meet specific needs.

Also, Nationwide Solar provides assistance so that customers can create their own facilities. This help system has been implemented for eighteen years. In addition, the company offers warranty products that can vary from 90 days to twenty-five years. (Nationwide Solar)

3.3 Parameters for the selection of the suppliers

Quality: A photovoltaic system shows high quality when it meets the sale catalogue specified characteristics. The variables to be taken into account are: efficiency, energy production, energy storage and energy efficient conversion capacity.

Logistics and financing: It refers to the form of negotiation that the producer or distributor uses to sell its products and the facilities provided to the buyer on financing issues.

Terms of delivery: It refers to the way the company sends the product in terms of packaging (packing), since it can directly influence the container space capacity and the integrity of the product.

Customer service: It refers to the warranty offered by the company with respect to the product and technical advice.

Tariff: Trade agreements, as well as the existing tariff preferences between Ecuador and the producer country or supplier of the product shall be taken into account.

Technical barriers: They should be considered in case the photovoltaic system has technical restrictions for entering the country.

3.4 Providers Rating

Anern: After rating the different variables, its average is 9 and appears as one of the two strongest suppliers. As a company operating worldwide, the assurance of the quality of their products is obvious. Direct contact with Wendy Deng, Sales Executive and Senior Engineer in Anern, contributed to collect complete information about the photovoltaic system, its prices, shipping and details that will be shown in the next chapter.

Quality: 9

According to contacts made with the company, it was obtained that a 3KW panel produces 12KW/H daily. Additionally, during those days where people use more energy than usual or days without much sunlight, the panel includes the option to automatically connect to an electric grid, ensuring its efficiency (the capacity of the battery is 12V/150AH and the system includes eight batteries). According to Eliseo Sebastian (environmental consultant) when multiplying 150 AH by 12V, the capacity of the battery represents 1800 W (1.8 KW). The system includes eight batteries (14.4 KW), so the photovoltaic system as a whole, is capable of supplying the household consumption in the parishes of Cuenca as it was shown that in 2015 the daily consumption average was 9,89 KW/H. (Eliseo Sebastian)

Logistics and financing: 9

The history of the company demonstrates its seriousness so it is guaranteed that the products will arrive in the country without any damage.

Shipping conditions: 9

According to the obtained information, the company invests a lot of money in order to ensure that their products arrive intact to its destination (without any damage).

After-sales service: 9

The company guarantees a 25 year-panel use, as well as a minimum 5 year-warranty. This service includes online technical support if necessary.

Tariffs: 9

There are no restrictions to import products from China, while the company has international certifications that guarantee the photovoltaic system quality.

Technical barriers: 9

There are no restrictions for the photovoltaic system to enter the country.

Solaris: After rating the different variables, its average is 7.2.

Quality: 6

The company offers 2.2 KW panels, which, in its entirety, do not cover the demand in certain parishes and the prices are similar to the panels offered by Anern (higher capacity).

Logistics and financing: 6

The company operates in United States so the EXW Inconterm must be used in order to import the products. Costs associated with internal security, transportation, expenses of shipment, contract with the shipping company and others have to be covered by the importer.

Shipping conditions: 7

There is not much information about the protection the company gives in terms of shipping.

After-sales service: 7

Even though the company grants a guarantee of up to 30 years, it operates only in the United States so it would be hard to access to technical service and get help when needed.

Tariff: 7

There are no restrictions to import products from the United States, however there are logistical barriers that increase costs.

Technical barriers: 9

There are no restrictions for the photovoltaic system to enter the country.

Hebei Mutian Solar Energy Scientech Development: After rating the corresponding variables, this company obtained an average of 8.4. Qualifications and the description of each variable are shown below:

Quality: 8

According to contacts made with the company, it was obtained that a 3KW panel produces 12KW/H daily. Additionally, during the days where people use more energy than usual or days without much sunlight, the panel includes the option to automatically connecting to an electric grid, ensuring its efficiency (the capacity of the battery is 12V/150AH and the system includes four batteries).

Logistics and financing: 8

It provides the importer the flexibility to negotiate with the EXW and FOB Incoterms. The company is also flexible with the financing methods, offering payment options such as: credit card, telegraphic transfer (t/t) and letter of credit (l/c).

Shipping conditions: 9

According to the obtained information, the company invests a lot of money in order to ensure that their products arrive intact to its destination (without any damage).

After-sales service: 9

Hebei Mutian Solar Energy Scientech Development offers a warranty up to 20 years for the solar panels and they also offer technical service for all its products.

Tariff: 7

There are no restrictions to import the system from China. The importer only needs to cover the general tariffs.

Technical barriers: 9

There are no technical restrictions to import photovoltaic systems from China.

Nationwide Solar: After rating the different variables, this company obtained a 7.7 average. The ratings and the description of each variable are displayed below:

Quality: 8

According to contacts that have been made with the company, it was obtained that the 3KW panel produces 12KW/H daily. Unlike the systems used by other companies, it works without batteries, reducing its autonomy but creating an advantage in terms of the system durability.

Logistics and financing: 6

The company delivers its products within the United States, which means that the importer would have to cover costs such as: internal transport, insurance, loading management and transportation to Ecuador. The company does not offer information about the payment methods.

Shipping conditions: 7

The company attaches great importance to the packing of products in order to keep their integrity. However, as it only operates in the United States, the risk of damages increases by sending the products to a different country.

After-sales service: 9

The company offers a warranty up to 25 years. Technical service is available within the United States.

Tariff: 7

There are no restrictions to import the system from the United States. The importer only needs to cover the general tariffs.

Technical barriers: 9

There are no technical restrictions to import the photovoltaic systems from the United States.

Chapter 4: Explanation of the import process and its results for the local market

4.1 Definitions

Import

The National Customs Service of Ecuador (SENAE) defines importing as the action of entering foreign goods into the country, complying with customs formalities and obligations and depending on the import regime in which it has been declared.

The comparative advantage concept that belongs to David Ricardo, suggests that countries should export goods that are easier for them to produce (through specialization in the production of certain goods,) as this translates into lower production and sales costs. In addition, the importance of imports lies in the possibility of acquiring goods that are not produced in a country or that are produced with a better quality in foreign markets and at the same time necessary for the development of their population activities. Countries have the need to produce goods such as food, clothing, medicines, computer equipment, among others. However, a country cannot produce all the goods that are necessary for its population or, failing that, it is not always capable of producing one good or a service with the same efficiency as another.

The definitions exposed in the previous paragraph can be applied to Ecuador, and specifically, to Cuenca. In this particular case it will be taken into account that Ecuador does not have the capacity to produce all the goods or produce them with the same efficiency as in foreign markets. It is necessary to import products or services to Cuenca, to offer goods with competitive prices and superior quality for local consumers.

The import of photovoltaic solar panels to Cuenca must be carried out according to the characteristics of the demand, in relation to the production of energy that the system provides. In addition, the supplier company that offers the best price and quality must be selected.

Importers

According to the National Customs Service of Ecuador: companies and individuals, Ecuadorian or foreigners located in the country that have been registered as an importer in the ECUAPASS system and approved by “SENAE” are able to import.

Tariff

"Tariffs are foreign trade taxes and can be: ad valorem, specific or mixed" (COPCI, 2015). Money collected from tariffs is received by the State to give it the use that it considers suitable.

Ad-Valorem

Certain products, depending on their tariff item, will have to pay an ad-valorem value. "They are those laid down by the competent authority, consisting of percentages to be applied on the value of the goods." (COPCI, 2015)

Specific

Certain products, depending on their tariff item, have a specific tariff. "They are established by the competent authority, consistent in fixed surcharges that are applied based on certain conditions of goods, for example: weight, units, physical dimensions, volume, among others." (COPCI, 2015)

Mixed

Certain products, depending on their tariff item, have a mixed tariff. "They are laid down by the competent authority; In this case, the ad valorem and specific duties are applied jointly." (COPCI, 2015)

Support Documents

To carry out an import, it is necessary to have the documentation that shows the origin, the characteristics, the quantity, the price and the assurance that it has a load that will be or has

been transported for it later to be imported. Among the necessary documents, can be mentioned: commercial invoice, bill of lading, insurance policy and cargo manifest. (COPCI, 2015)

Commercial Invoice

The commercial invoice indicates the monetary value that was paid for the purchased goods and the payment of these. It is defined as "the original commercial invoice or document attesting to the commercial transaction or transfer ownership of equipment, apparatus or vehicle." (COPCI, 2015)

Bill of Lading

"It is a receipt given to the freight forwarder for the delivered goods." "It shows the existence of a maritime transportation contract and the merchandise granted rights." (ExportAr Mar del Plata Office –Division of Outside Trade & Secretary of Productive Development, 2016)

Insurance Policy

"Document that contains the stipulated conditions between insurer and insured, regarding the insurance contract. The applicable premiums are calculated according to the lasting of the contracts, the insured value and the inherent risks in the cargo during its handling and transportation." (COPCI, 2015)

Cargo Manifest

The cargo manifest is one of the indispensable documents when importing goods, as it contains relevant information about the cargo and its transportation. "Physical or electronic document containing information on the means of transport, number of packages, weight and generic identification of the goods comprising the cargo, which must be presented by any international carrier or its transport operator at the entrance or exit to customs."(COPCI, 2015)

4.1.1 Logistics and Operations

"In essence, logistic is about planning and implementing the necessary activities to carry out any project. To do so, the variables that define it are taken into account, establishing the relationships that exist between them. "(Aparicio, 2014)

Incoterms

In order to avoid misunderstandings, international trade participants (when importing or exporting goods) developed terms to facilitate foreign trade, called incoterms. "These terms are defined and elaborated by the International Chamber of Commerce (ICS), in order to establish a standardized language that can be used by buyers and sellers involved in international business. These are international rules for the interpretation of trade terms established by the International Chamber of Commerce. Its objective is to establish defined criteria on the distribution of expenses and transmission of risks, between exporter and importer. During the last review in 2010, the existence of 11 terms were determined: EXW, FAS, FOB, FCA, CFR, CIF, CPT, CIP, DDP, DAT, DAP. The Incoterms regulate: the delivery of goods, the transmission of risks, the

distribution of costs, and the related paperwork. They do not regulate: the form of payment or the applicable legislation and its use is not obligatory."(Mar del Plata Export-Office - Foreign Trade Division & Secretariat for Productive Development, 2016)

Merchandise

Refers to goods that are intended to be imported or exported and to which a corresponding tariff is applied. "Any property that can be object of transfer and that is susceptible of being classified in the national import tariff." (COPCI, 2015)

Packing

Packing is of great importance when transporting goods since it is intended to preserve the integrity of the cargo. "It offers merchandise protection during all transportation and handling operations involved in the export process, so that they reach the end customer abroad, in the best conditions." (ExportAr Mar del Plata Office - Foreign Trade Division & Secretariat for Productive Development, 2016)

Consolidation

"Combination of several small shipment units in order to apply port rates for full load containers."(Mar del Plata Export Office - Foreign Trade Division & Secretariat for Productive Development, 2016)

Container

Containers are used to carry the load, the dimensions may vary between 20 ft., 40 ft. and 40 ft. high-volume (high cube). "Packing metallic large and recoverable, of internationally agreed types and dimensions." (ExportAr Mar del Plata Office - Foreign Trade Division & Secretariat for Productive Development, 2016)

CONTAINERS CONTENEDORES						
20' STANDARD (DRY CARGO) 20' ESTÁNDAR (CARGA EN SECO)						
Capacity: Capacidad:	33,3 m3					
Tare Tara:	2.210 - 2.400 Kg					
Maximum Cargo: Carga Máxima:	**21.700** - 28.240 Kg					
Measurements Medidas	Outer Externa		Inner Interna		Open Door Puerta Abierta	
Length Largo	6,05 m	20'	5,90 m	19' 4''		
Width Ancho	2,43 m	8'	2,34 m	7' 8''	2,33 m	7' 8''
Height Alto	2,59 m	8' 6''	2,40 m	7' 10''	2,29 m	7' 6''
40' STANDARD (DRY CARGO) 40' ESTÁNDAR (CARGA EN SECO)						
Capacity: Capacidad:	67,7 m3					
Tare Tara:	3.630 - 3.740 Kg					
Maximum Cargo: Carga Máxima:	**26.742** - 28.750 Kg					
Measurements Medidas	Outer Externa		Inner Interna		Open Door Puerta Abierta	
Length Largo	12,19 m	40'	12,03 m	39' 6''		
Width Ancho	2,43 m	8'	2,34 m	7' 8''	2,33 m	7' 8''
Height Alto	2,59 m	8' 6''	2,40 m	7' 10''	2,29 m	7' 6''
40' STANDARD HC 40' ESTÁNDAR HC						
Capacity: Capacidad:	76,5 m3					
Tare Tara:	3.880 - 3.900 Kg					
Maximum Cargo: Carga Máxima:	**26.580** - 28.560 Kg					
Measurements Medidas	Outer Externa		Inner Interna		Open Door Puerta Abierta	
Length Largo	12,19 m	40'	12,03 m	39' 6''		
Width Ancho	2,43 m	8'	2,34 m	7' 8''	2,33 m	7' 8''
Height Alto	2,89 m	8' 11''	2,59 m	8' 6''	2,29 m	7' 6''

Illustration 39: Containers Dimensions

Source: (Despaxt, 2015)

4. 1.2 Tariff item and technical standards (INEN)

For the purpose of importing photovoltaic systems, research has been carried out to investigate the tariff item and determine the taxes that must be paid, as well as its constraints, preferences and other relevant aspects. As it is a photovoltaic solar panel, a battery, an inverter and wiring are required in order to operate efficiently. On the website (http://ecuapass.aduana.gob.ec/ipt_server/ipt_flex/ipt_arancel.jsp) it was obtained that the solar panel tariff item (85.41.40.10) requires “RTE INEN 069” for its import and the importer needs to pay an additional 5% (Ad Valorem), 14% (Value-Added Tax) and 0,5% (FODINFA). In addition, the battery tariff item (85.07.10.00) needs to fulfill the “RTE INEN 115” and the importer needs to pay an additional 25% (Ad Valorem), 14% (VAT) and 0.5% (FDI). In the inverter tariff item, there is no INEN requirement but it needs to pay other tributes named above with the exclusion of Ad Valorem. Adding all amounts, the final value to pay would be very high, so after several contacts made with different suppliers, it has been concluded that it is more profitable to import the photovoltaic system as a whole, classified in the 85.01.61.20.00 tariff item.

Within the explanatory notes that include the different tariff classification chapters, chapter 85 mentions:

> Machines, appliances and electrical equipment, and thereof parts; recording apparatus or reproduction of sound, recording or playback of images and sound in television, parts and accessories for these devices.

Chapter 85.01 refers to: "engines and electric generators, except generator sets”. 85.01.61 mentions "power output not exceeding 75 KW". While 85.01.61.20.00 refers to "solar panels combined with other devices and AC inverters, lower than 18.5 KW". In the current

classification, there is not any type of requirement by the “INEN”, and there is no restriction or Ad Valorem to be paid. The unique tributes to be paid are VAT (14%) and FODINFA (0.5%), so it is much more convenient to import the photovoltaic system as a whole.

To determine energy demand both in dollars and Kw/h, information has been requested in Centrosur in order to have a daily, monthly and yearly consumption average to establish the number and capacity of the panels to be imported. The results for the 2012-2015 period show a 4KW daily consumption average in the residential sector, so that imported panels shall comply with such capacity. Based on the data, the feasibility study will focus on urban parishes, including Baños, Sayausí, Ricaurte, San Joaquin and Nulti since they are practically part of the urban area (the 20 analyzed parishes cover more than 70% of the Cuenca Canton). The study will focus on the residential sector since the consumption of households can be supplied with photovoltaic systems to be imported from a provider that will be discussed later. Industrial consumption is much larger, so it is difficult to implement PV systems in the productive processes in the different companies whether they are big or small.

4.2 Suppliers and characteristics of the systems to be imported

In the preceding chapter, a comparison between different providers based on selection criteria allowed to choose the provider that adjusted to the parameters. Anern is the company that obtained the highest score in the various criteria, in addition to the confidence provided by a company that has been able to position worldwide. Also, it was possible to contact Wendy Deng (Sales Executive and Senior Engineer) who provided relevant data in terms of systems costs, warranty, general specifications and logistical matters.

Anern Industry Group Limited

Address: F101, No.11 Caipin Road, Science City, Luogang District, Guangzhou, China
Tel: +86 20 89269669/89269660 Email: export8@anern.com Website: www.anern.com

3KW Off-grid (with grid switch) Solar System Quotation			Ref No.: OFF-SGHP-3KW
System Basic Information:	Solar Panel Rated Output Power: 3KW Suggested for 24hrs Power Consumption: <12KWH Rated Loads Capacity: 3KW		
Solar Panel	Type: Polycrystalline Silicon PV Module Max Power: **250W** Vmp: 30.5V; Imp: 8.20A Size: 1640*990*40 mm Weight: 22kg/pc 25 years power output guarantee	QTY: 12 pcs Unit Price: $135 **Subtotal: $1,620**	
Controller	**PV Charging Controller 48V 60A**; PMW charging type, intelligent control. Temperature compensation; **Protections:** short circuit, deep discharge, input surge voltage, over current.	QTY: 1 pc Unit Price: $81 **Subtotal: $81**	**System Working Principle:** This system uses batteries to store the solar energy, at the same time, the system can be connected with the grid for utilization of grid power optionally. The system uses battery power in priority, but when sunshine is not so good or loads consumption is too big which caused the battery power inadequacy, then the system can switch automatically to grid power supply. When the batteries restore capacity, the system can switch back to battery power source.
Inverter	DC48V input, AC220V/110V 1-phase output, 50/60Hz; Rated Output Capacity: **3000W** Pure sine-wave output, off-grid with grid power switch type, with transformer. • **Various Protections:** Short circuit, overload, surge current, over temperature, over/under voltage, lightning, reverse polarity.	QTY: 1 pc Unit Price: $265 **Subtotal: $265**	
Battery	**12V/150AH** per piece AGM valve-regulated lead-acid battery, fully sealed, deep cycle, free maintenance type Service Life: 5~6 years	QTY: 8 pcs Unit Price: $148 **Subtotal: $1,184**	**Terms and conditions:** 1. Price: EXW Guangzhou. 2. Payment: 30% by T/T, balance by T/T before shipment or upon BL copy. Negotiable for big order. 3. Package: Export standard package suitable for tough handling and sea transport. 4. Delivery: Goods to be ready within 7~30 days depending on order quantity. 5. Warranty: 5 years for solar panel, 2 years for controller/inverter/battery. 6. Certification: CE,ROHS 7. Validity: 30 days.
Solar Panel Rack	Roof type mounting rack including complete fittings, aluminum alloy (Rack can be customized per request)	QTY: 1 set Unit Price: $215 **Subtotal: $215**	
Cables	International standard, with specification suitable for solar system, RVV-2*4 series	QTY: 50m Unit Price: $1.2 **Subtotal: $60**	
Connectors	3-terminal connectors, used for panels connection in parallel	QTY: 6 pairs Unit Price: $8.0 **Subtotal: $48**	
Total System Price: US$3,473			

Illustration 40: Pro-Forma Invoice

Source: (Anern, 2016)

As it can be seen in the previous image, the photovoltaic system is ready to be installed in a household and includes all devices and cables necessary for its operation, with the advantage that it can be additionally connected to the electric grids in case there is no enough solar energy or when consumption exceeds the normal levels. If none of the two scenarios occur, the system has eight batteries that store solar energy which guarantee the efficiency of the system as a

whole. The warranty for the solar panels is 5 years (useful life of 25 years), while for the inverter, controller and batteries is 2 years.

4.3 Import terms and conditions

The system total price is $3473 (EXW). However, contacts made with Wendy Deng allowed better terms of negotiation, where the final price of the system is $3633 (CIF), with a $1089,90 advance (30%) to ensure the order and then $2543,10 (70%) before the shipment (7 to 30 days) or with the Bill of Lading copy. In addition, the photovoltaic systems to be imported in a 20-foot container are 15 to 20 units, while in the 40-foot container are 35 to 40 units. It has been decided to import a 20 ft container (20 photovoltaic systems) in order to reduce the initial investment.

4.4 Import costs

According to the newsletter (363-2015) released by the National Customs Service of newsletter of Ecuador, minimum fees of a customs agent over procedures entering by sea shall be 60% of a basic wage, with an additional 14% VAT ($366). Similarly, according to the values displayed at the “Contecon” website (Guayaquil), port storage tariff is $3.26 per a 20 ft. container and $4.52 per a 40 feet container, with a 10-day maximum-storage term. The cost of transportation from Guayaquil to Cuenca is:

COOPERATIVA INTERPROVINCIAL DE TRANSPORTES ECUATORIANOS PESADOS

C.I.T.E.P.

SIRVIENDO A TODO EL PAIS CON MUCHOS AÑOS DE EXPERIENCIA EN EL TRANSPORTE DE CARGA

Cuenca 26 de octubre de 2016

Señor

RICARDO JÁCOME

Ciudad.

De mis consideraciones:

A nombre de todos quienes conformamos la Cooperativa Interprovincial de Transporte Ecuatorianos Pesados C. I. T. E. P., reciba un cordial saludo y a la vez que nos permitimos presentarle nuestra empresa, pionera en el Austro Ecuatoriano, fundada mediante Acuerdo Ministerial No 11703 e inscrita en el Registro General de Cooperativas con el número de orden 313, de fecha 9 de agosto de 1968, debidamente autorizada para prestar el Servicio de Transporte de Carga Pesada a nivel nacional, con Permiso de Operación vigente hasta noviembre de 2022, según resolución No 4820-DT-ANT-2011, establecida en el artículo 70 del reglamento de la LOTTTSV, contamos con una FLOTA vehicular de 20 TRACTOCAMIONES en perfecto estado de funcionamiento, equipados con rastreo satelital Hunter y teléfonos celulares, y para mayor seguridad a nuestros clientes, SIEMPRE viajamos en convoy, tenemos oficinas en la ciudad de Cuenca y Terminal propio en el Puerto de Guayaquil.

CONTENNEDORES DE IMPORTACIÓN:

Contenedores de 40 pies Guayaquil - Cuenca.....$ 700,00

EL PRECIO POR DÍA DE STAND BY $ 120,00

Las movilizaciones de carga suelta del Puerto a la oficina tiene un precio de: Camioneta desde $ 35,00 a $ 45,00, estibada de $ 5,00 a $ 10,00 dependiendo la cantidad, movilización de la oficina de Guayaquil a la Aduana en Cuenca el precio de la paleta $ de 50,00 a 80,00.

Atentamente,

Ing. Diego Ortiz L.

Gerente CITEP

0994133328 - 0992150349

COOPERATIVA INTERPROVINCIAL TRANSPORTES ECUATORIANOS PESADOS C.I.T.E.P.

CUENCA: Río Machángara s/n y Octavio Chacón Edificio de Exhibiciones Parque Industrial Oficina 234 y 235 Telfs.: 2807-098 2866-156 Telefax: 28

Correo Electrónico: ingdortiz69@yahoo.com R.U.C. 0390002734001

GUAYAQUIL: Av. 25 de Julio s/n y Vía al Puerto Marítimo (Frente a Petro Ecuador) Telfs.: (04)3842624 - (04) 3842660

Illustration 41: Pro-Forma Invoice

Source: (C.I.T.E.P., 2016)

In this way, the final cost of the photovoltaic system is explained below:

CIF	$3633
VAT (14%)	$508,62
FDI (0.5%)	$18.16
Customs agent	$250,34/20:12,52
Storage CONTECON - 3 days	$ 19.56/20: 0.98
Transportation GYE-CUE	$700/20: 35
TOTAL	$4208,30

Chart 15:Import costs

Prepared by: (Jácome & Ordóñez, 2016)

The final cost of the photovoltaic system is $4208,30. In order to import 20 units in a 20 feet container, the required investment is $84.166.

4.5 Technical study

Once the costs of the import for the photovoltaic systems have been determined, the results of the technical study will be displayed. Therefore, it needs to be clarified that monthly and annual sales are based on 1% of the conservative scenario (4530 clients), which represents around 45 potential clients pointing to a high socioeconomic level due to the costs of the system as a whole. The profit margin is 28%, while the direct labor and the administrator costs are based on a $400 monthly salary, apart from the benefits recognized by law.

Technical study	
Units per month	3-4
Units per year	45
Unit cost	$4.208,30
Sale price	$5.844,86
Annual sales	**$264.772,00**
Direct costs (Annual total)l:	**$204.556,00**
Solar panels	$190.636,00
Installation supplies	$7.200,00
Direct labor	$6.720,00
Indirect costs (Annual Total):	**$4.800,00**
Freight	$4.800,00
Administrative costs (Annual Total):	**$10.200,00**
Administrator	$5.400,00
Advertising	$4.800,00
Daily requirement	$28.00
Adm. working capital. Sales	$1.275,00
Fixed assets (furniture and furnishings)	$2500.00
furniture and fixtures depreciation (5%)	$150.00
Cash factor (credit to customers)	45

Daily requirement	$582,00
Cash cycle requirement	$26.169,00
Initial inventory	$84.166,00
Working operating capital	$110.335,00
Working capital	**$111.610,00**
Total investment	**$114.110,00**

Chart 16:Technical study

Prepared by: (Jácome & Ordóñez, 2016)

4.6 Financial study

Within the financial study, the State of results is projected, as well as the cash flow for the next five years (after that, the project needs to be re-evaluated).

% Annual increase		4%	6%	8%	10%
Description	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Sales	$264.772	$275.363	$291.885	$315.236	$346.759
(Direct costs)	$204.556	$212.738	$225.503	$243.543	$267.897
Utility gross	**$60.216**	**$62.625**	**$66.382**	**$71.693**	**$78.862**
(Indirect costs)	$4,800	$4.992	$5.292	$5.715	$6.286
Operational utility	**$55.416**	**$57.633**	**$61.091**	**$65.978**	**$72.576**
Sales and administrative expenses	$10,200	$10.608	$11.244	$12.144	$13.358
Financial Expenses	$5.391	$4.407	$3.317	$0	$0

Depreciation and amortization	$125	$125	$125	$125	$125
Income before benefits	**$39.700**	**$42.493**	**$46.404**	**$51.598**	**$58.317**
15% (workers utilities)	$5,955	$6.374	$6.961	$7.740	$8.748
Income before taxes	**$33.745**	**$36.119**	**$39.444**	**$43.858**	**$49.569**
22% (tax income)	$7.424	$7.946	$8.678	$9.649	$10.905
Net income	**$26.231**	**$28.173**	**$30.766**	**$34.210**	**$38.664**

Chart 17:State of results projected

Prepared by: (Jácome & Ordóñez, 2016)

Sales Recovery	98%

Description	Year 1	Year 2	Year 3	Year 4	Year 5
Sales	$259.477	$269.856	$286.047	$308.931	$339.824
(Direct costs)	$200.465	$208.483	$220.992	$238.672	$262.539
(Indirect costs)	$4,800	$4.992	$5.292	$5.715	$6.286
Sales and administrative expenses	$10,200	$10.608	$11.244	$12.144	$13.358
Operating flow	**$44.012**	**$45.772**	**$48.519**	**$52.400**	**$57.640**
Non-operating income					
Credit					
Self-contribution					
Non-operational expenses	**$27.979**	**$28.921**	**$30.239**	**$31.989**	**$34.253**

Investments					
Fixed assets					
Working capital	$50.500				
Dividends payment	$9.209	$10.194	$11.283	$12.490	$13.825
Financial expenses	$5.391	$4.407	$3.317	$2.111	$776
Taxes	$13.379	$14.320	$15.638	$17.389	$19.653
Non-operational flow	**-$27.979**	**-$28.921**	**-$30.239**	**-$31.989**	**-$34.253**
Net flow	**$127.643**	**$16.852**	**$18.280**	**$20.411**	**$23.387**
Accumulated flow	**$127.643**	**$144.495**	**$162.775**	**$183.186**	**$206.573**

NPV Flow	**$30.633**	**$35.579**	**$37.235**	**$39.911**	**$43.816**
NPV Flow 2	**$25.242**	**$27.045**	**$29.563**	**$32.901**	**$37.212**

Chart 18:Projected cash flow

Prepared by: (Jácome & Ordóñez, 2016)

In year 0, non-operating flow, net flow and accumulated flow are equal to $111.610: initial investment minus fixed assets.

4.7 Project Evaluation

To complete the analysis, it is necessary to present the most relevant financial ratios to demonstrate the feasibility of the thesis and its projection for the next five years.

Discount rate	**12.60%**					
Description	(Initial Inv.)	Year 1	Year 2	Year 3	Year 4	Year 5

Investor flow	-$114.110	$29.621	$35.579	$37.235	$39.911	$43.816
Accumulated flow		$29.621	$65.200	$102.435	$142.346	$186.161

Payback (investment recovery)		**(Less than the granted term)**		
Investment recovery year		Year	3	
Difference with the initial investment		$114.110	$102.435	$11.675
Monthly flow average (next year)		$39.911	12	$3.326
Months		$11.675	$3.326	3.51
PAYBACK	**3**	**Year (s)**	**4**	**Month (s)**
Net Present Value (NPV)	**$15.366**			
Internal rate of return (IRR)	**17,62%**			

Chart 19:Financial index

Prepared by: (Jácome & Ordóñez, 2016)

As shown in the previous chart, investment is recovered after three years and four months. The net present value of the project is $15366 with a 17.62% internal rate of return. According to the Grows Business website, "the NPV is a financial indicator that measures the flow of future inflows and outflows which will take a project, to determine, if after discounting the initial investment, any gain would be ours." If the result is positive, the project is viable"

(Grows Business, 2016). In relation to the internal rate of return, the website “Expansion” mentions that "the internal rate of return (IRR), is an evaluation investments method that measures the profitability of charges and updated payments, generated by an investment, in relative terms (as a percentage) and makes the NPV equal to zero". (Expansion, 2016)

4.8 Conclusions

To carry out this thesis, the transformation of the energy matrix that is being promoted in Ecuador was established by one of the main pillars, in order to develop commercial activities that generate economic benefits directly linked to trade, technological development and responsibility with the environmental care.

This thesis has determined the feasibility of the insertion of photovoltaic solar systems in the local market (Cuenca). To accomplish the goal, specific objectives have been attained such as: the definition of the guidelines, requirements and conditions for the solar panels import; the analysis and establishment of the origin of the panels (country) and involved costs; a market study in Cuenca Canton; the explanation of the import process and its results for the local market.

The results of this research show that the feasibility of the import and subsequent inclusion of photovoltaic panels in the local market, is linked to the compliance of certain technical regulations (in terms of market conditions and the financial area).

According to the obtained information by means of primary and secondary sources, it has been concluded that there are 4530 potential buyers, so the purpose of this project is focused on reaching 1% of that amount (45 potential buyers).

The photovoltaic system will be imported as a whole as there are no restrictions and therefore it is feasible (in the technical regulations area) to enter the local market.

In the financial area, the results indicate that the project is viable. The Net Present Value (NPV) shows a positive result ($15.366) and the internal rate of return (IRR) is 17.62%.

4.9 Recommendations

The recommendations for this project are focused on solving certain peculiarities that were found in the research. Price-wise, the first recommendation made is that the company that decides to execute the importation and subsequent sale, must seek a strategic alliance with credit cards that facilitate the financing of PV systems. In what refers to the place where the marketing will be held, it must be taken into account that the product is directed to the medium high (B) and high (A) consumer purchasing power.

The marketing of the product should emphasize the benefits related to long-term energy saving that generate this type of systems, based on the information obtained through primary sources, where 85% of the participants consider energy-savings essential. It should also emphasize the benefits generated since this type of system does not produce any pollution to the environment.

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[1] Other brands that represent 11.11% total; i.e. 20 marks.

Thesis Scheme:

Chapter 1: Definition of the guidelines, requirements and conditions for the solar panels import.

- Renewable Energy: Growth and Importance nowadays
- Energy Matrix: State Boost
- Solar Panels: Advantages and Benefits
- Import requirements, tariff classification, containerization.

Chapter 2: Market study in Cuenca Canton.

- Surveys elaboration (Urban and rural area)
- Survey Results Analysis

Chapter 3: Analysis and establishment of the origin of the panels (country) and involved costs

- Suppliers Analysis
- Analysis of the national solar panels acquisition (already in the market)
- Suppliers Study
- Selection of the most convenient supplier

Chapter 4: Explanation of the import process and its results for the local market

- Elaboration and exposition of the complete importation process
- Local market impact (results)