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**TRABAJO DE TITULACIÓN PREVIA A LA OBTENCIÓN DEL
TÍTULO DE LICENCIADA MULTILINGÜE EN NEGOCIOS Y
RELACIONES INTERNACIONALES**

**DESIGN OF A BUSINESS PLAN INTENDED FOR THE CREATION OF THE
FLUVIAL TRANSPORT COMPANY KARA SOLAR IN PASTAZA PROVINCE
WITH POSITIVE SOCIAL AND ENVIRONMENTAL IMPACT**

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DEDICATION

To our aboriginal elders. It is time we recognize, respect, and prolong the wisdom of all those who have gone before us, guiding our minds and spirits to keep nature and humanity alive.

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Every demanding work needs self-efforts as well as guidance, especially those who were close to our hearts.

My humble effort is dedicated:

To my beloved parents, Inés and Humberto, for being my guide stars, motivating me to pursue my dreams with passion and courage.

To my brothers, Diego and Israel, for taking care of me.

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I. THEME

DESIGN OF A BUSINESS PLAN INTENDED FOR THE CREATION OF THE FLUVIAL TRANSPORT COMPANY KARA SOLAR IN PASTAZA PROVINCE WITH POSITIVE SOCIAL AND ENVIRONMENTAL IMPACT

II. ABSTRACT

Since the industrial era, anthropogenic activities have caused the acceleration in the emission of greenhouse gases causing the planet's atmosphere to have a concentration of 407.61 ppm in 2018 which has not been observed in the last 800,000 years. This has generated the increase in temperature in the ocean and air, sea level rise, the loss of ice, and extreme weather events affecting the health of people, ecosystems, and economies. Correspondingly, the international community, including the private and public sectors, has created mechanisms and implemented measures to deal with this phenomenon based on the concept of sustainable development. Ecuador is not far behind and has inserted these two concepts in its Constitution and Plans of Good Living to face climate change. Also, there are projects and companies that seek not only to get economic benefit, but also to have a social and environmental impact. This is how Kara Solar came about, a project located in Pastaza province that seeks to tackle climate change and achieve sustainable development through a solar boat. This project seeks to become a community enterprise run by nine Achuar communities. However, Kara Solar does not have a model or a business plan. That is why the present dissertation project proposes to design these two in only one through the Lean Startup method, which includes a survey, and the Business Model Canvas (BMC), with positive social and environmental impact. For this purpose, the global, national, and local context will be analyzed mainly from the point of view of sustainable development, whose principles will allow us to understand the relationship between the social, environmental, and economic dimensions. This information and the survey will allow determining the environmental and social impacts that Kara Solar seeks to achieve through its business plan.

Key words: *climate change, sustainable development, business model, survey, canvas, renewable energy, solar energy, achuar, fluvial transport*

III. RESUMEN

Desde la era industrial, las actividades antropogénicas han causado la aceleración de la emisión de gases de efecto invernadero, ocasionando que la atmósfera del planeta tenga una concentración de 407.61 ppm en 2018, la cual no ha sido observada en los últimos 800.000 años. Esto ha generado el aumento de temperatura en el océano y el aire, del nivel del mar, de la pérdida de hielo y de eventos climáticos extremos, afectando a la salud de las personas, los ecosistemas y las economías. Es por ello que la comunidad internacional, incluyendo el sector privado y público, ha creado mecanismos e implementado medidas para hacer frente a este fenómeno principalmente basándose en el concepto de desarrollo sostenible. Ecuador no se ha quedado atrás y ha insertado estos dos conceptos en su Constitución y en sus Planes del Buen Vivir, estableciendo instituciones para hacer frente al cambio climático. Asimismo, existen proyectos y empresas que buscan no solo el beneficio económico, sino también tener impacto social y ambiental. Es así como surgió Kara Solar, un proyecto localizado en la provincia de Pastaza que busca hacer frente al cambio climático y alcanzar el desarrollo sostenible mediante un bote solar. Este proyecto busca convertirse en una empresa comunitaria que esté a cargo de nueve comunidades Achuar. Sin embargo, Kara Solar no cuenta con un modelo ni un plan de negocios. Es por ello que el presente trabajo de disertación propone diseñar estos dos en uno solo a través del método Lean Startup, el cual incluye una encuesta, y el Lienzo de Negocios (BMC, por sus siglas en inglés) con impacto social y ambiental. Para este propósito, el contexto mundial, nacional y local serán analizados principalmente desde el punto de vista del desarrollo sostenible cuyos principios nos permitirán comprender la relación entre la dimensión medioambiental, social y económica. Esta información y la encuesta permitirán determinar los impactos ambientales y sociales que Kara Solar busca lograr mediante su plan de negocios.

Palabras clave: *cambio climático, desarrollo sostenible, modelo de negocio, encuesta, lienzo, energía renovable, energía solar, achuar, transporte fluvial*

IV. RÉSUMÉ

Depuis l'ère industrielle, les activités anthropiques ont provoqué l'accélération des émissions de gaz à effet de serre, ce qui a entraîné une concentration de l'atmosphère de 407,61 ppm en 2018, ce qui n'a pas été observé depuis 800.000 ans. Cela a généré l'augmentation de la température dans l'océan et l'air, le niveau de la mer, la perte de glace et les phénomènes météorologiques extrêmes qui affectent la santé des personnes, des écosystèmes et des économies. C'est pourquoi la communauté internationale, y compris le secteur privé et le public ont créé des mécanismes et mis en œuvre des mesures pour faire face à ce phénomène principalement basé sur le concept de développement durable. Et l'Équateur n'a pas été laissé de côté en insérant ces deux concepts dans sa Constitution et ses Plans du Bien Vivre établissant des institutions pour faire face au changement climatique. En outre, il existe des projets et des entreprises qui recherchent non seulement des avantages économiques, mais aussi un impact social et environnemental. C'est ainsi que Kara Solar est né, un projet situé dans la province de Pastaza qui vise à lutter contre le changement climatique et à atteindre un développement durable grâce à un bateau solaire. Ce projet vise à devenir une entreprise communautaire gérée par neuf communautés Achuar. Cependant, Kara Solar n'a pas de modèle ou plan d'affaires. C'est pourquoi le présent mémoire propose de concevoir ces deux en un à travers la méthode Lean Startup, qui comprend une enquête, et le Business Model Canvas (BMC) avec un impact social et environnemental. A cet effet, le contexte global, national et local sera analysé principalement du point de vue du développement durable dont les principes nous permettront de comprendre la relation entre la dimension social, environnementale et économique. Ces informations et l'enquête permettront de déterminer les impacts environnementaux et sociaux que Kara Solar cherche à réaliser à travers son plan d'affaires.

Mots-clés: changement climatique, développement durable, business model, enquête, *toile, énergie renouvelable, énergie solaire, Achuar, transport fluvial*

V. INTRODUCTION

Climate change is the abiding alteration in Earth's climate due to anthropogenic activities. These have caused a rise in the concentration of greenhouse gases (GHGs) in the atmosphere which ensuing have increased the natural greenhouse effect (IPCC, 2018). Consequently, the number of parts per million of atmospheric carbon dioxide is 407.61, an amount not recorded in the last 800,000 years. This has threatened food security and augmented the number of droughts and ocean acidification. Likewise, in 2012, around seven million people deceased due to environmental pollution (UNFCCC, 2017).

In 1992, the UNFCCC, a binding international treaty, recognized climate change as a real and current situation and seeks to respond to this phenomenon (KAS, 2018). This has led the international community to implement practical measures to reverse environmental problems and achieve sustainable development. The World Commission on Environment and Development states its definition as follows:

"Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987).

For this purpose, the General Assembly defines *development* as “*a comprehensive economic, social, cultural, and political process, which aims the constant improvement of the well-being of the entire population*” (United Nations General Assembly, 1986). Therefore, it involves a progressive transformation of the economy and society (WCED, 1987) in a continuous process of social interaction (Qerimi, 2012), while retaining respect for the cultural values, which are the basis for the design and management of public agencies and policies in each country (Cooper & Vargas, 2004); *sustainability* implies not only the protection and improvement of the environment (UN, 1990), but also a concern for social equity between and within each generation; and, the concept of *needs* refers particularly to the ones of the world's poor. This vision highlights the need to conserve and enhance the natural resources and ecosystems as the base of a sustainable future, combined with the need to

redistribute wealth to achieve equity in an ecologically limited world (WCED, 1987).

In this way, since the recognition of climate change is a true global threat and sustainable development a means to address it, these concepts have gained attention and application by governments worldwide to the point of being implemented in initiatives such as the Intergovernmental Panel on Climate Change, the United Nations Framework Convention on Climate Change, the Millennium Declaration, the Kyoto Protocol, the Paris Agreement, and the 2030 Agenda (ICM, 2016).

Ecuador, as a signatory to the aforementioned accords, has declared adaptation and mitigation of climate change as State Policy and the Ministry of the Environment was mandated to formulate and execute a national strategy. Also, the government has introduced the concepts of climate change and sustainable development in its Constitution and has implemented the National Plans for Good Living based on them. However, the Ecuadorian productive matrix still generates greenhouse gases, 0.15% of worldwide emissions (Ministerio del Ambiente, 2016), reaching a total of 51,424.20 kton CO₂-eq (MICSE, 2016). Consequently, due to climate change, glaciers of Andean moors have decreased and therefore water supplies (El Universo, 2017). Also, since the 90s, the amount of CO₂ absorbed by the Amazon rainforest has been reduced by half (ABC, 2015) because its wood resource has been destroyed by 30% (La Hora, 2014).

Accordingly, one of the means proposed by the government to face climate change was the energy industry. In fact, renewables correspond to 51.5% of the electricity sector (MICSE, 2016). Additionally, there are Ecuadorian companies devoted to the business of renewable energy, including initiatives that aim to have social and environmental impact. This is the case of Kara Solar, a community project located in the Ecuadorian Amazon. This initiative seeks to contribute to sustainable development in the region and tackle climate change. However, according to the Technical Assistant of ALDEA, Mónica Hernández

(2018), they have neither a model nor a business plan with their vision of social and environmental impact.

Hence, this dissertation considers the hypothesis that the design of a business plan through the Business Model Canvas and Lean Startup methodology, which would provide the adequate tools for the creation of the fluvial transport Company Kara Solar in Pastaza Province. In this way, the general objective is to design a business plan through the Lean Startup methodology and Business Model Canvas for the creation of the fluvial transport company Kara Solar in Pastaza Province, with a positive social and environmental impact that generates competitiveness and profitability.

Throughout this research, the aforementioned hypothesis will be tested and the general objective will be met with the design of the business model with information found in the three chapters on the Kara Solar website, and an interview with the project coordinator, Oliver Utne. These data will also be supported by the information obtained through the Lean Startup method, which includes surveys to the inhabitants of each Achuar community of Pastaza.

The results of the surveys are pertinent since they will give an idea of the transport service user patterns, their knowledge about the solar boats, the behavior of the client towards the prototype boat called Tapiatpia, and the reasons behind it. The results of this work will be beneficial not only for students and society, but also for projects that want to take the step of becoming an entrepreneurship and want to know the reasons behind which the community uses a product or service before launching a new one.

Therefore, the first chapter offers an overview of the history, environmental, social, and economic impact of climate change worldwide and in Ecuador, the initiatives implemented by the public and private international sector, and the reasons that these sectors have for generating social and environmental impact. The theoretical framework for this chapter includes the report "*Our Common Future*" published by the World Commission on Environment and Development (1987) in order to explain the impacts of climate

change, the reasons why the public and private sectors want to face this phenomenon, and the measures implemented. In addition to this document, the General Assembly resolutions A/RES/41/128¹ (UN, 1986) and A/RES/45/94² (UN, 1990), and the Agenda 21 (UN, 1992) will be used to define the concept of sustainable development. This section also takes into account the criticisms made to the application of sustainable development, as recommendations of other authors, to reinforce the concept and the way it must be applied.

Social Market Economy and Sustainable Development indicate that three aspects must go hand in hand: economic, social, and environmental. These dimensions will help determine the reasons for the public and private sectors to deal with climate change. Therefore, chapter I follows the first specific objective to determine the impact of climate change on the economic, social, and environmental development worldwide and in Ecuador.

The second chapter offers a brief introduction to the energy matrix, renewable energies, and electric power in order to know the energy potential in Ecuador. In addition, this chapter includes information on solar energy, its potential, and public and private initiatives in the country. Also, it contains an analysis of the oil industry in Ecuador, the oil concessions, its social impact, and the reasons why movements and NGOs have risen up against this industry. On the one hand, the analysis of this chapter is based on the theory of sustainable development given that it is the concept, as of 2007, the Ecuadorian government has relied on for the formulation of plans and the regiment of its institutions, which is a complement to the Good Living approach that is the ultimate goal. In this way, the country integrated the environment issue into the governmental decision-making process (WCED, 1987). Also, according to sustainable development, reorientation of technology towards innovation and exchange of knowledge is necessary to increase capabilities to improve the quality of life of people and the quality of the air we breathe (WCED, 1987). Thus, not only the government has implemented the renewable energy technologies to face climate change, but it also has allowed entrepreneurs to put them on the market,

¹ Declaration on the right to development

² Need to ensure a healthy environment for the well-being of individuals

allowing them to be responsible for their environment, as stated in the principles of the Social Market Economy by Erhard (1994), working together in solidarity to face climate change.

On the other hand, human intervention has endangered the natural systems of the planet through the diversion of the course of rivers, mineral extraction, and emission of pollutants. Thus, sustainable behavior is required (WCED, 1987) and this explains the motivations of some institutions to deal with the extraction of resources that, in turn, contribute to the acceleration of climate change. Therefore, chapter II partially follows the first specific objective to the extent of determining the impact of climate change on economic, social, and environmental development in Ecuador. Also, these first two chapters help the researcher determine the principles of sustainable development so that in the next chapter, a business model with sustainable development elements be designed.

Finally, chapter III contains the design of the business model based on the information provided by the first two chapters, more data obtained through the Kara Solar website, an interview with the project coordinator Oliver Utne, and a survey made to three inhabitants of each Achuar community in Pastaza, including its leaders. For this purpose, the methodology used in this chapter will be the Lean Startup of Eric Ries (2011), according to which it is important to know the needs of the client by obtaining information about their opinions. This will be achieved through the Build-Measure-Learn Wheel, which includes the survey. The information obtained through the Lean Startup method will be displayed in the Business Model Canvas by Alexander Osterwalder and Yves Pigneur (2010), published in their book "*Business Model Generation*". This will be used to design the model that at the same time is the business plan which differs from the traditional one, since it has the necessary information in a single canvas.

Subsequently, to carry out an evaluation on the viability of the idea captured on paper through the Lean Startup and Business Model Canvas, the researcher will use the methodology proposed by the United Nations

Organization for Industrial Development (Behrens & Hawranek, 1994) for the formulation and evaluation of investment projects through projections of costs, general expenses, and financial evaluation, in order to obtain sufficient information to evaluate the viability of the project and the relevance of its implementation.

The methodology applied in this work will be descriptive and exploratory. First, a descriptive study will be carried out with existing information. Second, this has an exploratory social research, consisting of information gathering with potential clients. It will also be deductive–inductive, as it uses existing information, but at the end of the research new data will be generated.

This research dissertation also responds to what was learned throughout the major in *Multilingüe en Negocios y Relaciones Internacionales*, since the student uses methodologies related to International Business. In addition, this is written in English, one of the main languages of the career, enabling the researcher to apply the knowledge and skills acquired through the business curriculum in respect to subjects such as International Marketing and Management.

CHAPTER I

CLIMATE CHANGE

The world must face changes in climate in intensity and magnitude. Indeed, a climate change has been accelerated by human activities that pollute and degrade natural resources, putting at risk the basic wellbeing conditions of current and future generations in every region of the planet. In this chapter, the student will review about climate change, its history, environmental, social, and economic impact thereof, public and private initiatives to address this issue, and its effect in Ecuador. In this way, the first research question of this thesis, which seeks to determine the impact of climate change on economic, social, and environmental development worldwide and in Ecuador, can be answered.

1.1. Climate Change

According to the UNFCCC³, climate change is a natural climate variability observed over comparable time periods. However, humans are forcing this natural phenomenon through the emission and augmentation of atmospheric carbon dioxide (CO₂) concentration by more than a third since the Industrial Revolution began. Recalling the projections about a rise in temperature to 2.5°C by 2100 according to the Paris Agreement, leads us to question the current and potential threat of the increase of an unprecedented amount of CO₂ emissions.

Therefore, this subchapter introduces the concept of climate change and addresses its environmental, social, and economic impact worldwide with statistics. Accordingly, the objective of the selected topics for this subchapter would be to determine the anthropogenic sources and the impact of climate change on the three aforementioned dimensions, as well as the background of this phenomenon, which is one of the concerns and reasons for the Achuar community to launch the Kara Solar project in the near future.

³ The United Nations Framework Convention on Climate Change (UNFCCC) was adopted in New York on May 9, 1992 and entered into force on March 21, 1994. It allows to strengthen public awareness, on a global scale, of the problems related to climate change

1.1.1. Climate Change and Environmental impact

During the past 800,000 years, the ability of the human being to alter the environment was limited. The ecosystem was stable and balanced, that is, it did not change or changed very little in time. Indeed, Earth's *global climate*, the average course of weather conditions, has cooled and warmed throughout history, and it has been influenced by factors such as solar radiation, wind, and ocean currents. This has been accompanied by a natural *greenhouse effect*⁴, making CO₂ one of the gases in our atmosphere that traps heat and makes the planet habitable. In this regard, the ice cores of Antarctica showed a tight connection between temperature and the levels of greenhouse gases⁵ (GHGs) through the ice cycles (NASA, 2018).

However, in the last hundred years, human beings have modified the natural environment and caused serious alterations in the ecosystems due to overpopulation, deforestation, loss of biodiversity, and pollution (Mgbemene, Nnaji & Nwozor, 2016). Indeed, since the industrialization era that began in 1750, characterized by the increasingly intensive agriculture, use of land, deforestation and, above all, the exploitation of fossil fuels contributed to the augmentation of greenhouse gases (WMO, 2017).

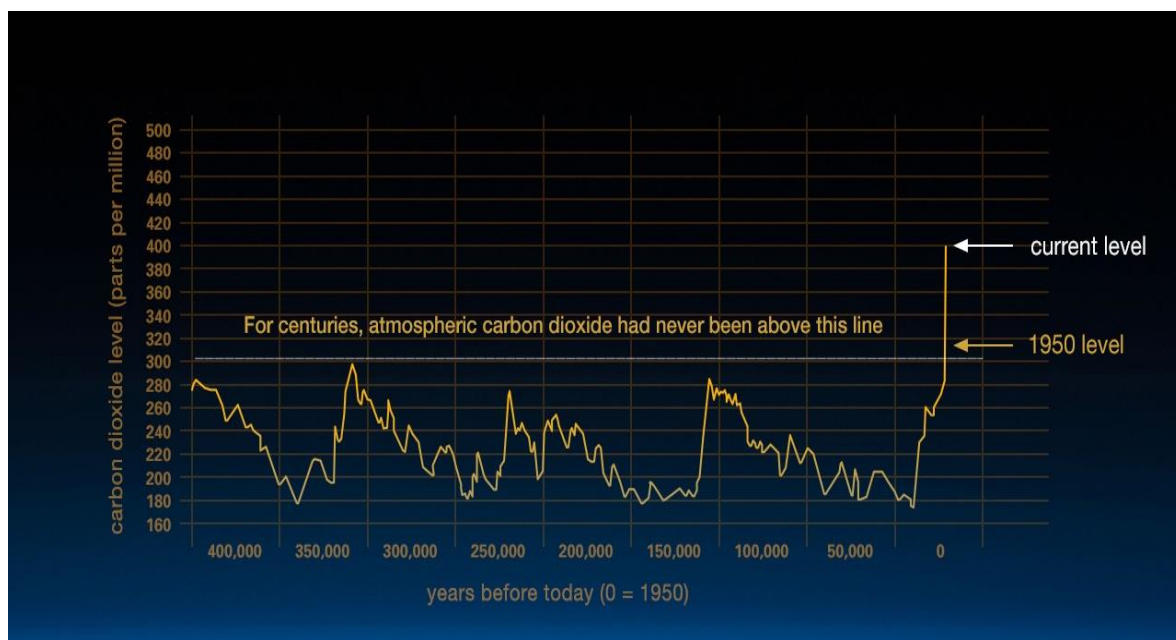
Oil, coal, and gas, thus, became the main sources of energy worldwide, causing an accelerated rise in CO₂ emissions (IPCC, 2012: 7). Indeed, during the 800,000 years prior to industrialization, the atmospheric concentration of CO₂ varied in scales of several decades or centuries around 280 ppm \pm 10 ppm⁶ as a result of natural processes. However, from 1750, CO₂ concentration increased approximately 100 ppm (IPCC, 2017), reaching 407.61 ppm in February 2018 (NASA). These data are portrayed in the following chart:

⁴ It is a phenomenon by which certain component gases of a planetary atmosphere retain part of the energy that the soil emits when it has been heated by solar radiation

⁵ A greenhouse gas (GHG) is an atmospheric gas that absorbs and emits radiation within the infrared range. This process is the fundamental cause of the greenhouse effect. The main GHGs in the Earth's atmosphere are water vapor, carbon dioxide, methane, nitrogen oxide, and ozone

⁶ PPM means parts per million. It is a unit of concentration measurement. It refers to the quantity of units of the substance that exists per million units of the set. Ppm also means the amount of milligrams in a kg of solution

GRAPHIC No. 1 Carbon dioxide concentration



Source: NASA (2018)

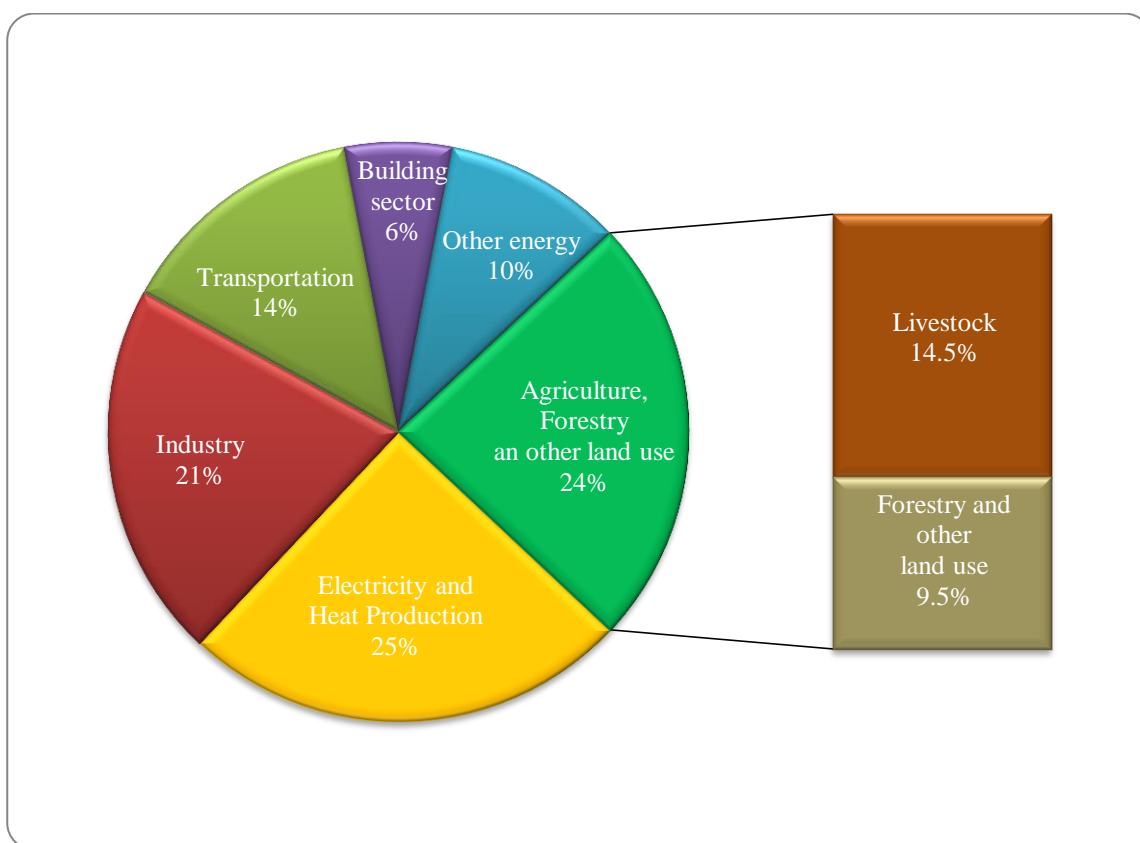
According to the scientist Erika Podest, this unprecedented amount means that the CO_2 in the atmosphere will remain there for hundreds and even thousands of years (NASA, 2013). Thus, in 1990, after an investigation carried out by 400 scientists, the Intergovernmental Panel on Climate Change presented the first evaluation report affirming the existence of the natural greenhouse effect of Earth, adding that activities of human origin accelerate this process, especially those that generate "*carbon dioxide, methane, chlorofluorocarbons, and nitrous oxide*" which can accelerate global warming⁷ by increasing the temperature of the planet through water vapor (IPCC, 1990: 19).

In this regard, according to the *Greenhouse Gas Bulletin* from the World Meteorological Organization (2017), concentrations of CO_2 , methane (CH_4), and nitrous oxide (N_2O) have increased by 145%, 257%, and 122% with respect to 1750. These gases are responsible for 63%, 19%, and 6% of global warming caused by humans (European Commission, 2018) not only by burning fossil fuels, but also by raising huge amounts of methane-producing livestock, and by cutting down vast areas of forests that would naturally absorb CO_2 . Moreover,

⁷ It is the increase in the average temperature of the oceans and Earth's atmosphere caused by the massive emissions

when they cut down the trees, these emit their reserves of carbon dioxide, adding to the GHGs in the atmosphere (WWF, 2018). Thus, 24% of CO₂ equivalent⁸ emissions come from agriculture, forestry, and other land uses, 25% from the electricity sector, 21% from industry, 14% from transportation, 10% from other energy, and 6% from the building sector (IPCC, 2014):

CHART No. 1
Global greenhouse gas emissions by economic sector



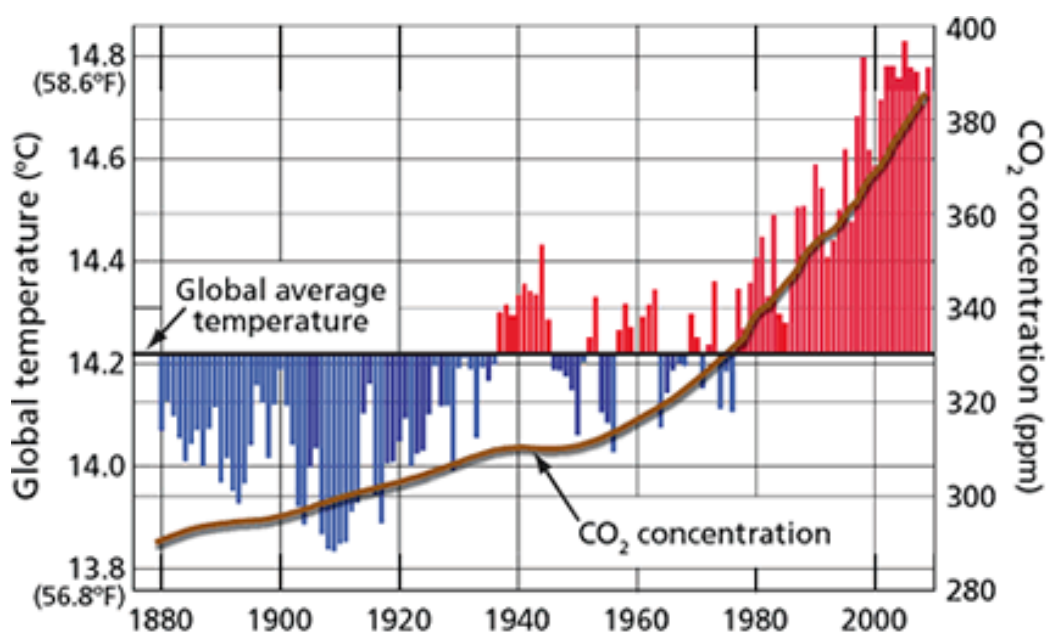
Source: IPCC (2014)
Elaborated by: Priscila Alvarado

Although CO₂ is the most emitted greenhouse gas, the agricultural sector is particularly alarming because its main contributions to GHGs emissions are CH₄ and N₂O produced by ruminant enteric fermentation and the use of nitrogen fertilizers in rice cultivation, respectively. Both absorb 21 and 310 times more energy than CO₂, and remain in the atmosphere from 10 to 100 years (Sharma & Sharma, 2018).

⁸ Carbon dioxide equivalent or CO₂eq is a term for describing different greenhouse gases in a common unit. For any quantity and type of greenhouse gas, CO₂eq signifies the amount of CO₂ which would have the equivalent global warming impact

These gases are trapping a growing portion of terrestrial infrared radiation and since 1880⁹ until 2016, the hottest year recorded, the temperature of the planet's surface increased 1.1°C (WMO, 2017), as seen in Graphic No. 2. In this regard, in its Fifth Report, the IPCC foresees an increase of 1.5 to 2.5°C by the end of 2100 (UN, 2018).

GRAPHIC No. 2
Global annual average sea surface temperature



Source: IPCC (2017)

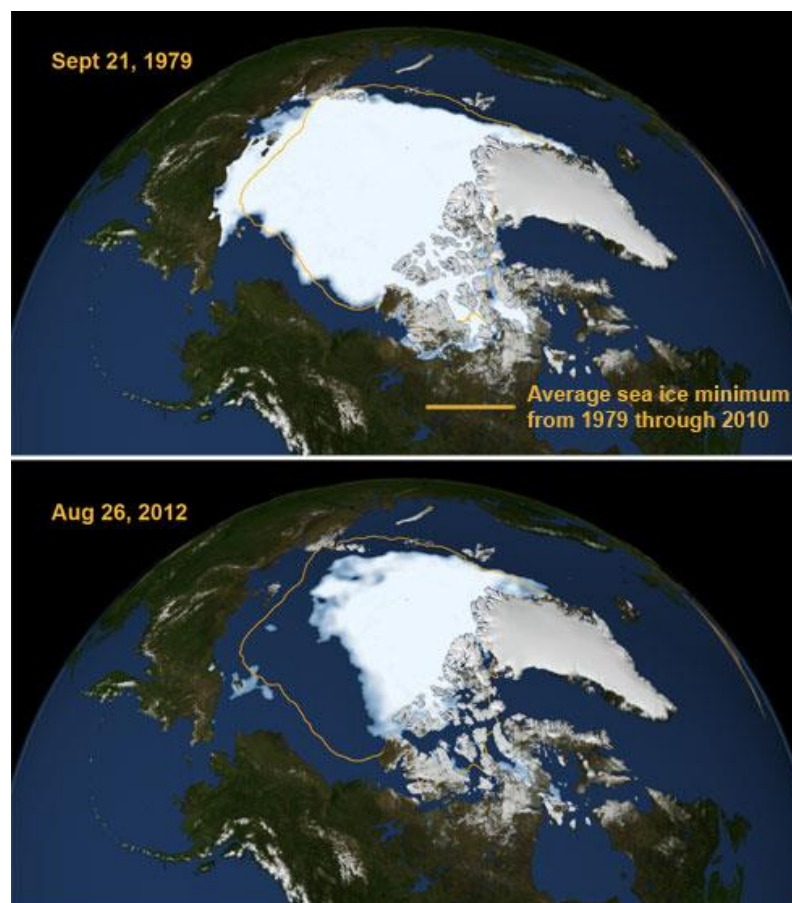
In response to the increase in temperature and GHG concentration, it is estimated that global climatic patterns and ecosystems will suffer alterations: “*a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods*”, also known as climate change (IPCC, 2018). This has been evidenced with increasing temperature trends in oceans and air, sea level rise, ice mass loss, and intensification of extreme weather events (NASA, 2018), as described below.

On the one hand, since the beginning of the industrial era, the incorporation of CO₂ in the ocean has led to its acidification. The pH of the

⁹ Temperature measurements have been made since 1880 in terrestrial meteorological stations

surface ocean water has decreased by 0.1 which corresponds to a 26% increase of acidity (IPCC, 2014), putting coral reefs at risk (WWF, 2018). This situation, together with the increase in temperature, has caused the Arctic to lose 1.07 million km² of ice every ten years since 1979, as seen in Image No. 1. This has led to not only the warming of the oceans, but also an increase of sea level that between 1901 and 2010 augmented 19 cm, which can reach 63 cm in 2100. This, hence, heightens the risk of catastrophic floods (UN, 2018).

IMAGE No. 1
Arctic sea ice minimum for 1979 and 2012



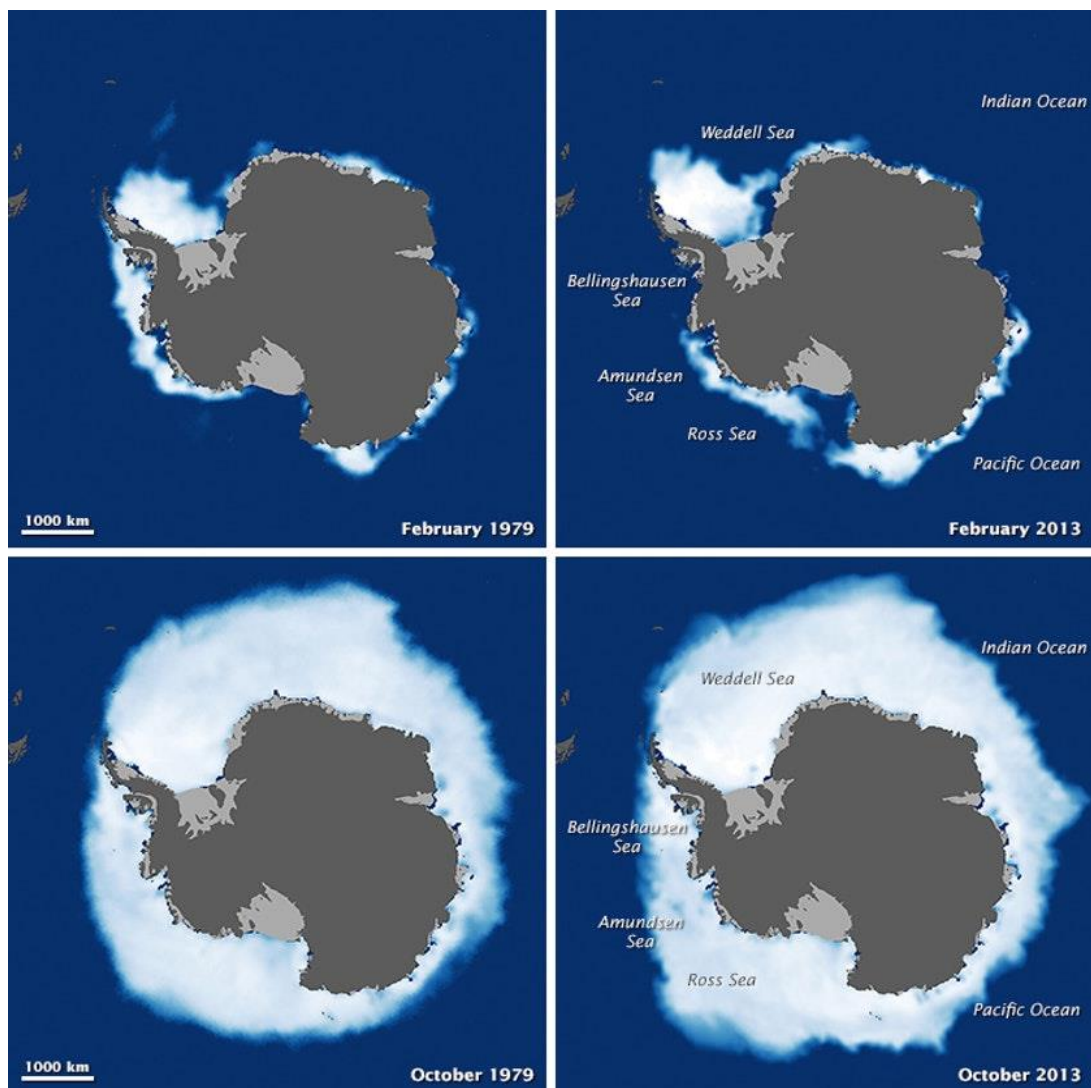
Source: NASA (2017)

In addition, arctic permafrost stores a third of the carbon in frozen soil on Earth (Mauritz, 2015). Due to global warming, this permafrost is disappearing and activating 44 million tons of old coal, from which 66% is released in the form of CO₂ every year (Vonk, Sánchez, Dongen, Alling, Kosmach, Charkin, Semiletov, Dudarev, Shakhova, Roos, Eglinton, Andersson & Gustafsson,

2012). If current conditions are maintained, 37% of the subsoil of the northern hemisphere could disappear by 2050 (IPCC, 2014).

Similarly, since 1979, Antarctica has lost 76 billion tons of ice annually. But between 2012 and 2017, it has lost 219 billion tons per year, an annual contribution of 0.6 mm to rising sea levels (Shepherd, Ivins & Rignot, 2018). However, while the Arctic is receding, the Antarctic is growing by 6,600 square miles annually, as shown in Image No. 2. Yet, this does not compensate what is happening in the north, and the global system is heating up (NASA, 2012).

IMAGE No. 2
Antarctic sea ice minimum and maximum for 1979 and 2013



Source: NASA (2015)

Parallel to these events, according to the Fourth Report of the IPCC, since the industrial revolution, not only the ice cover has decreased, but also it rains less in Sahel, the Mediterranean, southern Africa, and South Asia; and it rains more in the eastern parts of North and South America, northern Europe and northern and central Asia. Moreover, over the last 50 years, cold days and nights have been less frequent, while warm days and nights have been more frequent. Also, given that hot air is fuel for cyclones and hurricanes, since 1970, there has been an increase in tropical cyclone activity in the North Atlantic (IPCC, 2018).

Furthermore, for every further degree of temperature, cereal production is reduced by 5%. In fact, the production of corn and wheat was reduced by 40 megatons due to a warmer climate (UN, 2018). On the other hand, in 2010, a heat wave killed half the population of short-beaked black cockatoos, an endangered species in Australia; and, since 1994, more than 45,000 of the world's largest bats died in 21 heat waves. Also, in 2015, the extreme cold killed 170,000 alpacas in Peru (World Animal Protection, 2017).

Climate change is also altering the migratory patterns of birds, butterflies, and fish. These include the Great Tit in Europe, Alaska Salmon, Monarch Butterfly, White Stork, Canadian Geese, and Coast Birds of Israel (Moore, 2011). Nevertheless, this phenomenon not only affects the environment, but also the people, as will be seen below.

1.1.2. Climate Change and Social Impact

The World Bank report, presented at the eighth UNFCCC conference in 2002, highlighted that climate change increases the risk of flooding and salinity intrusion, reduces access to drinking water, decreases food security¹⁰, and has adverse effects on health (CFS, 2012). This is what has happened in recent years, and the situation could get worse in the future.

¹⁰ Food security is met when “all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life

Firstly, climate change increases the risk of floods. Currently, a significant part of the population in developing countries lives in coastal areas of low elevation exposing it to the effects of the phenomenon. Moreover, most of the population belongs to the rural area: 84% in Africa, 80% in Asia, 71% in Latin America and the Caribbean, and 93% in the less developed countries. Due to the sea level rise, this population is more prone to flooding, erosion, and intrusion of salinity. Also, approximately 70% of agricultural activity ceased partially or totally in these areas due to high levels of salinity (CFS, 2012).

Secondly, it is estimated that two thirds of the world's population live in conditions in which water is scarce for at least one month of the year (CFS, 2012). Moreover, 1,600 million people have shortages of fresh water (UN, 2014). If the GHG emissions are not reduced, the number of people exposed to droughts could increase by 9% and 17% in 2030. In fact, in the Amazon area, droughts are more severe over the years, increasing their impact from 1997 to 2005. This has caused a limited access to water for indigenous peoples, and the death of trees, reducing CO₂ uptake and increasing emissions (CFS, 2012).

On the other hand, glaciers cover 10% of the Earth's surface and are the most extraordinary reservoirs of water. Yet, geophysicists Philip Mote and Georg Kaser (2007) assert that global warming caused their retreat for more than 150 years, jeopardizing access to drinking water. In this way, between 1912 and 2011, 85% of Mount Kilimanjaro's glacial ice disappeared, and the rest could vanish before 2030 (NASA, 2012). The glaciers of the Andes Mountains are also shrinking by 1.35 cm each year since 1970, which could leave millions of people without drinking water in a matter of decades (BBC, 2013).

Regarding food security¹¹, the High-Level Panel of Experts on Food Security and Nutrition pointed out that the increase in temperatures during the night reduces the yield of rice and maize to 10% and 1.7%, respectively, for each degree Celsius that increases the minimum temperature of 30°C during the dry season. In addition, higher temperatures are associated with higher

¹¹ According to FAO, there is food insecurity when people do not have access to enough safe food that allows them to live an active and healthy life

concentrations of ozone, which is detrimental to all plants and especially to soybeans, wheat, oats, green beans, peppers, and cotton. On the other hand, Free-Air Carbon dioxide Enrichment's experiments in the United States and China demonstrate that the content of proteins and minerals such as iron and zinc are considerably reduced in cereal crops other than legumes due to the high concentration of CO₂, for example in wheat (CFS, 2012).

Although the protein and mineral content would be reduced, the increase in temperature will accelerate the plant growth and development. This will generate an improvement of agricultural productivity in certain regions of the lands and high latitudes of the tropics. Regarding livestock, the ideal temperature for most of its species is by 10 and 30°C. At higher temperatures, the animals reduce food consumption by 3% to 5% for each additional degree of temperature. This reduces animal production and affects fertility (CSF, 2012).

Climate change has also impacts on human health. Indeed, high temperatures along with air pollution worsen respiratory and chronic cardiovascular problems (IPCC, 2014). Thus, in 2012, the World Health Organization declared that 7 million people died due to environmental pollution (Piqueras & Vizenor, 2016). Besides, dehydration caused by heat waves increases hospitalizations for chronic kidney diseases. Construction, sugar cane, and cotton workers are the most affected (IPCC, 2014).

Furthermore, temperature variations and precipitation patterns have generated a greater spread of diseases such as malaria, diarrhea, and even death (WHO, 2018). The Council for the Defense of Natural Resources points out that the increase in temperature and changes in rainfall patterns have contributed to longer summers and, therefore, that these diseases, which are transmitted by insects, have longer seasons (Sifferlin, 2014). For example, excessive monsoon precipitation in India and high humidity are related to the current climate change, improving the reproduction and survival of mosquitoes. Analyzes have shown that the risk of malaria epidemic increases about five times in the year after El Niño event (WHO, 2018). Additionally, diseases such as the West Nile,

dengue fever, and Chikungunya virus are increasing in the US in warm states such as Florida (Sifferlin, 2014).

Finally, natural disasters caused by climate change such as floods, earthquakes, droughts, and rising ocean levels cause displacement and expose people to the risk of statelessness. According to the Observatory on Internal Displacement, 22.4 million people were forced to move during 2016 as a result of natural disasters in 118 countries. Indeed, since 2008, there have been 227.6 million displacements with an average of 25.3 million per year (UNHCR, 2017).

1.1.3. Climate Change and Economic Impact

According to a publication entitled "*The Economic Impacts of Climate Change*", a study conducted with data from 1950 to 2003, an increase of 1°C in temperature is associated with a decrease of 8.5% of national income per capita and 1.2% of labor income worldwide (Dell, Jones & Olken, 2009). Since 1960, losses due to climatic conditions worldwide have multiplied by 8 and between 1980 and 2008 they have risen to US \$1,400 million per year (IPCC, 2014).

In 2010, climate change generated losses of around 1.6% of world GDP¹², which means US \$695 billion a year. For the least developed countries, this meant a loss of US \$500 billion or 7% of their GDP. The main causes of monetary losses were environmental disasters such as droughts, floods, landslides, storms, and forest fires, adding up to around US \$29 trillion. In terms of habitat changes, the losses generated by biodiversity damage, desertification, labor productivity, reduction of permafrost, sea level rise, and water scarcity reached US \$563 billion. In the industry area, the economic losses in agriculture, fishing, forestry, hydro energy, tourism, and transport amounted to US \$80 billion (DARA, 2012). Each of these causes is detailed below:

Regarding environmental disasters, droughts led to US\$5 trillion in losses per year. Since the temperature of the planet is increasing, droughts are

¹² Gross Domestic Product

more frequent. In 2030, this could lead to a reduction in livestock and agricultural production (DARA, 2012), especially in the regions with the greatest food insecurity. Additionally, 815 million people worldwide suffer from hunger and in 2050 this figure could rise to 10 billion (FAO, 2017).

However, repercussions of climate change will not affect all countries equally. Indeed, given their geographical and economic characteristics, the poorest areas will suffer the consequences before and with greater intensity (Stern, 2006). Thus, agricultural production in warmer countries with an annual average of 13°C will decrease as heat increases, as it is the case of the center of Argentina. In contrast, production will increase in colder regions such as China and the United States even due to the increase in rainfall as in eastern Argentina, Paraguay, southern Brazil, and Uruguay (IPCC, 2014).

By 2050, the demand for agricultural products will increase by 70%, and climate change will cause a global reduction in agricultural productivity between 2% and 15%, compared to 2010. This will generate an increase of 1.3% to 56% of agricultural products' prices, and the cultivated area will expand by 1% and 4% (Delincé, Ciaian & Witzke, 2015).

Since climate change generates more air and increases water temperature, this affects the hydrological system, causing greater and unpredictable rainfall and floods that generate US \$10 trillion in losses and 2,750 deaths annually. By 2050, these figures could increase to US \$95 billion and 3,500 deaths respectively. On the other hand, storms provoked US \$15 trillion in losses and 2,500 deaths each year. This amount could rise to US \$100 billion and 3,500 deaths by 2050. Also, forest fires generate US \$15 million in losses annually and this figure can rise to US \$90 million in 2050. Heat waves and droughts increase the probability of the occurrence of this environmental disaster (DARA, 2012).

Regarding habitat change, this refers to the increase in deforestation, use of land for agriculture, desertification due to the reduction of rainfall, water scarcity, reduction of permafrost, and sea level rise. Also, the increase in temperature causes erosion, a higher probability of flooding which damages

infrastructure such as buildings and streets, affects the seas and agricultural production with more salt, encourages the use of conditioning systems, and reduces the productivity of people in warmer conditions. All of these changes led to losses of around US \$563 billion (DARA, 2012).

Thirdly, one of the economic sectors that has monetary losses is agriculture, due to droughts and the fact that plants do not adapt quickly to erratic changes in climate. With regard to fishing, the amount of fish will increase in the north of the planet, while it will be reduced at the equator, due to the higher temperatures and the smaller nutrients, generating the disappearance of habitats. Moreover, forests are disappearing because of deforestation, the appearance of invasive species, and floods. Also, the hydroelectric sector is in danger given the lower amount of rainfall, reducing the energy capacity and therefore the supply. In terms of tourism, small islands are the most affected because they have a higher risk of flooding. Finally, in transportation, countries that depend on the rivers will have to incur in logistics costs for land transport, since the levels of the rivers are decreasing. All of this generates annual losses of US \$80 billion and could increase to US \$565 billion in 2050 (DARA, 2012).

The study entitled "*Global non-linear effect of temperature on economic production*", conducted with data from 166 countries, indicates that if adaptation and mitigation measures are not implemented, the world GDP will be reduced by 23% annually from 2100 (Burke, Hsiang & Miguel, 2015). However, according to the Stern Report (2006), the costs and impacts of climate change could be avoided if an investment equivalent to 1% of global GDP is made in mitigation.

1.2. International public and private sector on climate initiatives

In this subchapter, the researcher will identify the work carried out by the international community to achieve sustainable development and address climate change. For this purpose, the first concept will be defined along with its principles and objectives. As a final point, the initiatives of the private sector to tackle this phenomenon will be described. This section is relevant because another reason to implement the Kara Solar project is to support the scope of

sustainable development and address climate change through social entrepreneurship. The purpose of the subchapter is to provide with the elements that characterize an enterprise with social, economic, and environmental impact, and not only for profit.

1.2.1. International Program on sustainable development

Since the 1950s, several conceptual explanations have been articulated around the notion of *development*. They sought to interpret the gaps in living conditions in the world, where high levels of poverty and exclusion prevail. This concept became known worldwide in 1949 through a speech given by the then United States President Harry Truman, in a post-war context, and when its fundamental axis was economic growth measured by GDP (Valcárcel, 2006).

In 1970, the World Bank President Robert McNamara acknowledged that economic growth did not necessarily translate into well-being (Esteva, 2000). Poverty, inequalities, deforestation, and pollution were affecting the world. This growth was being achieved at the expense of people and nature. Resources were considered inexhaustible, and profit was the main goal (Valcárcel, 2006). The need to build a new development model was evidenced in 1972, when the Club of Rome presented the report "*The Limits to Growth*". Its projections about the depletion of resources in the next hundred years if the then economic model was continued sparked a broad discussion about the development objectives that nations should pursue (Turner & Alexander, 2014).

Accordingly, the United Nations Conference on the Human Environment (1972) established the close relationship between economic development and environmental degradation and, in 1987, the Brundtland Commission's report "*Our Common Future*" gave rise to the concept of sustainable development:

"A development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs" (WCED, 1987).

In this regard, the General Assembly resolution A/RES/41/128¹³ defines development as: “*a comprehensive economic, social, cultural and political process, which aims the constant improvement of the well-being of the entire population*” and the “*equality of opportunity for all in access to basic resources, education, health services, food, housing, employment and the fair distribution of income*” (UN, 1986). Therefore, it involves a progressive transformation of the economy and society (WCED, 1987) in a continuous process of social interaction (Qerimi, 2012), while maintaining respect for the cultural values, which are the basis for the design and management of public agencies and policies in every state (Cooper & Vargas, 2004). Indeed, “*communal rights in particular must be respected*” (WCED, 1987).

To guarantee this well-being, resolution A/RES/45/94¹⁴ establishes the responsibility to “*protect and improve the environment for present and future generations*” (UN, 1990). This notion of *sustainability* was formerly mentioned in the Stockholm Declaration in 1972 (Günther, 2012). This concept also implies a concern for social equity between and within each generation (WCED, 1987).

With respect to the *needs*, the report emphasizes the essential ones of the poorest (WCED, 1987). Likewise, the concept of *limits* is based on the fact that natural resources are finite, and the existence of limits to the carrying capacity of ecosystems (CEPAL, 2003).

This report also lists the objectives of Sustainable Development. First, reactivate economic growth in the developing countries to eradicate poverty¹⁵ through the increase of per capita income and equal redistribution so that people can satisfy their essential needs. Second, change the quality of growth: its content must be less material to preserve the environment. The report also recognizes that the income per capita does not take into account the exploitation and degradation of natural resources. Thus, it encourages the rejection of

¹³ Declaration on the right to development

¹⁴ Need to ensure a healthy environment for the well-being of individuals

¹⁵ The Brundtland Report defines poverty as the level of income below which an individual cannot afford their basic needs

activities that, although financially appealing, could disrupt ecological systems (WCED, 1987).

Third, people must have access to resources to meet their basic needs for food, housing, energy, water, sanitation, and health. These, in addition to education, work, and the protection of the environment, are fundamental for the well-being of people. The fourth objective is to stabilize the population size to a level consistent with the productive capacity of the ecosystem (WCED, 1987). Fifth, in order to conserve and improve the resource base, its depletion must not exceed their generation rate. Industrialized countries must recognize that they are polluting the biosphere, reduce their consumption, and shift to non-polluting sources and technology. The replication of their consumption patterns in the developing countries is neither feasible nor desirable. They must change that through policies (WCED, 1987).

The sixth objective focuses on reorienting technology that produces social goods such as improved air quality or long-lasting products. Before executing these measures, communities must be part of the decision-making process. Finally, governments must integrate the environment in the adoption of public policy, planning, and management decisions (WCED, 1987).

Subsequently, *Agenda 21* was the result of the United Nations Conference on Environment and Development held in 1992. This non-binding¹⁶ action plan included aspects such as international cooperation, peace, and citizen participation in environmental issues, especially of women, youth, and indigenous peoples. The culture, identity, and interests of the latter are also recognized (UN, 1992).

This Agenda enshrines five principles: intergenerational equity¹⁷, the precautionary principle¹⁸, the polluter pays principle¹⁹, the principle of

¹⁶ The parties are not legally obligated to carry out its terms

¹⁷ It seeks to meet people's needs and conservation of resources for present and future generations

¹⁸ Lack of full scientific certainty is not a reason for delaying measures to prevent environmental degradation

international environmental law²⁰, and the principle of common but differentiated responsibilities²¹ (UN, 1992). These must be part of legal instruments, and be reflected at the institutional level (UN, 2012).

In 2000, the Millennium Declaration aimed to combat poverty, hunger, diseases, illiteracy, environmental degradation, and gender inequality (UNDP, 2015). As a result, in 2015, the number of people living in extreme poverty and hunger, and maternal and children mortality rates were halved compared to 1990 levels (UN, 2015). Subsequently, in 2012, the outcome of the United Nations Conference on Sustainable Development was the *2030 Agenda*. Unlike previous resolutions, it was the result of a consultation process involving all stakeholders, including local and regional authorities, and civil society (SDSN, 2016). Moreover, the MY World 2015 global survey, involved almost ten million people from 194 countries (UN, 2015). It aims to achieve 17 goals and 169 targets which revolve around 5 dimensions, as shown in the next graphic:

GRAPHIC No. 3
Sustainable Development dimensions



Source: UNSSC (2017)

¹⁹ Those who produce pollution should bear the costs of managing it to prevent damage to human health or the environment

²⁰ Countries should cooperate to conserve, protect and restore the environment

²¹ All countries have responsibilities to bear on the problems of environmental degradation, but the magnitude of these responsibilities is different

The *people dimension* seeks to end extreme poverty and hunger, guarantee health and well-being, quality education, and gender equality. The *planet dimension* aims to guarantee clean water and sanitation, responsible production and consumption, action for climate change through the Paris Agreement, and protect underwater and terrestrial life. The *prosperity dimension* focuses on non-polluting energy, decent work and economic growth, industry, innovation and infrastructure, reduction of inequalities, and sustainable cities and communities. The *peace and alliances dimensions* seek to strengthen a global alliance for development based on the needs of the most vulnerable with the participation of all. These goals place people and the planet at the center and emphasize respect for the reality and leadership of each country for the implementation of policies according to their priorities (UN, 2018).

Furthermore, the Board on Sustainable Development gathered data from the literature on sustainable development and, in order to achieve it, most authors agree that nature, life support, and communities must be sustained for the future generations. While the dimensions of well-being, economy, and society must be developed through a process of change and evolution of concepts because the needs and aspirations of the new generations will not be the same as today (NRC, 1999). This is displayed in the next table:

TABLE No. 1
Sustainable development: common concerns

What is to be sustained:	What is to be developed:
Nature Earth Biodiversity Ecosystems	People (well-being dimensions) Life expectancy Education Equity/Equal opportunity
Life Support Ecosystem services Resources Environment	Economy Wealth Productive sectors Consumption
Community Culture Groups Places	Society Institutions Social capital States Regions

Source: NRC (1999)

Elaborated by: Priscila Alvarado

This Sustainable Development is complemented by the Human Development Report based on the human capabilities. The latter involves what a person is capable of doing or being, such as being able to be well nourished, write, read, communicate, take part in community life, and so on (Sen, 1999). It focuses on improving the well-being of people, and income is seen as a means to development, rather than as an end (UNDP, 2016).

Unfortunately, rapid growth, with the deterioration of income distribution, has been the dominant trend in the last decades, and many societies are thriving in terms of material growth, but failing to fulfil basic needs (Moore, 2015). On the one hand, the problem is that "development" is a polysemous concept, and therefore applied as synonymous with growth, translating "sustainable development" into "sustainable economic growth", which is not sustainable in a world with finite resources. The term "sustainable development" must be understood as development without economic growth. In the long run, economy must eventually stop growing, but can continue to develop (Daly & Townsend, 1993).

Political ecology criticizes this characteristic, since the myriad of definitions of "development" makes the concept ambiguous, and used for the benefit of individual interests (Trujillo, 2009). Thus, the tools that measure the economic success of a nation must be modified, and there must be a theoretical renewal of the concepts of wealth, poverty, and value (Marcellesi, 2012).

On the other hand, the concept of "well-being" is complex and context-oriented. The perspective that has mostly been adopted is that of the wealthy western countries, which gives greater value to the material status (Dłużewska, 2017). These consumption patterns can be replicated in the rest of the countries if the respective policies are not applied. Likewise, culture and cultural heritage could be threatened by governments that implement measures for the sake of urbanization or economic growth (UNESCO, 2013). Nevertheless, the Brundtland Commission rejects the replication of these consumption patterns (WCED, 1987), and Agenda 21 encourages respect for cultures (UN, 1992).

However, between 1960 and 2015, the world population increased from 3 billion to 7.2 billion. The deceleration of population growth will contribute not only to reduce the pressure on the environment, but also to a better allocation of resources to achieve sustainable development (Güney, 2017).

Likewise, authors such as Serge Latouche (2006) rely on the “degrowth”, which criticizes the Western consumerist and individualist desire for an economic system based on unlimited growth. It also emphasizes the risks that societies face by being part of this kind of development. For instance, the latter is considered as an obstacle to the expansion of autonomous societies. It could destroy the local by creating territories without power at the mercy of powers without territory. Local development could make territories compete to offer better conditions for multinationals to settle. Money from "disadvantaged areas" might end up in urban concentrations. It may not only suppress local institutions such as schools, health centers, and so on, but also build mercantile societies based on excessive consumption that no longer give priority to social relations.

As we can observe, the concept of sustainable development has been reflected in different documents, from the Brundtland Report and Agenda 21 to the 2030 Agenda, establishing the relationship between the economic, social, and environmental dimensions. However, economic growth is one of the objectives. Consequently, in practice, the predominant development model has been the one of Western consumerism based on unlimited growth, which is unsustainable. Despite the criticism, the international institutions worked even more on the subject, emphasizing the environmental issue (UN, 2018), as will be seen in the following paragraphs.

1.2.2. International Regime on climate action

Since the industrial revolution, energy supply has originated in the use of fossil fuels such as oil, coal, and gas, causing an accelerated increase of CO₂ emissions (IPCC, 2012: 7). Thus, the efforts of the international community on climate action can be divided into four periods (Bodansky, 2010), as explained below.

The foundational phase was characterized by a scientific concern about global warming (Bodansky, 2010). Indeed, after noting the anthropogenic origin of climate change, the United Nations Conference on the Human Environment took place in 1972. It settled the close relationship between economic growth and environmental degradation, and made the first mention of the environment in the international arena. Since then, progress was made in scientific and technical knowledge on the subject. Yet, it was in 1979 at the First World Climate Conference when the accelerated global warming due to human activities was recognized and considered as a threat (UNFCCC, 2000).

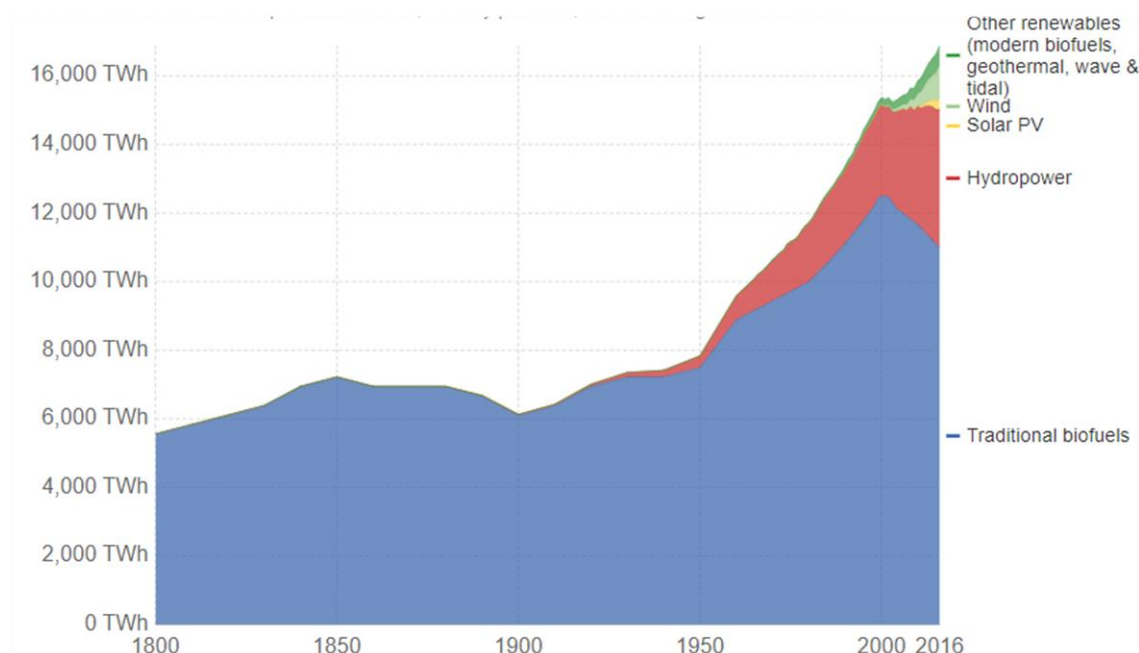
In the agenda-setting period, the concept of sustainable development was published by the Brundtland Commission in 1987. Also, climate change went from being considered a scientific to a policy issue, and governments demanded the creation of the Intergovernmental Panel on Climate Change (IPCC). This was created in 1988 and published its first evaluation report in 1990, reflecting the research of 400 scientists. It stated that global warming of the Earth was real and demanded the international community to take action to avoid it (IPCC, 2017). Then, the formal intergovernmental negotiations phase started with the United Nations Framework Convention on Climate Change, which was adopted during the Earth Summit in 1992 with the objective of stabilizing the concentration of gases that cause this issue. Currently, its members are called "*Parties*" which are the 195 countries that have ratified it (UNFCCC, 2015).

The Convention aims to enhance global awareness about the threat of climate change and encourages countries to stabilize concentrations of GHGs to avoid affecting the food and climate system. The Conference of the Parties (CP) is the supreme organ of the Convention, that is, its highest decision-making authority that meets every year for two weeks. Thousands of government delegates, observers, and journalists participate in these assemblies. In this regard, as part of the post agreement phase, the Kyoto Protocol was created at CP3 and came into force in 2005. This represents the commitment of 37 industrialized countries and the European Union to stabilize GHG emissions (UNFCCC, 2016).

Individual targets for Parties included in Annex I of the Convention are listed in Annex B of the Protocol. They all add up to a total cut in greenhouse gas emissions of at least 5% compared to 1990 levels in the 2008-2012 commitment period. The targets cover emissions of six greenhouse gases, such as: Carbon dioxide (CO₂), Methane (CH₄), Nitrous oxide (N₂O), Hydrofluorocarbons (HFC), Perfluorocarbons (PFC), and Sulfur hexafluoride (SF₆) (UNFCCC, 1997). Although countries pledged to reduce 5% of their emissions in 2012 with respect to 1990 levels, as a result, they managed to reduce 22.6% thereof (UNFCCC, 2016).

Despite the efforts made over the years, the A/RES/70/1²² resolution of the General Assembly of the United Nations (2015) indicated that the increase in temperature worldwide, ocean acidification, and growing extreme poverty demonstrated the need for countries to make stronger commitments and viable solutions. Indeed, although countries are harnessing the potential of renewable resources, consumption of traditional resources increases over the years (Our World in Data, 2017), as shown in the following graphics:

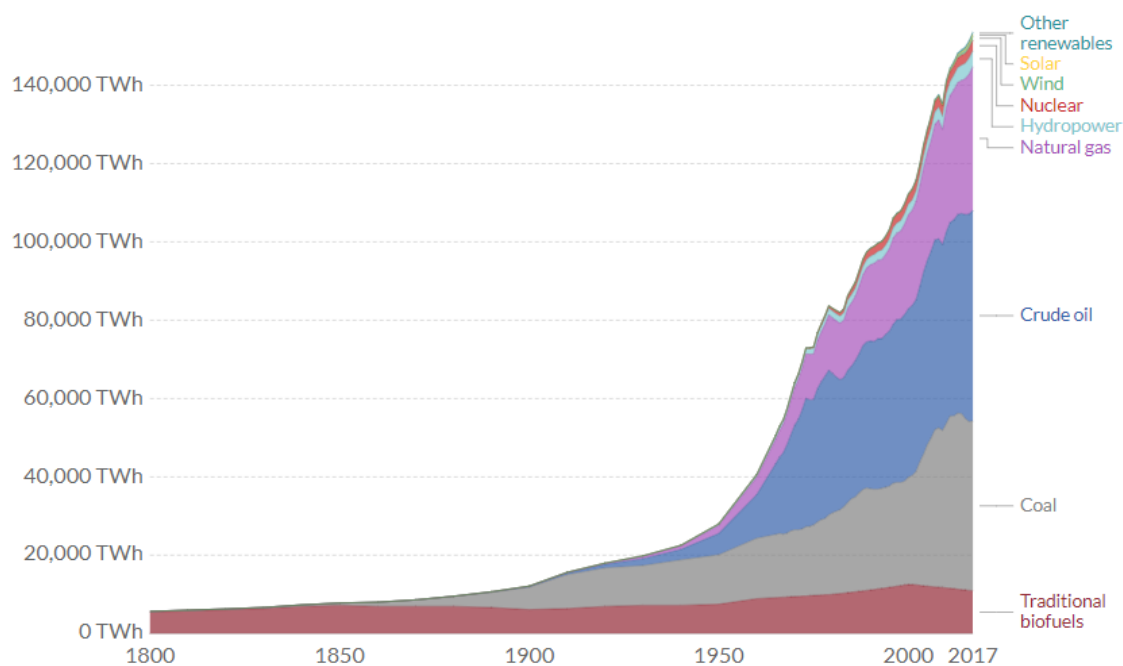
GRAPHIC No. 4
Global renewable energy consumption



Source: Our World in Data (2018)

²² Transforming our world: the 2030 Agenda for Sustainable Development

GRAPHIC No. 5 Global primary energy consumption



Source: Our World in Data (2018)

That is why the Paris Agreement was adopted in 2015, during the CP21. This worldwide commitment aims *"to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty"* as well as *"to maintain the increase in average temperature globally well below 2°C with respect to pre-industrial levels and continue efforts to limit that temperature increase to 1.5°C"* (UNFCCC, 2015: 2). This agreement includes not only the environmental dimension of reducing emissions to lower the temperature, but also the social dimension to end poverty, as established in the Brundtland Report (WCED, 1987).

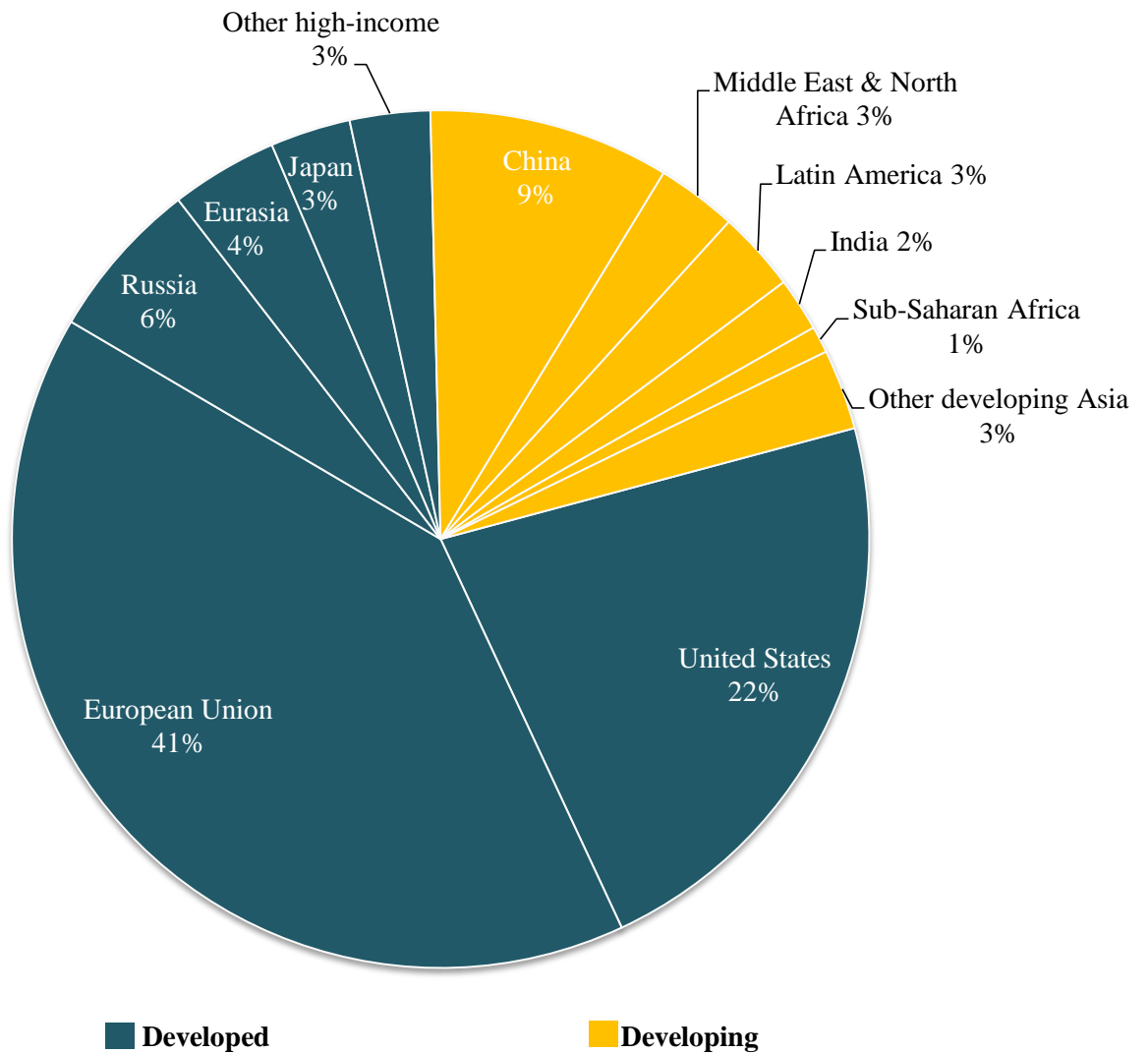
This Agreement is a combination of legally binding and non-binding provisions. For example, countries are obliged to prepare, communicate, and maintain nationally determined contributions²³ (NDCs). Besides, they shall report their GHG emissions, and implement mitigation measures. Developed countries shall communicate the financial and other assistance provided to developing countries to help meet their NDCs (UN, 2018). In this way, although emission reduction targets are nonbinding, the NDCs indicate that the member

²³ Efforts by each country to reduce national emissions and adapt to the impacts of climate change

countries are making progress in ensuring that each of the countries remains committed to the Paris Agreement and meet their objectives (UN, 2018).

Accordingly, historical emissions show that developed countries are mainly responsible for 79% of emissions from 1850 to 2011 (CGDEV, 2015):

GRAPHIC No. 6
Responsibility for climate change



Source: Center for Global Development (2015)

However, nowadays, China is the most polluting country in the world, generating 29% of CO₂ emissions (Netherlands Environmental Assessment Agency, 2016) and causing about 1.6 million deaths annually (Rohde & Muller, 2015). Therefore, based on the Paris Agreement, this country proposed to reduce

its CO₂ emissions by 60% and 65% in 2030 compared to 2005 levels (UNFCCC, 2015). For its part, the United States is the second largest polluter, producing 14% of total CO₂ emissions worldwide (Netherlands Environmental Assessment Agency, 2016: 11). In 2017, it announced its intention to withdraw from the Paris accord, making it difficult to reach the objectives thereof (BBC, 2017).

Also, the European Union and India generate 9% and 7% of global CO₂ emissions (Netherlands Environmental Assessment Agency, 2016: 11). The first proposed to reduce its emissions by 40% in 2030 with respect to 1990, and the second will reduce 35% of its emissions compared to 2005 levels (CAT, 2018).

Although some provisions of the Agreement are legally binding, the objectives of reducing GHG emissions are not. Then, as mentioned previously, if the gas increase is maintained, the rise in temperature will be greater and therefore the risk of water scarcity, health effects, extinction of species, forests, glaciers, alteration of ocean circuits, damage to infrastructure, and reduction of agricultural, livestock, and fishing production (IPCC, 2014). On the other hand, countries are not the only ones that are implementing these measures to deal with climate change, but also the private sector through the implementation of renewable energy, as discussed below in the present dissertation.

1.2.3. Private sector initiatives against global warming

Worldwide, several renewable energy projects have been launched. In fact, based on the Paris Agreement, countries that produce the most CO₂ emissions such as China, United States, India, and the European Union have set several goals to reduce their emissions so that the global increase in temperature does not exceed 2 °C by the end of this century (UNFCCC, 2015).

Firstly, China emphasized the use of renewable energies (UNFCCC, 2015). According to the REN21 Report (2017), the country's goal is to obtain 15% of its energy from renewable sources by 2030. China also consolidated itself as the leader in renewable wind and solar manufactures (World Watch Institute, 2018). Indeed, Trina Solar and Jinko Solar are leading the

manufacturing of solar panels worldwide (Wade & Eckhouse, 2017). Founded in 1997 and with revenues of US \$ 2.9 billion in 2014, Trina Solar works through a business model based on a vertically integrated supply chain. It develops products that range from crystallization of silicon to manufacture ingots, wafers, cells, modules and systems, and their installation (Trina Solar, 2011).

Secondly, the United States pledged to generate 20% of its energy from renewables (The Hill, 2015). This country is home to the companies that top the list in the residential installation of solar panels: SolarCity, Vivint Solar, and Sun Power (Fortune, 2016). The first offers products from solar panels, energy storage batteries or powerwalls, and solar roofs to the installation of a complete solar energy system at home. This company offers three options for its clients. The first consists of a loan that does not require an initial payment and can be repaid within 10 to 20 years with an interest of 2.99%, covering installation costs and facilitating daily monitoring by Internet connection. The second option is the cash payment of the entire system and the service. The third is the rent of the solar energy system which must be paid monthly. With the Energy Purchase Agreement, that includes the installation and maintenance of the photovoltaic system free of charge, the customer pays only for the solar energy consumed monthly (SolarCity, 2017).

Thirdly, the European Union (2018) aims to obtain 27% of its energy from renewable sources by 2030. In 2018, this percentage reached 17% of its final energy consumption (Bigordá, 2018). Besides, Denmark seeks to generate electricity completely based on renewable energy by 2050 (REN21, 2017).

For its part, India generates 7% of global CO₂ emissions (Netherlands Environmental Assessment Agency, 2016:11) and has undertaken initiatives such as Barefoot College founded by Bunker Roy in 1972 to make technology available to the poor in the rural sector with the aim of "*extending self-sufficiency and sustainability*" (Barefoot College, 2017), focusing on poor and isolated communities that face gender and access to education issues. One of its programs is *Enriche* which seeks to promote women empowerment through solar electrification, generating engineers with a social focus. This work has

been expanded throughout Africa, Latin America, and the Pacific (Barefoot College, 2016). Thus, its mission is to:

“Disseminate the Barefoot Approach throughout rural communities around the world, accomplishing what many less comprehensive approaches have failed to achieve: Sustainable knowledge and skills for communities, adapting a lifestyle in harmony with our environment and overall community transformation and empowerment” (Barefoot College, 2017)

Its operation is based on the principles of Mahatma Gandhi and 14 out of 17 sustainable development goals (Barefoot College, 2017). Indeed, innovation has been one of the fundamental pillars to confront climate change and poverty, making the economic, social, and environmental axes converge. In this way, companies such as Solar Aid offer portable photovoltaic systems for African households and part of the proceeds go to food, health, and educational projects. Moreover, M-KOPA distributes solar systems in Africa through credits which are paid through a mobile platform (Mountford, 2016).

Furthermore, B companies are new business models which include the triple line of sustainable development: economic, social, and environmental. These not only seek economic gains, but mainly generate value for employees, customers, competitors, suppliers, the community in which they perform, and the environment in order to achieve sustainability in the business world (Sistema B, 2018). An example of B companies is Iluméxico, which solves the electricity needs of Mexican communities most in need in rural areas that lack access to the electricity grid. This company offers not only payment credits, but also accompaniment workshops such as financial and environmental education and community participation tools, which are taught in the communities in which they work. They also have ILUCentros which are service branches where the communities are trained to be part of the work team responsible for providing training and technological assistance to clients (Iluméxico, 2018).

There are also private initiatives like the Breakthrough Energy Ventures fund created by several millionaire entrepreneurs, including the founders of Amazon, Microsoft, Virgin Group, and Alibaba Group Holding who have

decided to invest their money in "*risky and long-term energy technology that could drastically reduce emissions of greenhouse gases*"(Vance, 2016).

In this way, countries have allowed the free initiative to thrive, which includes the protection of natural resources (Müller-Armack, 1956: 249). Hence, different private initiatives have emerged, especially B companies, which seek to contribute to society and the environment in a sustainable way (Sistema B, 2013). Likewise, communal rights are respected (WCED, 1987) in India, for example, through the Barefoot College and its operation based on the principles of Mahatma Gandhi, which are complemented by the sustainable development goals (Barefoot College, 2017).

1.3. Climate Change and Sustainable Development in Ecuador

This subchapter will deal with the impact of climate change in Ecuador, a country in which there has been an increase in temperature, a greater frequency of extreme events, changes in the hydrological regime, and retreat of glaciers. The researcher will further describe the incorporation of the sustainable development, the Sumak Kawsay, and the rights of nature in the Constitution of Ecuador as a result of the concern about the impacts of climate change and the commitments of the country acquired in the international treaties and plans of action for sustainable development. Finally, the development plans that have laid the foundations for sustainable development, adaptation, and mitigation to climate change will be mentioned. The topics proposed in this section describe how sustainable development has been incorporated into the normative field of the country in the midst of a global context of great concern for the sustainability of the planet.

1.3.1. Climate Change in Ecuador

Ecuador is a territory vulnerable to the effects of climate change due to its geographical, geological, oceanographic, climatic, and human conditions. According to the National Institute of Meteorology and Hydrology, in recent years the country has recorded sustained increases in temperature, changes in the

frequency and intensity of extreme events such as droughts, floods, frosts, changes in the hydrological regime, and retreat of glaciers (MAE, 2015).

Between 1960 and 2007, the annual average temperature increased 0.8°C. For the same period, the annual amount of precipitation has varied differently in the regions. It increased by 33% in the Coastal Region and 8% in the Interandina Region, especially in the coastal areas of El Oro, Guayas, Santa Elena, and Manabí. According to the Economic Commission for Latin America and the Caribbean reports, in 1997 and 1998, El Niño caused losses of US \$2,869.3 million equivalent to 15% of the country's GDP of 1997 (MAE, 2015).

With respect to extreme events, according to the National Institute of Statistics and Census, from 2002 to 2007, 45% of transitory crops²⁴ and 11% of permanent crops²⁵ were lost due to droughts. Besides, according to MAGAP, the 2010 droughts in provinces such as Cotopaxi, Bolívar, Tungurahua, and Chimborazo affected 98% of the cultivated area from which 2% was declared as a total loss, leaving 18,000 families economically affected (MAE, 2015).

In 2012, floods in the Coastal region affected 24% and 23% of rice cultivation in Guayas and Los Ríos, respectively. In general, about 80,000 ha of rice were lost, representing 19% of the cultivated area nationwide. Other damaged crops were hard corn and sugarcane. This situation caused a price increase of up to 30%. Moreover, 62% of the most vulnerable households depended on the income obtained from work as a day laborer in these areas. Also, during the winter of 2012, the heavy rains in Guayas, Los Rios, Esmeraldas, Manabí, El Oro, and Loja affected 56,000 houses and 107,000 people. That year, rainfall was the largest in the last decade, damaging around 195,147 ha and causing losses of at least US \$237 million (MAE, 2015).

²⁴ Transitory Crops are crops of agricultural products characterized by a vegetative cycle or growth usually less than a year, even a few months. These are intended for human and/or animal feed or for industrial raw materials or other uses. For example: rice, potatoes, and corn

²⁵ Permanent crops are crops of agricultural products which are intended for human and/or animal consumption, industrial raw materials, or other uses. These have a prolonged period of production that allows harvests for several years without needing to be planted after each harvest. For example: cocoa, coffee, African palm and goods that are used for agroindustry such as coffee, chocolates, and oils

According to a study conducted by the Ecuadorian Civil Space Agency, countries located in the equatorial belt which includes Ecuador, Peru, and Colombia would be the most affected by high levels of ultraviolet radiation due to the thinning of the ozone layer, increasing the risk of burns and cancer (El Telégrafo, 2008). Also, according to the World Health Organization, levels of 10 ppm are responsible for cerebral infarcts and chronic respiratory diseases. In this regard, the Secretariat of Environment of the Municipality of Quito explained that Ecuador has an environmental contamination of 15 ppm, and Quito has 18 ppm, which is 3 ppm above what is considered not risky for health in Ecuador and 8 ppm above the international standard (Notimundo, 2016).

Although Ecuador's GHG emissions compared to the rest of the world are less than 1%, the retreat of glaciers in the Andean region was around 20% to 30% in the last 30 years. According to the director of the Institute of Hydrology, Meteorology, and Environmental Studies (IDEAM), at the end of 1980, Cotopaxi, Cayambe, Antisana, El Altar, Los Illinizas, and Carihuayrazo summits covered a glacier area of 92 km², decreasing to 44 km² by 2010. This decrease in mountain glaciers would cause an increase in the ocean level of 24cm by 2100 and affect the flow and composition of rivers (El Universo, 2014).

In this regard, the Amazon, considered as the lungs of the planet, stores 109,660 million tons of CO₂ in its 4 million km² within nine countries that is 50% of the CO₂ in the tropical forests of the planet. Also, 400 indigenous peoples live in this region. However, between 1990 to 2000 and 2000 to 2008, 595 and 479 km² of the Ecuadorian Amazon area was deforested (Sierra, 2013). This has caused the reduction of transpiration, modification of rainfall, and prolongation of the dry season in this region. In general, 20% of the Amazon has been destroyed (El Telégrafo, 2015). From the 2 billion tons of CO₂ absorbed by the jungle in the 1990s, that amount has been reduced by half. Moreover, excess carbon is causing trees to grow faster and die sooner (ABC, 2015).

Furthermore, the agriculture sector has transformed the native forests to cultivation areas in the littoral region due largely to the banana boom. This has caused the degradation of soil and water resources due to the use of fertilizers

and agrochemicals. In the Amazon region, the oil and mining boom brought with it the unplanned occupation of the forests that also generated social problems such as conflicts between indigenous populations and settlers. The annual net deforestation for agriculture was 94,817ha/year from 1990 to 2000 and 75,287ha/year from 2000 to 2008 (MAE, 2015).

Ecuador recognizes that climate change is a challenge that can negatively affect the security, development, and well-being of the population. Thus, taking into account the commitments made under the UNFCCC, since 2007 the governments have implemented actions to reduce the emissions of GHGs. Indeed, the State agreed on the political guidelines in instruments of action with the 2008 Constitution and the development plans from 2007 to 2017 in order to promote energy efficiency, the development, and use of clean technologies, as well as mitigation measures (MAE, 2015), as described below.

1.3.2. Constitution of Ecuador 2008 and its environmental principles

In Ecuador, unlike the western origin of sustainable development, the *Good Living* or *Sumak Kawsay* emerged from indigenous peoples who have a worldview, philosophy, and lifestyle different from the western countries. Accordingly, this is the oldest formulation of indigenous resistance to the coloniality of power. Etymologically, *Sumak* means fullness and *Kawsay* means life: life in fullness. Its principles include complementarity, proportionality, reciprocity, correspondence, and relationality (Rodríguez, 2016).

“Complementarity” refers to the counterpart or complement of each entity or event, as a condition to exist, act, and be complete. It is also the equality of conditions and mutual help, breaking the imposition, selfishness, and individuality. “Proportionality” seeks the distribution of goods, balance, correcting asymmetries through redistribution. “Reciprocity” is the ability to know how to give to receive, and know how to receive to give. This allows the existence of mutual aid relationships through solidarity to build the community and its power relations. “Correspondence” refers to different aspects, regions, or components of reality that correspond harmoniously. For example, the

relationship between human beings, economy, and culture. These principles reflect the diversity of the peoples and regions that are interrelated. Thus, “relationality” or bonding is the principle that allows us to be aware that we are part of a whole. Indeed, despite being different, we are complementary and need each other (Rodríguez, 2016).

This principle can be applied to sustainable development since according to Jesús Hernández and María Santiago (2016), despite the fact that sustainable development is an alternate concept, both approaches can be complementary. In this way, relating or identifying with the feeling of the other in all possible ways is necessary. Otherwise, we would individualize ourselves (Rodríguez, 2016).

The values on which Good Living is based are: solidarity, equity, discipline, respect, love, and recognition of difference. In addition to recognizing these subjective dimensions, it includes interacting with the spirit of nature. Spirituality allows the articulation of the human being with the natural and cosmological areas, which is expressed in the quality of the relationships with the environment and the ancestors (Rodríguez, 2016). In this way, Good Living is not limited to the material wellbeing, as articulated in the ownership of property or consumption of the western societies, but is a harmonious balance between material and spiritual components (Gudynas, 2011).

In Ecuador, the first references of this paradigm were found in 2002 in a Quechua²⁶ village called Sarayacu. The Confederation of Indigenous Nationalities of Ecuador (CONAIE) presented it as a national proposal, and with the support of the president of the Assembly, Alberto Acosta, the concept was incorporated into the 2008 Constitution. The Good Living was adopted as the structuring concept and main objective of the development policies implemented in the Plans of Good Living 2007, 2009-2013, 2013-2017, and 2017-2021 (Larrea & Greene, 2017).

²⁶ Native language of the central Andes that extends through the western part of South America

According to the Constitution, Good Living is defined as "*the lifestyle that allows happiness and permanence of cultural and environmental diversity; it is harmony, equality, equity, and solidarity. It is not seeking opulence or infinite economic growth*" (Consejo Nacional de Planificación, 2014). This model is presented as an alternative response to the extractivist model because it does not seek economic growth (Acuña, Naranjo & Abad, 2017), but a balanced development between nature, society, and economy, as the Brundtland Report states (WCED, 1987).

Although the construction of Good Living is based on ancestral knowledge, it does not ignore the possibilities of other cultures, since it is about finding common points that allow the paradigm change and the search for alternative schemes, including the western ones (Acosta, 2010). In this regard, the Constitution defines Ecuador as a constitutional and social State of rights which has, among other duties, to guarantee and promote "[...] *a sustainable model of development, environmentally balanced and respectful of the cultural diversity that conserves biodiversity and the capacity for natural regeneration of ecosystems, and ensures the satisfaction of the needs of present and future generations*" (Asamblea Constituyente, 2008). In addition to encompassing the three aforementioned axes, this concept contains the principle of intergenerationality (UN, 1992) that supposes that we must deliver to future generations a world that, from environmental stability, offers people the same development opportunities that the present generations have.

In order to achieve the aforementioned principle, the Constitution provides a development regime in Article 275 with several objectives, among them: to improve the quality of life and increase the population's capabilities and potential; to build a fair, democratic, productive, solidary, and sustainable economic system based not only on the equal distribution of development's benefits of the means of production, but also on the generation of decent and stable work; and, to recover, conserve nature, and maintain a healthy and sustainable environment. Also, Articles 12 to 34 guarantee the exercise of the Good Living rights of people to water, food, a healthy environment, education, health, housing, work, and social security (Asamblea Constituyente, 2008).

Thus, this development seeks to encourage the equitable distribution of wealth, freedom, and justice through the expansion of opportunities and capabilities of the human being to achieve the common good (Sen, 1999).

The Constitution grants rights not only to the population, but also to nature. First, Art. 71 asserts the right to respect for its existence, the maintenance, and regeneration of its life cycles, structure, functions, and evolutionary processes. Second, Art. 72 establishes the right to restoration (Asamblea Constituyente). In this way, nature is recognized in itself and not as a means for the benefit of the human being. These rights are also a response to the growing environmental destruction and indiscriminate exploitation, which has its sources in the unlimited production and consumption processes (Naranjo, 2016).

Furthermore, according to the Article 313, the State is in charge of managing, regulating, and controlling the strategic sectors, in accordance with the principles of environmental sustainability, precaution, and prevention. (Asamblea Constituyente, 2008). Therefore, these principles enshrined in Agenda 21 (UN, 1992) have been mentioned in the Ecuadorian Constitution.

Likewise, this document establishes environmental principles such as: protection through legal documents; prevention of damage to the environment through the use of clean technologies; caution to cause the least environmental damage; responsibility for the cost of preventive and corrective actions against current or future damage to the environment; environmental sustainability, balancing social, environmental, and economic aspects of development; efficiency to introduce environmental measures at the lowest possible cost; and, solidarity through cooperation to conserve and protect the planet (Asamblea Constituyente, 2008).

Additionally, in 2009, the Constitution incorporated climate change as part of its State policy based on two Articles. First, Article 413 establishes that the State will promote energy efficiency, development, and use of environmentally sound and healthy practices and technologies, as well as diversified renewable energy, which does not put food sovereignty, the balance

ecosystem, or the right to water at risk. Second, Article 414 affirms that the State will adopt appropriate and cross-cutting measures not only for climate change mitigation by limiting greenhouse gas emissions, deforestation, and atmospheric pollution, but also for the conservation of forests and vegetation, and protection of the population at risk (Asamblea Constituyente, 2008). In this way, the Executive Decree 1815 signed on July 1, 2009, declared adaptation and mitigation to climate change as State Policy and the Ministry of the Environment was mandated to formulate and execute a national strategy (MAE, 2015).

1.3.3. Development Plans to preserve the environment

The Constitution of Ecuador, approved in 2008, states in numeral 5 of Article 3 that it is the duty of the State to "*plan national development, eradicate poverty, and promote sustainable development, and the equitable redistribution of resources and wealth to access to Good Living*". Thus, since the country pledged to formulate, apply, publish, and regularly update national development programs according to the UNFCCC, and taking into account the principle of common but differentiated responsibilities with measures aimed at addressing climate change, it oriented its policies related to this problem since 2007 (MAE, 2017). In this regard, the National Development Plan 2007-2010 and the National Plans for Good Living 2009-2013 and 2013-2017 set objectives to achieve sustainable development (Vásquez & Tesarona, 2016).

First, the 2007-2010 National Development Plan emphasizes that, as a result of climate change, Ecuador has endured serious social, environmental, and economic consequences. In this respect, it defines development as:

"The achievement of everyone's good living, in peace and harmony with nature and the indefinite prolongation of human cultures. Good Living presupposes that the real liberties, opportunities, capacities, and potentialities of individuals are broadened in such a way that they can simultaneously achieve what society, the territories, the diverse collective identities and each one value as a desirable life goal" (SENPLADES, 2007: 54).

The notion of development is not assumed as a synonym of economic growth, but as a means to promote "*access to goods, opportunities, and conditions that guarantee a decent life for the individual, the community, and*

future generations without harming nature." (SENPLADES, 2007: 54). This plan raises a process of expansion of capabilities enjoyed by individuals as established by Amartya Sen (1999), a freedom that must be guaranteed by the State to eliminate the various types of impediments to human development.

This capability approach asserts that freedom to achieve well-being is a matter of what people are able *to do* and *to be* what they have reason to value. It is based on capabilities and functionings. The “capabilities” are the options to achieve valuable functionings. It reflects people’s freedom to choose. For instance:

- **Beings:** well-nourished, healthy, sheltered
- **Doings:** education, work, voting, participating in community life

Once people enjoy these freedoms, they can choose to act according to their own ideas about the kind of life they want to live. For example, each person should have the opportunity to be part of a community and practice a religion, but if someone prefers otherwise, they should also have this option. This refers to “functionings” or what people really do and are. These are achievements (Sen, 2009). In this way, the government has to create the social conditions in which one can decide on his life project (SENPLADES, 2007).

This plan also recognizes that not only the GHG emissions produced by the country represent less than 1% worldwide, but also the impacts of climate change described by the IPCC (SENPLADES, 2007). That is why this plan articulates economic development with environmental issues in order to promote a sustainable environment (Objective 4). Additionally, it acknowledges a society with improved capabilities and potential as the means to achieve development and a solidary economic system (Objective 11) (SENPLADES, 2007).

In this way, the first plan aimed to overcome the extraction of natural resources through renewables and innovation. The second plan (2009) sought to transition to an economy based on knowledge through education. The third plan (2013) intended the development of capabilities (SENPLADES, 2017).

These Development Plans were articulated with the Millennium Development Goals, and now the new National Development Plan 2017-2021 is articulated with the 2030 Agenda (SENPLADES, 2017). Thus, according to the latest INEC data (2015: 34-36) in the "Living Conditions Survey" conducted in 2014, as a result of the measures adopted by the government, 78% of households had access to water through the public network, covering 92.5% of the urban area and 46% of the rural area. Regarding sewerage by public network, it reaches 60% of the population, 77.1% of the urban sector and 22.3% of the rural one. In addition, 98.4% had access to public electric service, 99.7% of the urban sector and 95.6% of the rural sector. Likewise, multidimensional poverty²⁷ was reduced to 17% in 2015 compared to 27.2% in 2009. This is related to the Brundtland's objective to fulfil the basic needs of the most vulnerable (WCED, 1987). Also, for the same year the GDP doubled in relation to 2005, reaching US \$100,176,808 thousand dollars (at current prices). In general, the rate of economic growth was at an average of 3.96% in the last ten years (MAE, 2017).

Therefore, the State does not act passively, but actively implements regulatory measures through social and environmental policies in order to not only improve human well-being, meet the human needs of education, health, access to water, but also protect natural resources. In addition, the economy has served the well-being and needs of the population, and not vice versa according to the Social Market Economy (Müller-Armack, 1956: 249).

Currently, the National Plan of Good Living 2017-2021 has goals that seek to guarantee the rights of nature and face and climate change (SENPLADES, 2017). It also integrates the principles of Good Living being complemented by those of sustainable development. It recognizes plurinationality and interculturality, and proposes combating poverty and redistributing wealth equitably. It seeks to develop not only a society oriented towards an inclusive, equitable, and solidary development, but also a

²⁷ The Multidimensional Poverty Index contains 4 dimensions and 12 indicators that simultaneously evaluate the minimum fulfillment of people's rights. A person is identified as a multidimensional poor when he has deprivations in one third or more of the weighted indicators, and as an extreme multidimensional poor when he has at least half the deprivations in the weighted indicators

harmonious relationship between human beings and nature for the benefit of present and future generations. It also affirms that the country needs to move towards a social, solidary, and environmentalist economy, based on knowledge and human talent to get out of extractivism (Senplades, 2017). In this case, the plan recognizes that this process is necessary to achieve Good Living. However, it also includes achieving full employment, greater productivity, and economic growth, which is due to the inclusion of “economic growth” as part of the objectives (Rodríguez, 2016). This is a reflection of the first objective of the Bruntland Report (WCED, 1987).

Furthermore, Objective 3 seeks: "*To guarantee the rights of nature for current and future generations*". Specifically, policy 3.4 aims to promote good practices that contribute to the reduction of pollution, conservation, mitigation, and adaptation to the effects of climate change. It also establishes as a goal: "*To increase from 68.8% to 90% the generation of electricity through renewable energy sources by 2021*" (SENPLADES, 2017). These guidelines, set to tackle climate change, include the increase in the use of renewable energies and one of these alternatives is solar energy as described in the next chapter.

With the facts described throughout this section, the first chapter is concluded and the first objective of this dissertation that sought to determine the impact of climate change on economic, social, and environmental development worldwide and in Ecuador is met. To this end, a study was carried out on the history of this phenomenon and its environmental, economic, and social impacts, the public and private initiatives to deal with this problem, and its impact in Ecuador reflected in changes in its environment, Constitution, and development plans.

CHAPTER II

ENERGY SECTOR IN ECUADOR

After having studied the history of climate change and its impact mainly on a global level, this chapter will focus on its impact on Ecuador reflected in its energy matrix that aims to achieve environmental sustainability, the use of renewable energy, and the generation of regulations to promote it. For this purpose, the energy potential in the country, supply and demand, and the legal and institutional framework for renewable energy projects will be reviewed. Ensuing, the oil industry on which the country wants to stop being dependent, in order to face climate change and achieve sustainable development, will be examined, as well as its social impact. In this way, the first research question of this thesis, which seeks to determine the impact of climate change worldwide and in Ecuador, can be partially answered.

2.1. Energy Potential

As mentioned in the previous chapter, the world mainly uses non-renewable primary sources, particularly fossil fuels such as oil, coal, and natural gas, emitting large amounts of CO₂ into the environment and causing global warming, and therefore a climate change in the planet. Hence, to address this problem, Ecuador committed to generating 90% of electricity through renewable sources (REN21, 2017). Yet, this percentage was 51.5% in 2016 (MICSE), and the country does not have a target to replace the generation of primary energy through renewable sources (REN21, 2017).

Thus, this subchapter describes the Ecuadorian energy matrix structure. First, the sources that make up this matrix, the supply and demand of energy, and the CO₂ emissions emitted are described. The second part deals with the renewable energy potential, and the last one refers to the electrical matrix. This segment aims to identify the sources responsible for most contamination and the existing potential to replace them, given that Kara Solar's intention is to reduce the use of fossil fuels and therefore the emission of greenhouse gases.

2.1.1. Energy matrix

By constitutional mandate²⁸, the State is responsible for generating energy in any of its manifestations and it exceptionally delegates the private sector to produce it. In addition, energy generation is based not only on the principles of environmental sustainability, but also on making this energy production more efficient for future generations (Asamblea Nacional, 2008).

Nevertheless, in 2009, Ecuador's energy matrix reaffirmed the country as an exporter of primary goods of low added value as oil, for instance, and importer of industrialized goods as derivatives thereof (SENPLADES, 2009). Furthermore, for several years, Ecuador did not make sufficient investment in energy matters. Therefore, the energy supply decreased causing energy crises at the end of 2009 and the beginning of 2010, and economic losses of around US \$ 245 million (Roldán, 2013).

In 2007, more than 79% of the energy consumed in the country came from petroleum derivatives, 13% from electricity, 5% from biomass, and less than 1% from alternative energies (SENPLADES, 2013). Thus, the Ecuadorian State has implemented several actions to avoid the occurrence of such crises and built a more efficient matrix. First, the National Plan for Good Living 2009-2013 set in its policy 11.1: "*Restructure the energy matrix under criteria of transformation of the productive matrix, inclusion, quality, energy sovereignty and sustainability with an increase in the share of renewable energy*" (SENPLADES, 2013: 322). This plan recognized the need for a change in the energy matrix as one of the means to achieve a sustainable system. The measures established to achieve this were: the increase of renewable energies in

²⁸ Articles 313 and 314 of the Constitution provide as follows:

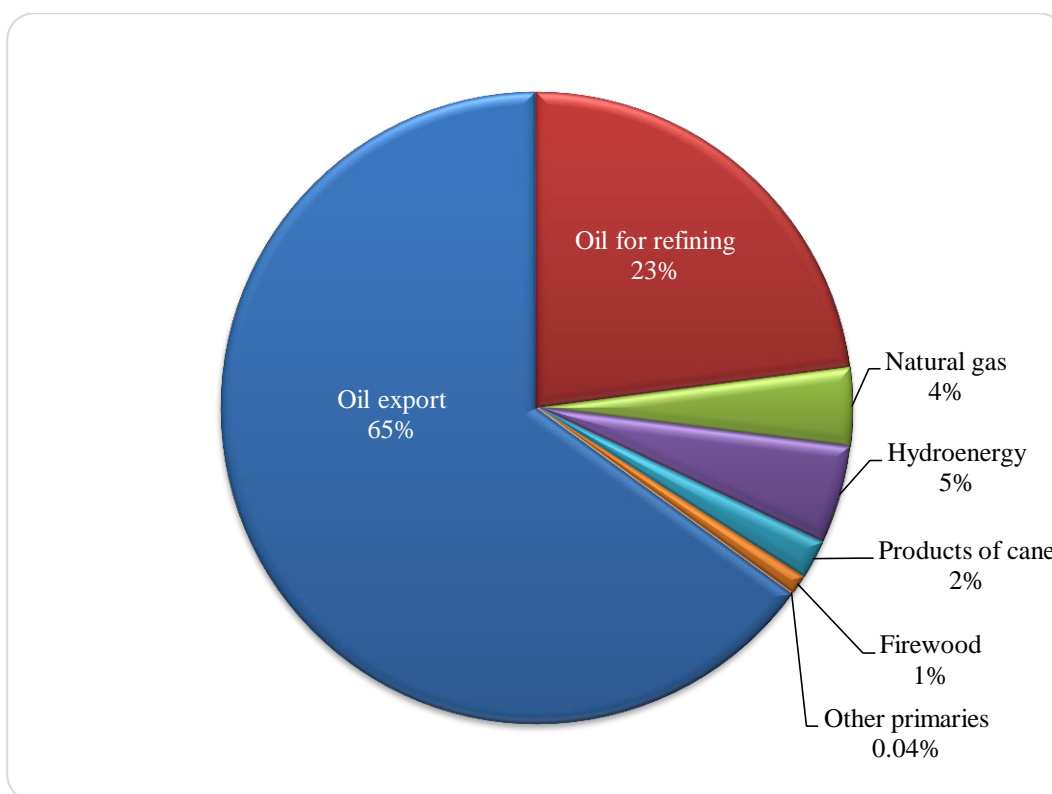
Art. 313. The State reserves the right to administer, regulate, control, and manage the strategic sectors in accordance with the principles of environmental sustainability, precaution, prevention and efficiency. The strategic sectors, of decision and exclusive control of the State, should be oriented to the full development of rights and social interest. Sectors considered strategic are: energy, telecommunications, non-renewable natural resources, transportation and refining of hydrocarbons, biodiversity and genetic heritage, the radio spectrum, water, and others as determined by law.

Art. 314. The State will be responsible the provision of public services such as potable water and irrigation, sanitation, electric power, telecommunications, roads, port and airport infrastructure, and others as determined by law.

national production such as geothermal, biomass, wind, and solar; petroleum derivatives imports reduction; the search for more efficient energy means of transport; implementation of plans and programs for the efficient use of energy; and, generation of awareness of energy saving (SENPLADES, 2009).

Nowadays, from the primary energy²⁹ production, 65% comes from oil that is exported, 23% is oil for refining, 5% comes from hydropower, 4% from natural gas, 1% from firewood, 2% from cane products, and 0.04% from sources such as solar and wind power (MICSE, 2016), as displayed in Chart No. 2:

CHART No. 2
Primary energy production (2015)



Source: MICSE (2016)

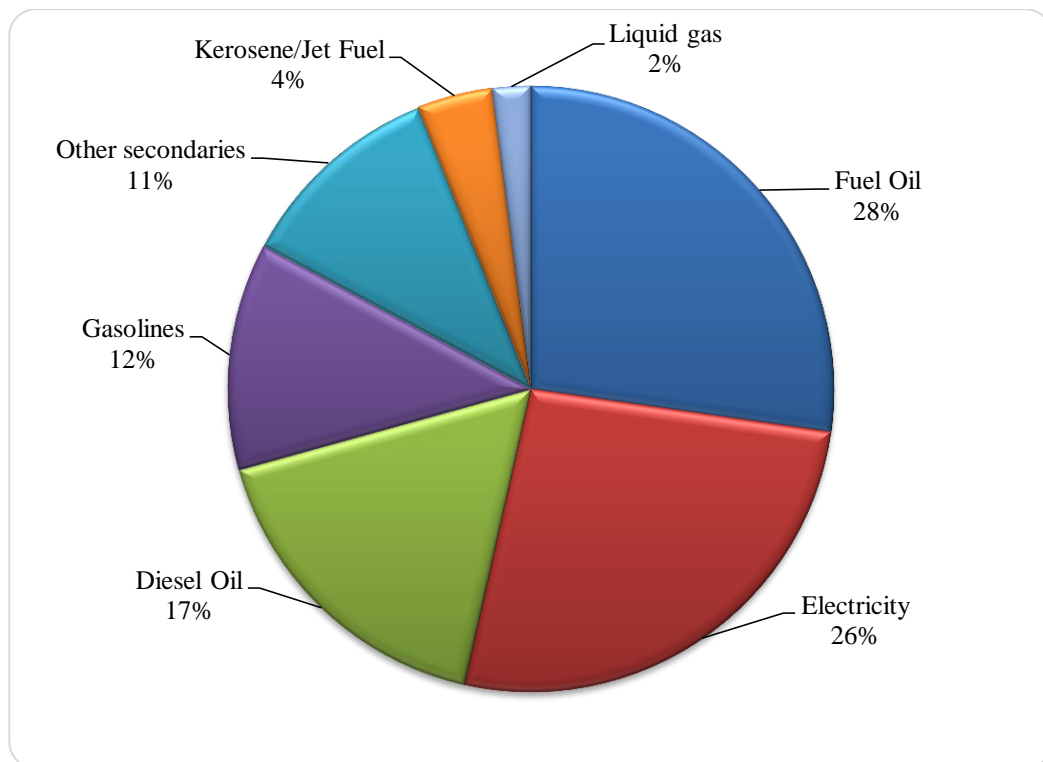
Elaborated by: Priscila Alvarado

Moreover, since 2016 Ecuador exports electricity to Peru and Colombia through the operation of the Coca Codo Sinclair and Sopladora Hydroelectric Power Plants (CELEC, 2016).

²⁹ Energy available in nature before being converted or transformed

As for secondary energy production³⁰, 28% corresponds to fuel oil, 26% to electricity, 17% to diesel oil, 12% to gasoline, 4% to kerosene, 2% to liquefied gas, and 11% to other secondary energies (MICSE, 2016).

CHART No. 3
Secondary energy production (2015)



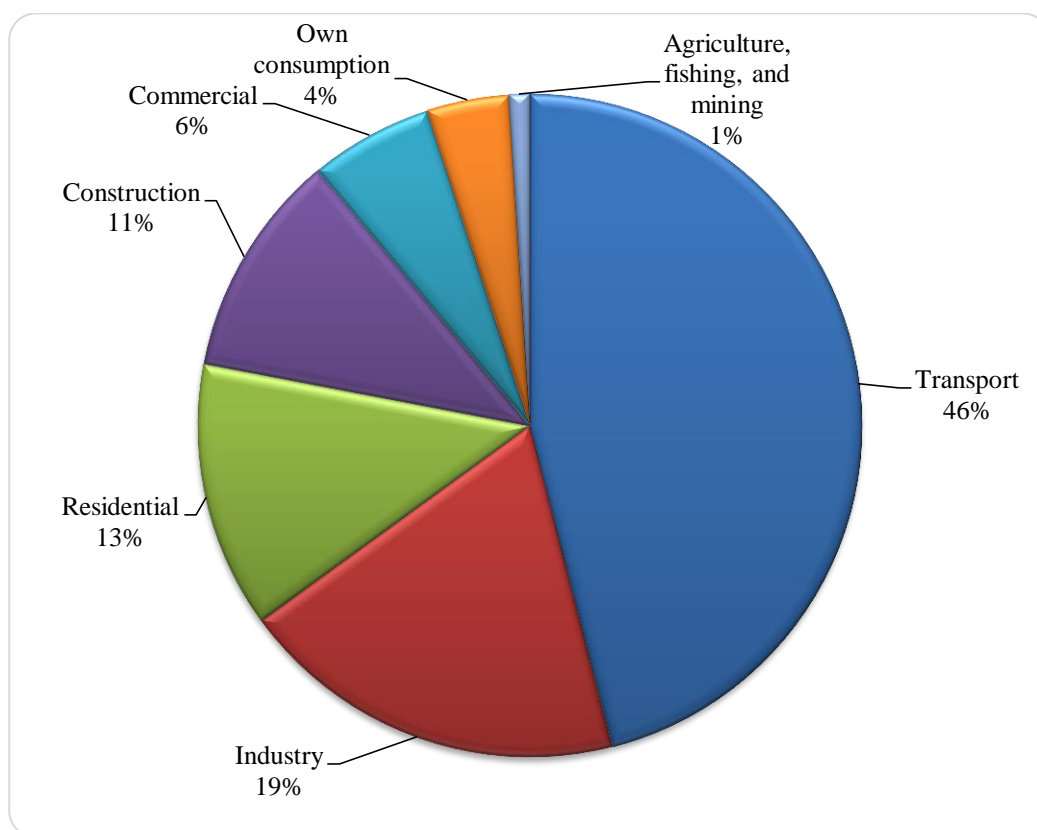
Source: MICSE (2016)

Elaborated by: Priscila Alvarado

Regarding energy demand, according to the National Energy Balance, in 2015, transport, industry, residential, and construction sectors had a share of 46%, 19%, 13%, and 11% from the total energy demanded (MICSE, 2016), as displayed in Chart No.4:

³⁰ Products resulting from the processing of natural energy resources

CHART No. 4
Energy demand (2015)

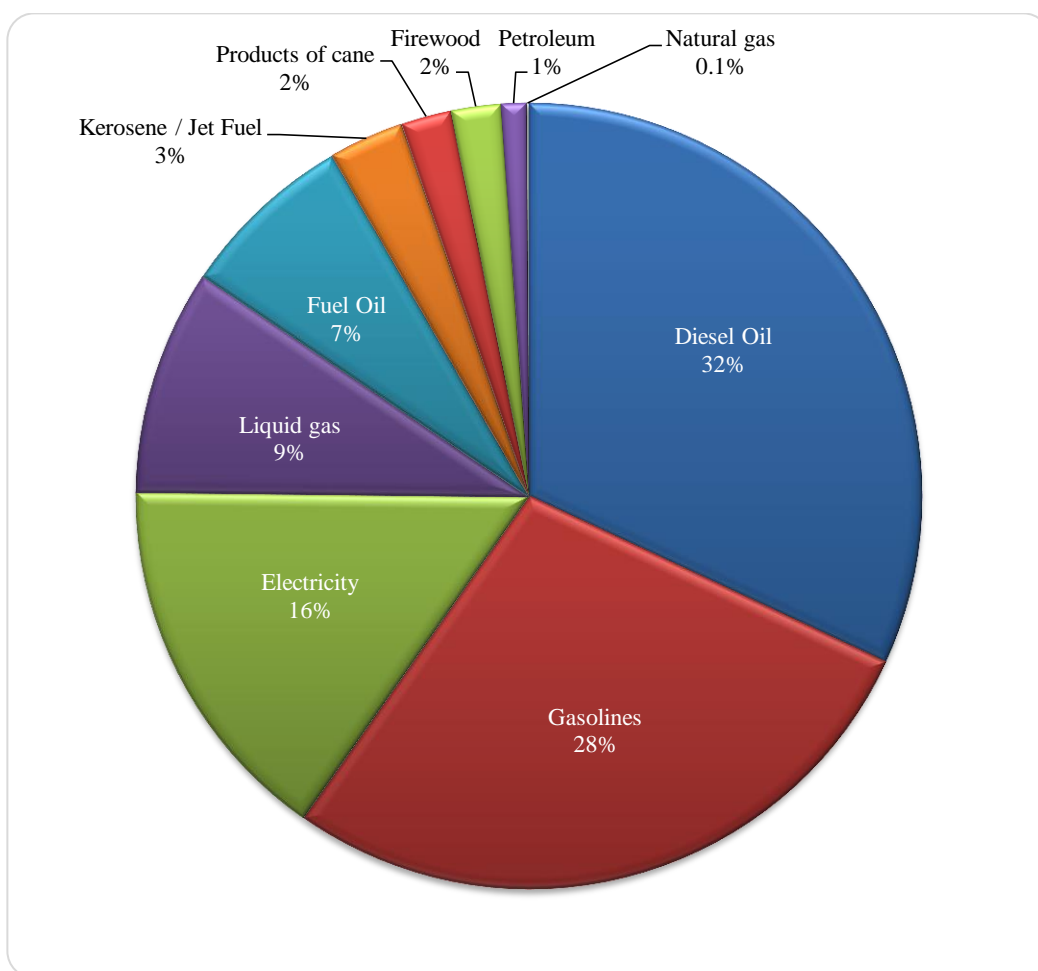


Source: MICSE (2016)

Elaborated by: Priscila Alvarado

On the other hand, in 2015, diesel represented 31% of the demand. It is used mainly for transport and thermoelectric generation. 27% of the demand consisted of extra gasoline, 9% of liquefied petroleum gas, 7% of fuel oil, 15% of electricity, 3% of kerosene, 2% of firewood, 2% of cane products, 0.1% of natural gas, 1% of oil, and 0.47% of energy obtained through other secondary sources (MICSE, 2016).

CHART No. 5
Demand structure by source

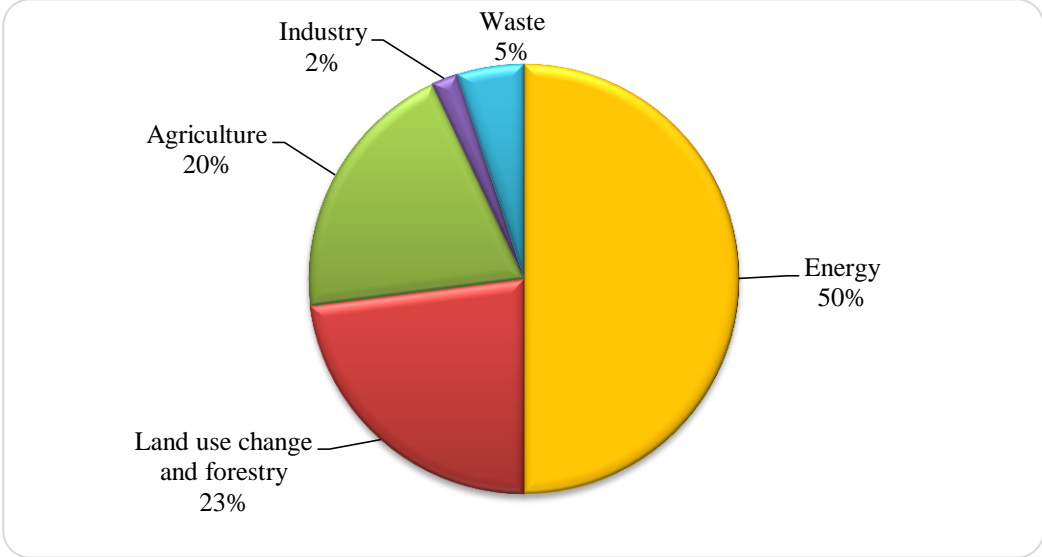


Source: MICSE (2016)
Elaborated by: Priscila Alvarado

However, Ecuador does not manage to cover the domestic demand of petroleum derivatives, such as liquefied petroleum gas, diesel, and naphtha, with the production of local refineries. Thus, these are imported to meet that demand (MICSE, 2016). Furthermore, it is important to highlight that the Electrification Master Plan was launched. This entailed the construction of hydroelectric power plants and gas stoves replacement with induction cookers (SENPLADES, 2009).

Nevertheless, due to energy consumption from non-renewable sources, the energy sector produces 50% of CO₂ emissions in Ecuador, amounting to 43.9 million tons of CO₂, 0.16 of N₂O, and 0.21 of CH₄ in 2015 (MICSE, 2016).

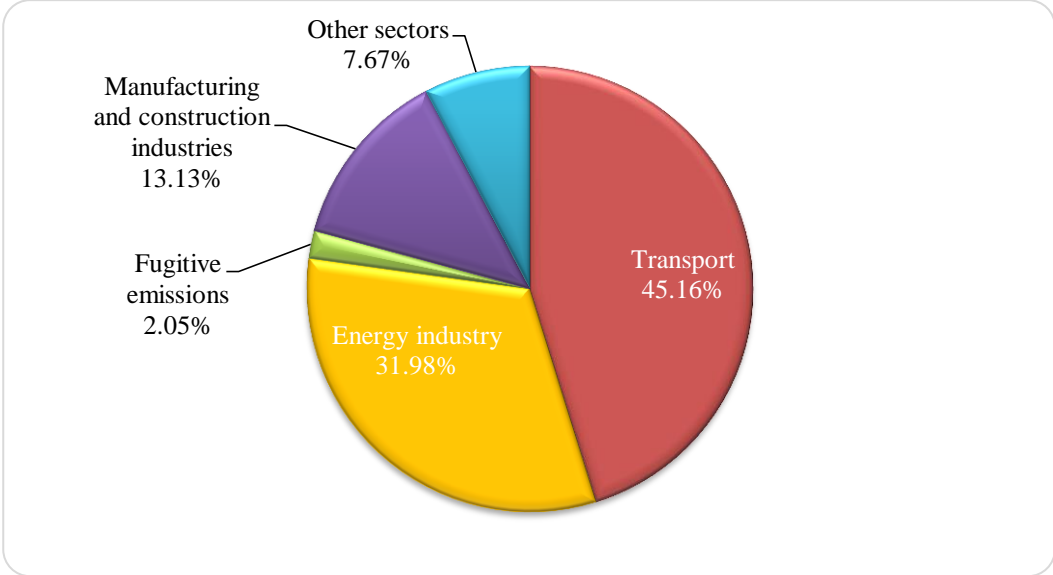
CHART No. 6
Emissions of tons of CO₂ equivalent



Source: MAE (2015)
Elaborated by: Priscila Alvarado

Accordingly, regarding the energy sector, the categories that contribute to emissions are: transport (45.16%); the energy industry (31.98%) through the combustion processes of electricity generation, oil refining, and gas treatment; and the manufacturing and construction industries (13.13%) due to the use of fuels in the production of cement, as shown in Chart No. 7:

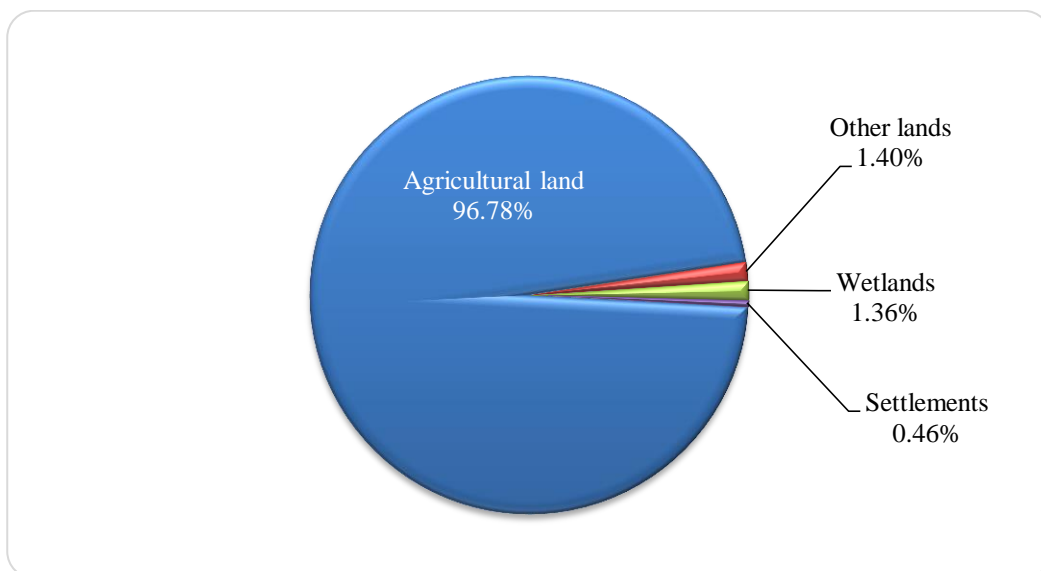
CHART No. 7
Distribution of GHG emissions in the energy sector



Source: MAE (2017)
Elaborated by: Priscila Alvarado

With respect to the land use change and forestry sector, agricultural land, wetlands, and settlements contribute to 96.78%, 1.36%, and 0.46% of emissions, as shown below:

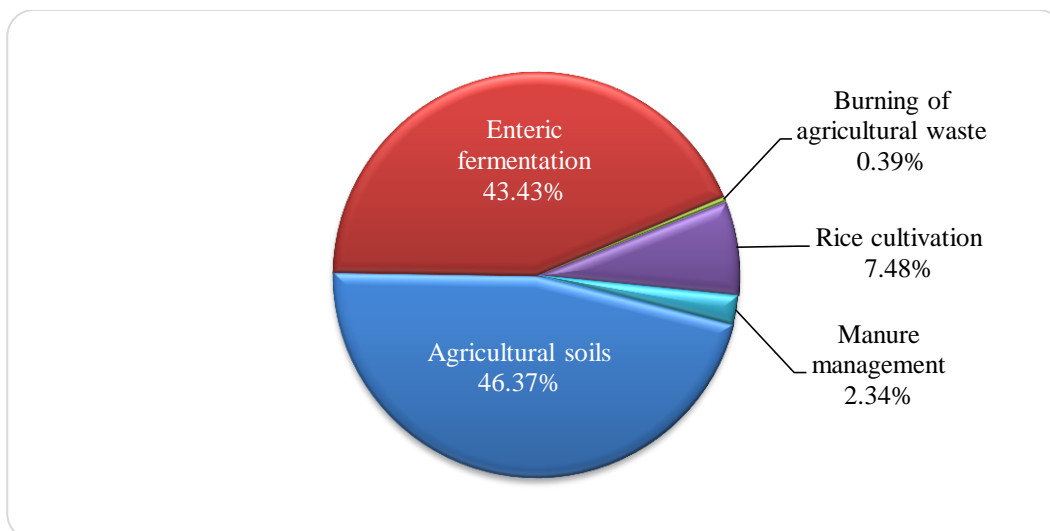
CHART No. 8
Distribution of GHG emissions in the Land use change and forestry sector



Source: MAE (2017)
Elaborated by: Priscila Alvarado

In the agriculture sector, the categories that contribute to the emissions of GHGs are the following:

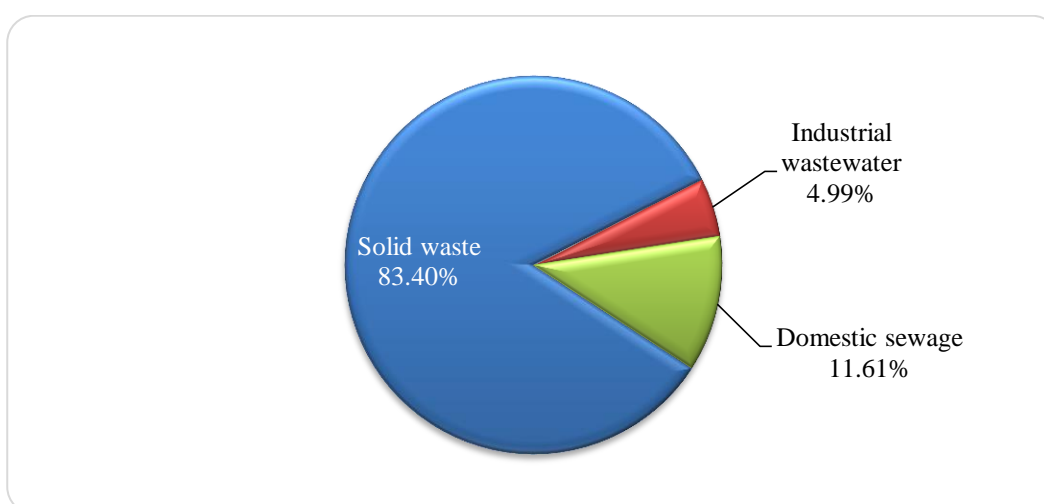
CHART No. 9
Distribution of GHG emissions in the agriculture sector



Source: MAE (2017)
Elaborated by: Priscila Alvarado

The main causes are agricultural soils (46.37%), enteric fermentation (43.43%), rice cultivation (7.48%), manure management (2.34%), and the burning of agricultural residues (0.39%) (MAE, 2017). Among the GHGs emitted by the waste sector, solid waste (83.40%), the industrial wastewater (4.99%), and the domestic sewage (11.61%) generate methane and nitrous oxide (MAE, 2017).

CHART No. 10
Distribution of GHG emissions in the waste sector



Source: MAE (2017)

Elaborated by: Priscila Alvarado

These emissions and the need to achieve sustainability have urged the country to look for renewable solutions, whose potential is described below.

2.1.2. Renewable energy

Under the proposed change in the energy matrix, Ecuador has raised renewable energy projects to be executed in different parts of the country, most of which have been earmarked for the electricity sector (MICSE, 2016).

Among the projects aimed at generating renewable energy with the purpose of using clean technology and reducing pollution, there are more than thirty hydroelectric plants (Aguilera, 2013) such as: "*Coca Codo Sinclair, Minas San Francisco, Delsitanisagua, Manduriacu, Mazar Dudas, Toachi Pilatón,*

Quijos, Sopladora" (MEER, 2016). However, in 2015, power plants produced around 5.9, 0.14, and 0.4 million tons of CO₂, N₂O, and CH₄ (MICSE, 2016).

The report "Evaluation of the life cycle of electricity produced in Ecuador", conducted by the Polytechnic School of the Coast (ESPOL) and the National Institute of Energy Efficiency and Renewable Energy, identifies the environmental effects of this type of generation: depletion of mineral resources, acidification of water, and pollution due to the emission of brominated and chlorinated substances (El Comercio, 2014).

Populations have also been affected. For example, in 2013, the construction of the Baba Hydroelectric Plant in Los Ríos Province changed the course of the Baba River, 1,100 hectares of crops and forest were flooded, and the amount of fish that were a source of work for artisanal fishermen was reduced. This project was done despite the fact that the communities were against this initiative (Palma, 2017). Indeed, the construction of hydroelectric plants causes the displacement of the inhabitants (Escobar, 2015), deforestation, and destruction of ecosystems (Correa y Delgado, 2015). If countries want to make this sustainable, they must keep micro-hydroelectric plants whose impacts are minimal and are used for the same communities, rather than as a commodity for export (Morán, López, Moore, Müller & Hyndman, 2018).

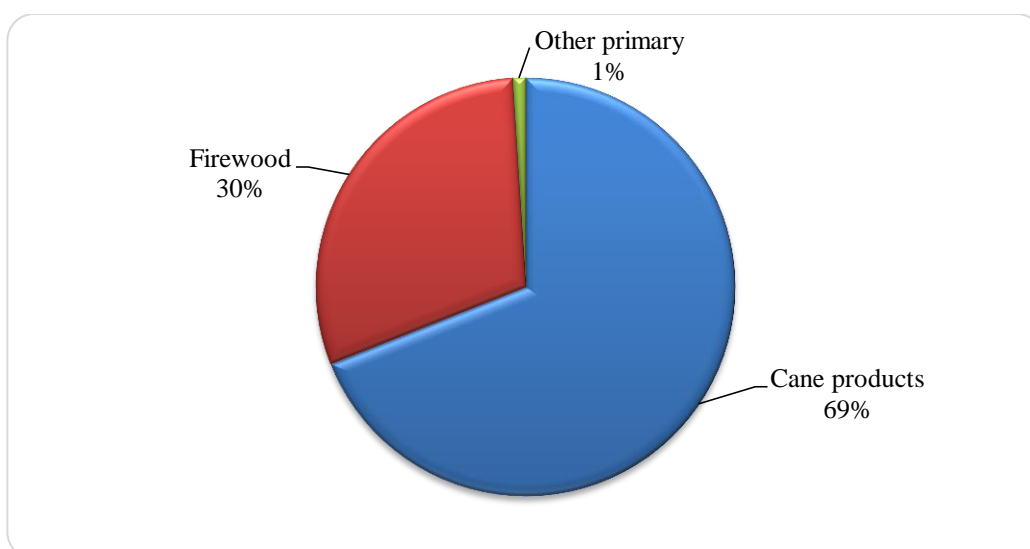
Regarding non-conventional renewable energies, Ecuador has wind, solar, sugarcane, and pine oil projects. As to wind energy, the Villonaco Wind Farm in Loja has been operating since 2013, and its installed wind turbines have a 16.5 MW capacity (MEER, 2017). Also, photovoltaic plants can be found on Floreana Island, Puerto Ayora, San Cristóbal, and Baltra in Galápagos that generate 1.1MWp, 1.5MWp, 2.4MWp, and 300kWp, respectively. In addition, Baltra has a wind farm of 2.25MW capacity since 2012 (ELECGALAPAGOS, 2016). Likewise, two other wind farms projects in Salinas and in Minas de Huascachaca are under study (CIE, 2018).

Concerning the electricity coverage demand in households far from the distribution networks and belonging to the rural sector, the government has been

able to reach them through projects such as Euro-Solar and the FERUM fund. The first began in 2007 through a financing agreement between the European Union and Ecuador, reaching 91 communities located in Esmeraldas, Guayas, Sucumbíos, Morona Santiago, Napo, Pastaza, and Orellana. This involved the construction of buildings to house the infocenters, photovoltaic systems to obtain electricity (Comisión Europea, 2013:1-3). Also, through the Urban-marginal Rural Energization and Electrification Program (FERUM) the goal of 97.04% electricity service coverage in the country was reached (MEER, 2018).

As for biofuels, 85% of the solid waste generated in Ecuador is thrown into ravines, wastelands, and clandestine garbage dumps, causing serious health and environmental problems. Only 15% of solid waste is disposed of in sanitary landfills. This is how the Public Toilet Company in Cuenca has a Pichacay landfill where the biogas generated is used to produce 2MW of electricity. Furthermore, through the National Agro-energy Project, people seek to plant 300 ha of sugarcane in Guayas Province to produce 800 million liters of biofuel until 2020 (Muñoz, 2013). Correspondingly, as can be seen in Chart No. 11, the largest share in non-conventional renewable energy production is the bagasse of firewood and cane.

CHART No. 11
Non-conventional renewable energy production



Source: SENPLADES (2016)
Elaborated by: Priscila Alvarado

Additionally, 1% represents the generation of wind and solar energy, and pinion oil (SENPLADES, 2016). In terms of geothermal energy, the Tufiño-Chiles, Chalupas, and Chachimbiro projects located in the highlands of north-central Ecuador generate around 534 MW. Regarding biomass projects, there is a dual thermal system of 138kW on Floreana Island since 2011 (Muñoz, 2013).

Between 2018 and 2030, energy demand is expected to increase by 3.2% per year. According to the National Secretariat of Planning and Development, by 2030, the demand would be 170 Mboe³¹ per year, requiring the application of energy efficient programs. In this regard, the potential of hydro, solar, and wind power technically and economically usable for electricity generation in the country reaches 22.5GW, 312GW, and 1,670 MW (Muñoz, 2012).

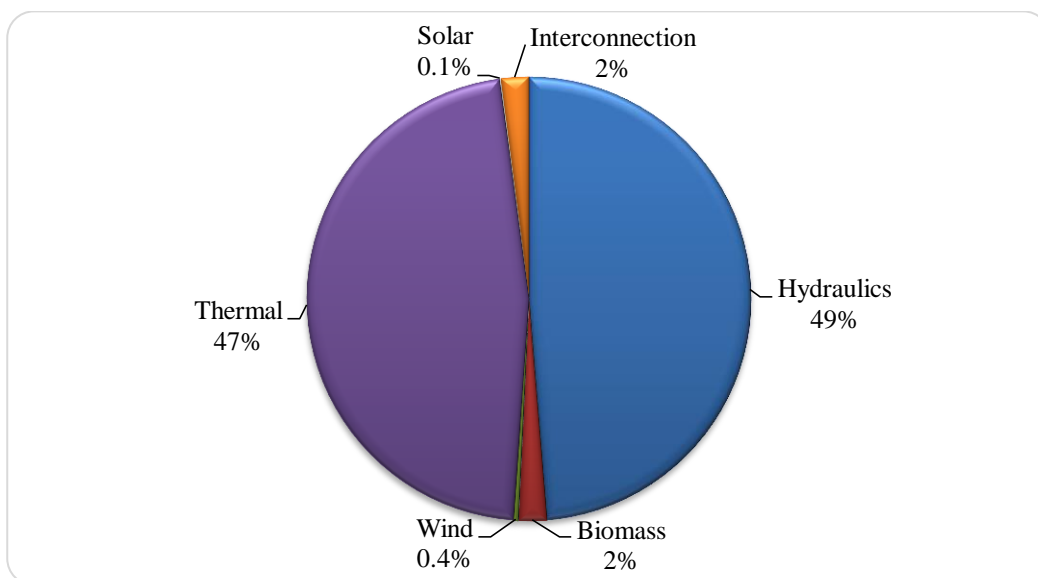
2.1.3. Electric power

In Ecuador, the Master Electrification Plan aims to provide the electricity service throughout the country (MEER, 2012). For this purpose, between 2007 and 2015, US \$9,550 billion was invested in this sector, 11 times more than in the 2000-2006 period (MICSE, 2016). Also, the Ministry of Electricity and Renewable Energy, the National Electricity Council, public and private companies, the National Center for Energy Control, and the Institute for Energy Efficiency and Renewable Energy were appointed to work together to provide this service (Vintimilla, 2013). As a result, according to the "Living Conditions Survey" (INEC, 2015), 98.4% of the population had access to public electric service: 99.7% corresponding to the urban sector and 95.6% to the rural sector.

Regarding the sources for electricity generation, 51.54% comes from renewable energies, among them 49% from hydroelectric power, 2% from biomass, 0.14% from solar energy, 0.4% from wind energy, 2% is from the interconnection with Peru and Colombia, and the remaining 47% has thermal origin (MICSE, 2016). From the total diesel used by the country in 2012, 5% was earmarked for the thermoelectric plants operation (Revista Líderes, 2013).

³¹ Thousands of Barrels of Oil Equivalent

CHART No. 12
Consumption structure by source



Source: MICSE (2016)

Elaborated by: Priscila Alvarado

Since power plants and self-producers require fossil fuels for their operation, the electricity sector emits pollutants. Indeed, although hydroelectric projects help reduce 11 million tons of CO₂ per year, diminishing the use of thermoelectric plants (Gobernación Azuay, 2016), they are also responsible for 34% of the emissions generated in the electricity sector (MICSE, 2015: 37-38).

The Electrification Master Plan 2012-2021 discloses the environmental impacts of the electricity industry. On the side of thermal generation, it involves the discharge of effluents to the environment or to sewage systems, and the emissions of Nitrogen Oxide and Sulfur Dioxide surpasses the limit determined in the Environmental Technical Standards for the Prevention and Control of Environmental Pollution. This has affected air, soil, water quality, and therefore people's health. On the other hand, hydraulic generation decreases river flows, making it impossible for aquatic species to migrate. Also, productive and populated areas are flooded, causing their displacement (MEER & CONELEC, 2015: 330-332). This is not aligned with the principles of Good Living, since nature is not being respected (Puente, 2014), and the inhabitants are stripped of their territory (Trujillo, 2009). Although changing the energy matrix is a process that takes time to achieve sustainability (SENPLADES, 2009), the principles of

Good Living urge to empower communities so they can manage and decide on their own resources (Rodríguez, 2016).

2.2. Solar energy

In this subchapter, Ecuador's solar energy potential will be determined and private initiatives and public projects will be identified. Also, information will be gathered about the legal framework and institutions that regulate the generation of renewable energy. This section is relevant because, through the development of the proposed topics, it will be possible to know the country's solar potential and also comply with the provisions of the law regarding private renewable energy initiatives. The objective of this subchapter is to provide the necessary data so that when the Kara Solar project becomes a community enterprise it has the necessary legal information for its constitution and know the potential of this source in the market.

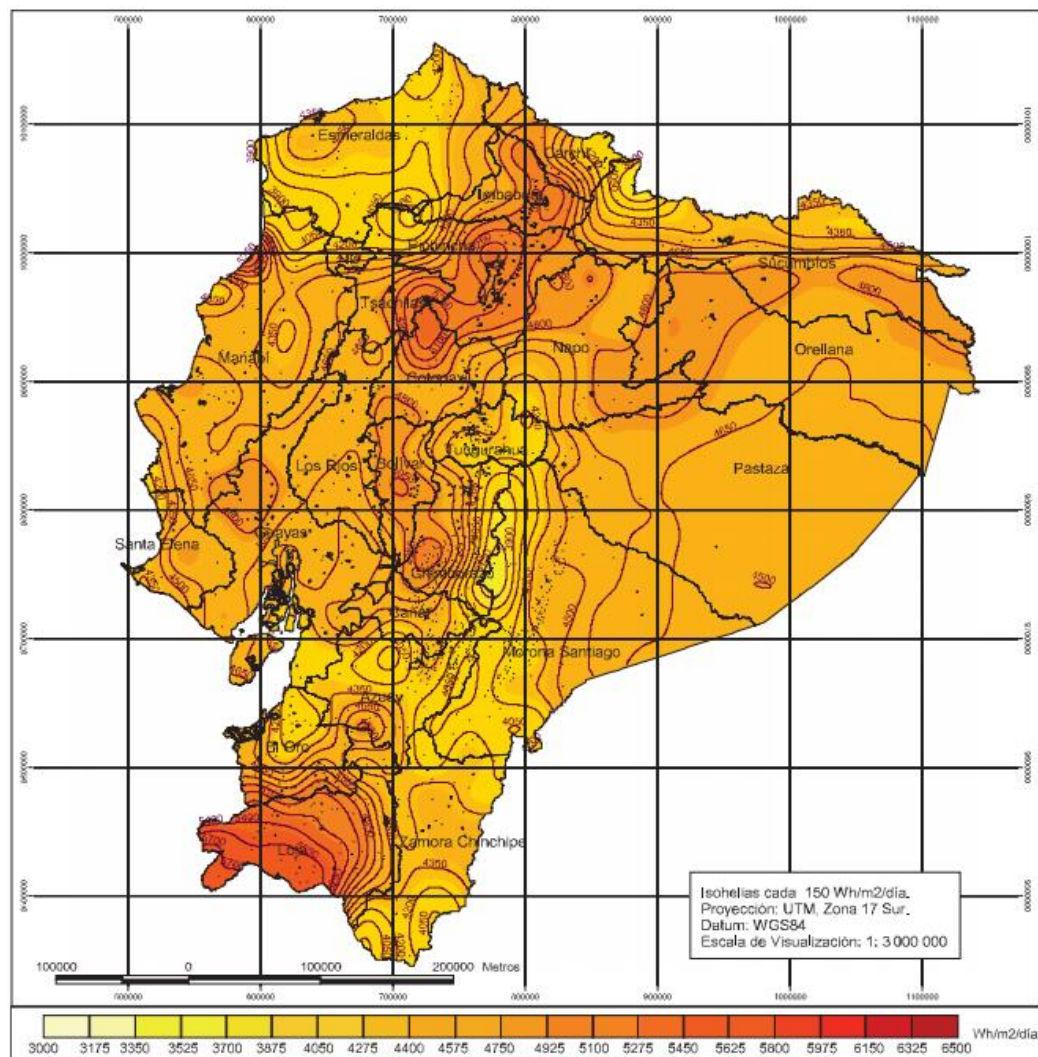
2.2.1. Solar potential

Solar energy is constituted by the portion of light emitted by the sun that is intercepted by Earth (Delgado, 2007), which is equivalent to 178,000TW-year (CONELEC, 2013). Thus, one hour of solar radiation received represents the world's annual electricity consumption (CNRS, 2018). Since solar radiation is homogeneous throughout the year, this significantly reduces the problem of random variations, making the technological use of this resource very useful and reliable for various applications. It could be classified into two types: solar photovoltaic and solar thermal. The first is exploited by means of photoelectric cells, and the second is generated by heating some medium (CONELEC, 2013).

Furthermore, a part of this energy allows the formation of winds (~ 350 TW), which power the hydrological cycles. From this process, they can harness the geothermal energy that can be subtracted from the Earth's crust up to 30 TW-year. The energy of the tides created by the attraction of the moon can also deliver 3 TW-year of the usable energy (CONELEC, 2013).

For its part, Ecuador has very varied topographic features, climatic diversity, and unique conditions that give it a high potential for renewable energy with the possibility of reaching areas far from distribution networks with electricity. In this regard, the Corporation for Energy Research developed the "Solar Atlas" that shows the average global solar energy³² from daily values of total direct³³ and diffuse³⁴ insolation expressed in Wh/m²/day (CONELEC, 2013). The following image shows the areas with the highest insolation in the country and therefore with the greatest potential for photovoltaic generation:

IMAGE No. 3
Ecuador's solar map for power generation purposes



Source: CONELEC (2013)

³² The total short-wave radiation from the sky falling onto a horizontal surface on the ground

³³ Radiation that comes directly from the sun

³⁴ Solar radiation reaching earth's surface after having been scattered from the direct solar beam by molecules in the atmosphere

Since this country is located on the equatorial line, most of the territory has an average annual potential for power generation purposes of 4.4 to 4.7 kWh/m²/day in global insolation. In general, the insolation levels are greater than or equal to 4,000 Wh/m²/day, showing homogeneity of the values throughout the year. This potential reaches 456 TWh per year, a value fifteen times greater than the country's technically and economically usable hydroelectric potential (CONELEC, 2013).

The places with the highest potential global average insolation are Quito (5.1 kWh/ m²/day), Sigchos and Pedernales (5.25 kWh/m²/day), southern Zapotillo (5.25 kWh/m²/day), and Macará (5.5 kWh/m²/day) (CIE, 2008). Moreover, the Amazon daily values oscillate between 3.35 kWh/m² in May and 4.33 kWh/m² in September (CONELEC, 2013).

Since the community company Kara Solar will be set up in Pastaza, a table with data on solar radiation in this province was prepared with information from the Solar Atlas, and displayed in the Chart No. 13:

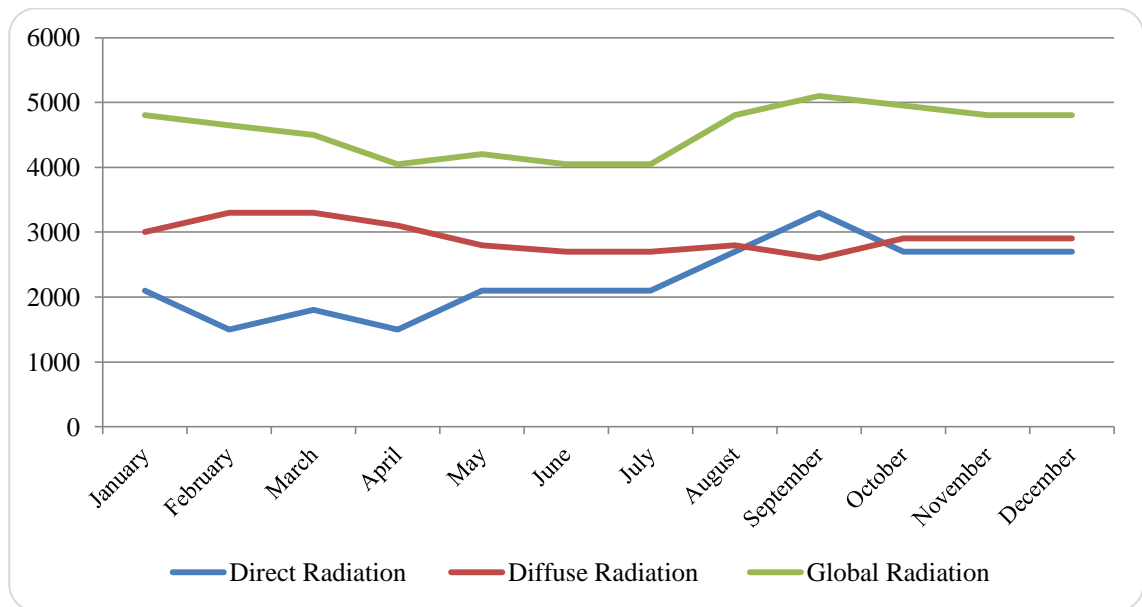
TABLE No. 2
Average solar radiation in Pastaza Province

Month	Direct Radiation (Wh/m²/day)	Diffuse Radiation (Wh/m²/day)	Global Radiation (Wh/m²/day)
January	2100	3000	4800
February	1500	3300	4650
March	1800	3300	4500
April	1500	3100	4050
May	2100	2800	4200
June	2100	2700	4050
July	2100	2700	4050
August	2700	2800	4800
September	3300	2600	5100
October	2700	2900	4950
November	2700	2900	4800
December	2700	2900	4800

Source: CONELEC (2013)

Elaborated by: Priscila Alvarado

CHART No. 13
Average solar radiation projection in Pastaza



Source: CONELEC (2013)

Elaborated by: Priscila Alvarado

Solar insolation varies according to the time of year. As can be seen in Chart No. 13, during May, June, and July the insolation is lower (CONELEC, 2013) due to the high cloudiness that exists during the rainy season (Carbonell, 2016). However, the radiation is high and varies between 2 to 5kWh. However, unlike stationary countries, the solar resource in the country is constant, being an opportunity to take advantage of in the energy sector (Díaz, 2018).

2.2.2. Public and private initiatives

Regarding solar energy projects located in Ecuador, the public and private sectors are involved in the generation of this type of energy. As for the public sector, under the Electrification Master Plan, the Ecuadorian government implemented solar energy projects to change the energy matrix. The main initiatives promoted are found in Galapagos and the rural areas of the Amazon Region (UNDP, 2015).

Due to the commitment with sustainable development and conservation of Galápagos, the Ecuadorian government implemented the Zero Fossil Fuels program with the objective of eradicating the use of petroleum fuels in the

Galápagos Archipelago (MEER, 2018). In this way, photovoltaic parks were built in Puerto Ayora and Baltra, which generate 120kWp and 50kWp since 2013. The hybrid systems of Isabela Island and San Cristóbal, which include wind, photovoltaic, and diesel generators, have a capacity of 700kWp and 7,423kWp. In addition, photovoltaic plants on Floreana Island and San Cristóbal produce 20.5kWp and 13kWp (UNDP, 2015).

According to the IPCC's Guidelines for the National Inventories of Greenhouse Gases, a river transport unit requires 4,200 gallons of fossil fuels for its annual operation, generating 38 tons of CO₂. Thus, the National Institute of Energy Efficiency and Renewable Energy launched the first solar catamaran in the country called "Solar Genesis" in Santa Cruz Island. This is a sustainable alternative to the use of fossil fuels to transport passengers from Baltra to Santa Cruz Island (INER, 2015). This will help reduce 33,000 gallons of fuel per year and avoid the emission of 33 tons of CO₂ (INER, 2015).

In 2008, specific programs of rural energization with renewable energies were undertaken and financed by the Rural and Urban Marginal Energization Fund (FERUM). One of them was the Yantsa Project located in Morona Santiago province that included electrification with 150Wp photovoltaic systems for 2,096 families and 300Wp for 218 Shuar communities (CONELEC, 2013).

Regarding EuroSolar, this program was implemented, with the support of the European Union. This benefited 91 rural communities with a population of around 40,000 inhabitants, electrifying 30,174 homes (Comisión Europea, 2013). However, according to the Ministry of Electricity and Renewable Energy:

“Frequently the installations of renewable energy systems in rural areas have not been accompanied by the necessary training and awareness of the beneficiary population. The lack of empowerment of the population with these solutions and their non-incorporation in the process of identification of needs and installation has limited its sustainability” (MEER, 2017).

In this case, there has not been joint participation and management with the communities (Rodríguez, 2016), but it is thought that the social reality can be managed or planned (Escobar, 1999), leading to these projects not being

sustainable. The Bruntland Commission recognizes international cooperation, but also that “*communal rights in particular must be respected*” (WCED, 1987). Also, Agenda 21 states that the communities must participate in the development decisions and the establishment or management of protected areas (UN, 1992).

In this way, based on reports of the Euro-Solar program status, 15% of the beneficiary communities showed infocentres with an infrastructure in deteriorated conditions. Also, 56% lacked security generating a large number of thefts. Regarding photovoltaic solar systems, 86% of the communities did not show correct maintenance because people did not know how to do it. Moreover, 60% had problems with computers due to viruses, theft or need for repair; only 35% managed the accounting and 65% had access to the internet, but one of low quality (Comisión Europea, 2013:9-14).

Furthermore, between 2011 and 2012, CONELEC approved the installation and operation of 17 private power generation projects with photovoltaic panels in several provinces for a total of 290.7MW (CONELEC, 2013). As shown in Table No.3, the largest projects that will be implemented with their respective energy productions are the following:

TABLE No. 3
Ecuador’s largest renewable energy projects

Enterprise	Project	Project Type	Location	Capacity (MW)
Desarrollos Fotovoltaicos del Ecuador SA	Shyri 1	Photovoltaic	Distrito Metropolitano de Quito	50
Condor Solar SA	Condor Solar	Photovoltaic	Cayambe	30
Solar Connection SA	Solar Connection	Photovoltaic	Cayambe	20
Ecuador Energético SA	Imbabura-Pimán	Photovoltaic	Imbabura	25
Guitarsa SA	Vaiana	Photovoltaic	Guayas	20

Source: CONELEC (2013)

Elaborated by: Priscila Alvarado

The company that will generate the largest amount of solar energy is Desarrollos Voltaicos del Ecuador SA, which will produce 50 MWp in

Pichincha. Besides, in the same province, Condor Solar and Solar Connection are part of the multinational energy company Solar Energy Inc. and each one will produce 30 and 20 MWp, respectively. Also, in the mountains of Imbabura, Ecuador Energético will implement a solar energy project that will generate 25 MWp. Moreover, Guitarsa SA, located in Guayas, will have a capacity of 20MWp (CONELEC, 2013).

2.2.3. Legal and institutional framework for renewable energy projects

In order to establish the legal and institutional framework of renewable energies in Ecuador, it is important to mention that the national policy under which these energies are developed has its origin in the Republic of Ecuador Constitution. Indeed, it considers the promotion and use of renewable energies in articles 15³⁵, 313³⁶, 413³⁷, and 415³⁸. With respect to the provision of electric power, Article 314 asserts that the State is responsible for the provision of electric power services. In this regard, the "*Organic Law of the Public Electric Power Service*" (LOSPEE) regulates the participation of the public and private sectors in activities related to this service (INER, 2015).

According to the LOSPEE, the Ministry of Electricity and Renewable Energy (MEER) is responsible for developing programs to achieve energy efficiency through the electricity sector and renewable energy. Article 24 establishes that the MEER, through the State, can authorize the activities of generation, transmission, distribution, commercialization, import, export, and public lighting service to public and mixed companies. Article 25 states that private and popular economy and solidarity companies can benefit from the

³⁵ Article 15: The State shall promote, in the public and private sectors, the use of environmentally clean technologies and alternative, non-polluting, and low-impact energies. Energy sovereignty will not be achieved to the detriment of food sovereignty, nor will it affect the right to water.

³⁶ Article 313: The State reserves the right to administer, regulate, control and manage the strategic sectors, in accordance with the principles of environmental sustainability, precaution, prevention and efficiency.

³⁷ Article 413: The State shall promote energy efficiency, the development and use of environmentally sound and healthy practices and technologies, as well as renewable, diversified, low-impact energies that do not jeopardize food sovereignty, the ecological balance of ecosystems or the right to water.

³⁸ Article 415: The Central State and the decentralized Autonomous Governments shall adopt comprehensive and participatory urban land use planning policies. Decentralized autonomous governments will develop programs for the rational use of water and reduction, recycling and adequate treatment of solid and liquid waste.

aforementioned, exceptionally: when it is necessary to satisfy the public, collective or general interest; when the demand cannot be covered by public or mixed companies; when it comes to projects that use non-conventional renewable energies (INER, 2015). Likewise, the Electricity Regulation and Control Agency (ARCONEL) regulates and controls the activities related to the public service of electric power and public lighting. It can also set tariffs for electric power, including renewable energies (INER, 2015).

On the other hand, there are incentives for investments in projects that use renewable energy. Article 26 of the "*Organic Law for the promotion of production, attraction of investments, and generation of employment*" establishes that productive investments in prioritized sectors will enjoy a tax exemption on income, and its advance, for 12 years counted from the first year in which income is generated (MICELI, 2018). In this regard, the "*Organic Law of Internal Tax Regime*" (LORTI) indicates that tourism and renewable energies are among the prioritized sectors (SRI, 2015). Also, the "*Organic Code of Production, Trade and Investment*" (COPCI) establishes that productive investment is the flow of resources or services that generate sources of employment. Moreover, new investment is the flow of resources to increase the capital stock of the economy, through investment in productive assets that generate a higher level of production of goods or services, or generate new sources of employment. New investment is also the one that is made for the generation of public projects under the modality of public-private partnership (SENAE, 2017).

Despite these incentives, Article 13 of the COPCI states that the change of ownership of productive assets, which are already in operation, does not imply new investment (SENAE, 2017). This article conditions Kara Solar because this is a project of the ALDEA Foundation, in partnership with the Achuar Nationality of Ecuador (NAE), which will pass control of operations of a boat at the hands of the Achuar communities. Thus, the boat is not considered as a new investment.

In addition to these incentives, in 2011, the State issued the regulation 0411 for the electricity sector, which set preferential prices for renewable

energies, with a regulated tariff of up to 15 years, as of the subscription date. This encouraged the projects to be executed in the shortest possible time. For example, if the project took five years to start its generation, the investor lost that privileged rate for the first five years. In this way, the company had to install the project as quickly as possible to benefit from the subsidy (Orozco, 2017).

Most of the projects proposed under regulation 0411 were photovoltaic, but they did not get to run due to administrative problems. The authorities of the electricity sector were not efficient enough to issue some basic conditions such as connection points, or environmental authorizations (Orozco, 2017). However, the incentives are still underway only for the projects already installed, and that have been signed until December 2012. The tariff was replaced as of 2013 by a new regulation. Since then, new photovoltaic projects no longer have a regulated tariff. Thus, the private sector does not have the clear rules for a possible investment in non-conventional renewable energies. A norm that sets tariffs, which allow an investment for 15 or 20 years is needed (Orozco, 2017).

Therefore, if the Achuar communities plan to build energy charging centers in the future, not only to recharge solar canoes, but also to transmit energy for residential use, these laws must be taken into account.

On the other hand, given that Kara Solar needs the solar boat, an investigation was made about the regulations regarding this topic. According to the National Institute of Energy Efficiency and Renewable Energy, there is no regulation for the maritime transport sector with private solar boats that provide the service to the community, nor a plan that is being executed by the governmental entities. Thus, there are no established prices for this service (INER, 2015). This is an opportunity for Kara Solar to establish an affordable price for the community. Also, according to the Single System of Environmental Information (SUIA), the company will be required to submit an environmental management plan to obtain its environmental record (MAE, 2015).

2.3. Oil industry in the Amazon region

In this subchapter, the oil concessions situation in Ecuador will be described since the energy matrix and exports depend mainly on this product. This section also deals with the affected protected areas and the indigenous populations disturbed by the oil industry. These topics are important since they constitute some of the reasons why Kara Solar was born. The purpose of this section is to understand why indigenous communities have opted for sustainable development and caring for the environment instead of oil exploitation.

2.3.1. Oil concessions situation

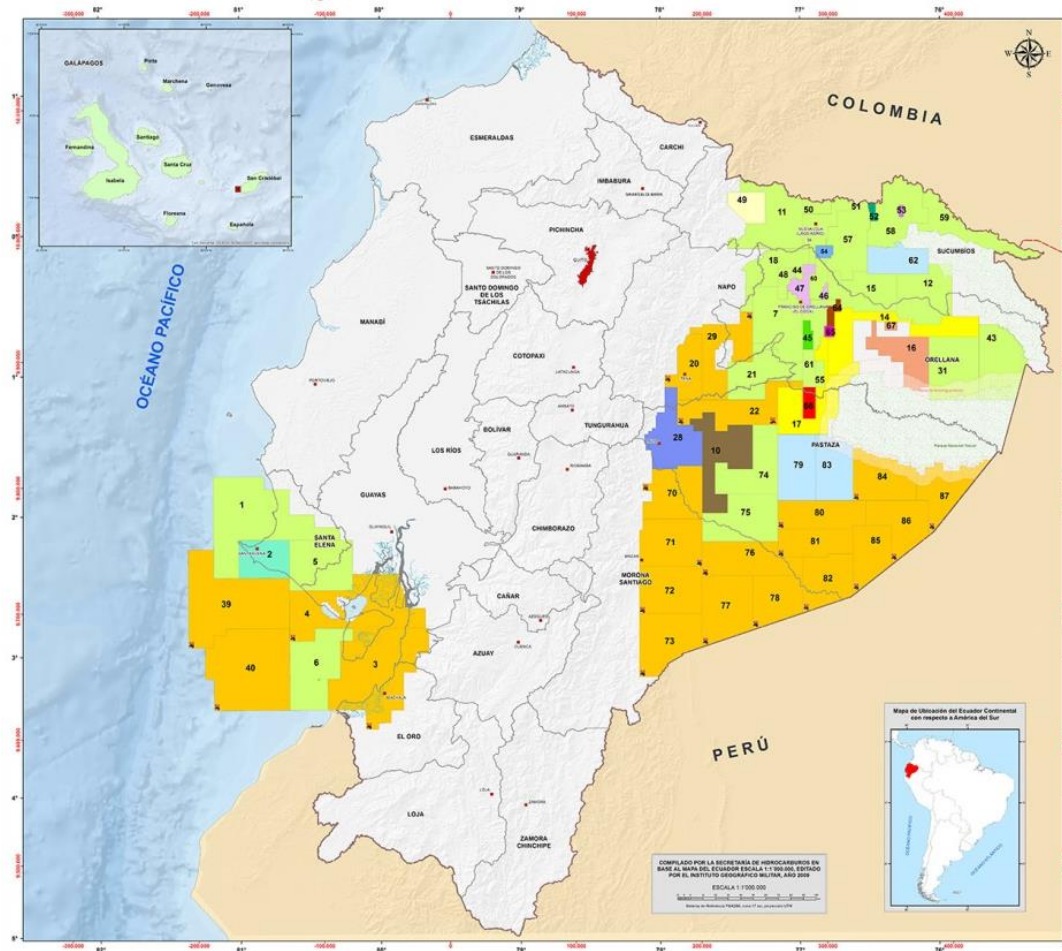
The Ecuadorian Amazon region reaches an area of 131,000 km² covered in lush vegetation typical of tropical rainforests (Fontaine & Le Calvez, 2009). Yet, it also has a high oil potential whose export is one of the main items of tax revenue in the country (El Tiempo, 2015). In fact, the search for oil and its extraction have led to an increase in national income over the last four decades. Consequently, this has become a threat of extinction of the forest and its biodiversity due to the harmful effects on the local environment and the health of the inhabitants (INREDH, 2018).

Indeed, in Ecuador, the first oil well was discovered in Santa Elena peninsula by the English company Anglo. However, production at commercial levels did not occur until 1925 and started exporting in 1928 (El Comercio, 2012). While it is true that the oil industry has boosted Ecuador's economy, it has also caused serious consequences for the environment. According to studies carried out in 1999, the river water used by the communities near the oil fields had high concentrations of petroleum hydrocarbons. In some streams, hydrocarbon concentrations were more than 100 times higher than the limit allowed by European Community regulations (Médicos Mundi, 2013).

In the past, most of the oil fields were located in remote places of the Amazon region, mainly in protected areas, such as the national parks Yasuní, Sangay, Sumaco-Napo-Galeras, and Llanganates; the biological reserves

Cayambe-Coca, Limoncocha, and Cuyabeno Fauna Reserve (Milanez & Pereira, 2016). In, 2015, the Hydrocarbons Secretariat of Ecuador approved the country's Map of Oil Blocks, as can be seen in the following image:

IMAGE No. 4
Ecuador's oil blocks map



Source: Secretaría de Hidrocarburos (2018)

In 2015, two public and seventeen private companies were assigned oil blocks. In addition, there were 206 wells drilled producing around 198 million barrels of oil per year (ARCH, 2015)

2.3.2. Social impact of oil industry

The Ecuadorian Amazon region, made up of Sucumbíos, Orellana, Napo, Pastaza, Morona Santiago, and Zamora Chinchipe provinces, has 131,137 km² and represents 48.4% of the national territory. According to the 2010 Population

Census, 739,814 inhabitants live in this area, which represents 5% of the national population. This is recognized as one of the most biodiverse regions of the planet and is home to 11 indigenous nationalities: Siona, Secoya, Cofán, Waorani, Kichwa, Shiwiar, Shuar, and Zápara in Sucumbíos, Orellana, Napo, and Pastaza; Shuar, Andoas, and Achuar in Pastaza, Morona Santiago, and Zamora Chinchipe (Guaranda, 2018).

Nevertheless, oil exploitation in this region is responsible for the deforestation of 2 million ha, while more than 650,000 barrels of oil have been spilled in forests, rivers, and estuaries. Toxic substances and heavy metals have contaminated water sources, which were used by indigenous people, causing serious diseases and the death of farmers (Guaranda, 2018).

One of the most known cases is Texaco Company, which started operating in the Ecuadorian Amazon in 1964, exploiting 336 oil wells and requiring the cutting of trees and the creation of 880 waste disposal pools without any type of waste protection. Texaco did not waterproof the floor of the pools to prevent leaks and did not treat the water. In addition, a portion of the surplus oil was incinerated and 80,000 tons of waste were sucked and watered along 1,800 km of roads built by the transnational. Currently, the pollution produced expands over 5,000 km, affecting surface water, groundwater, and land. Accordingly, more than 400 thousand hectares of forest were destroyed, five indigenous nationalities were affected, and two indigenous peoples became extinct: Tetetes and Sansahuari. In 2002, 760 Siona had registered and, currently there are barely 400 left. At the beginning of the operation there were 4,800 Cofan and today there are only 1,200 left (Funes & Pérez, 2016).

On the other hand, a study done after two decades of exploitation by Texaco indicates that women who drink water less than 200 meters from oil facilities have 147% more abortions than those who live where there is no contamination (Funes & Pérez, 2016). Since 1984, more than 2,300 cases of cancer have been registered in women of Orellana, Napo, and Sucumbíos (Echeverri, 2016).

In general, pollution has claimed at least 1,400 lives in the region due to diseases derived from discharges. Many indigenous people and farmers are still affected by the consequences, including malnutrition, skin rash, memory loss, headaches, fevers, spontaneous abortions, birth defects, and cancer (RT, 2015). In this regard, the book entitled "*The words of the jungle*" contains a psychosocial study of the impact of Texaco oil exploitation in the Amazonian communities of Ecuador which was operating from 1964 to 1990. Nonetheless, after several years, the most frequent types of cancer described by the population living less than 500 meters from the oil facilities were: 20.27% with stomach cancer, 19.6% with uterus cancer, and 9.3% with leukemia. In the case of men, 25.7% corresponds to stomach cancer, 12.5% to lung cancer, 12% to skin cancer, 11% to liver cancer, and 9% to leukemia. Among women, 37.34% corresponds to cancer of the uterus, 15.2% of the stomach, and 8.86% to leukemia (Beristain, Rovira & Fernández, 2009).

According to testimonies, remedies and healing practices of traditional medicine are not effective against these diseases, impacting negatively people's health and to the detriment of traditional medicine. Other consequences were the loss of biodiversity in the area, including numerous medicinal plants due to oil pollution and the loss of ancestral knowledge due to the death of shamans, acculturation, and loss of the conditions of transmission and reproduction of this knowledge (Beristain, Rovira & Fernández, 2009).

On the other hand, some communities had to move due to the contamination of land or rivers, noise, pollution, serious diseases, and the destruction of farms (Beristain, Rovira & Fernández, 2009).

Another example is the Italian company AGIP in Pastaza located in block 10 where, with more than 20 years of operation, its oil pollution affects animals, and production of cassava and plantain in the farms (Vallejo & Duhalde, 2016). This is how, in 2018, President Lenin Moreno proposed a bill that includes State support for people affected by cancer as a result of oil exploitation in the Amazon (El Comercio, 2018).

Therefore, CONAIE, the largest indigenous organization in Ecuador, demanded to put a limit on this problem, taking into account sustainability for future generations. Indeed, this organization proposed the implementation of sustainable development, respecting their worldview which offers a different meaning to the civilization of excessive consumption. In addition, it supports the interrelation between the human being, nature, and society as a foundation to achieve better conditions of individual and collective life (CONAIE, 2013). Thus, this vision not only proposes a social, environmental and economic balance, but also the principle of intergenerationality of sustainable development proposed by the Brundtland Report (WCED, 1987).

Furthermore, in this indigenous paradigm, education is assumed as a shared responsibility by all social actors of the different cultures involved in the process of transformation and management of local, national, and international human development in order to achieve Sumak Kawsay, for current and future generations. Accordingly, CONAIE proposes reciprocity through learning and the exchange of knowledge, which is fundamental in the indigenous world (CONAIE, 2013). This vision includes the theory of human development that according to Mahbub ul Haq (1990: 3), the exchange of knowledge around the world will ensure greater mutual understanding and countries will be more willing to share the world's resources in an equitable manner. This exchange of knowledge is also necessary to increase the capacities to improve the quality of life of the people and the quality of the air that we breathe (WCED, 1987).

2.3.3. Social Movements and NGOs against oil industry

The Ecuadorian Amazon contains one of the most biologically diverse areas in the world (Almeida & Albán, 2017). However, during the last 35 years, the oil industry in this region has not adequately contemplated the prevention of its direct and indirect impacts (Narváez, 2009). Indeed, the oil activity, the legal and illegal exploitation of wood, and the construction of roads that penetrate the jungle more and more, destroy it and displace indigenous peoples from their ancestral territories (DW, 2013). Thus, in opposition to the interests of oil companies, indigenous entities try to combat these impunities.

In 1996, the State signed a contract with the Argentine enterprise “Compañía General de Combustibles” (CGC) for the exploration and exploitation of oil in 65% of the territory of the Sarayacu community. This was carried out without the process of information, consultation, or consent of the indigenous peoples. Therefore, the case was brought to the Inter-American Commission on Human Rights (IACHR) by members of the Sarayacu community (García & Sandoval, 2007).

In 1996, the Organization of Indigenous Peoples of the Pastaza Province (OPIP) protested against CGC. In 2009, the company placed explosives in the territory, endangering the lives of the inhabitants. In 2003, the IACHR tried to implement judicial remedies for the elimination of explosives, but the State failed to comply. After several efforts, in 2012, the IACHR determined that the Ecuadorian State did not consult with the community of Sarayaku before signing a contract with CGC. It was also established that the government was responsible for the violations of human rights and the failure to protect the Sarayaku people, whose lives were at risk during the CGC operations (García & Sandoval, 2007). However, in 2018, the withdrawal of the explosives and the prior consultation are still pending (Pinto, 2018).

On the other hand, in 1998, the block 24, located in Pastaza and Morona Santiago, was granted to the ARCO Company. In 2000, the Independent Federation of the Shuar People of Ecuador (FIPSE) filed an amparo before the Constitutional Court against ARCO because it did not respect the indigenous authorities to negotiate the company’s presence in the area. Although the Court ruled in favor of FIPSE, the government did not guarantee the execution of this ruling. Subsequently, another company, Burlington Resources, bought the shares of ARCO, but also failed to comply with the sanctions. In 2005, the Minister of Energy, a representative of Burlington Resources, and the presidents of the Shuar federations FIPSE and the Interprovincial Federation of the Shuar Centers (FICSH), signed a tripartite agreement on socialization and dissemination of information, prior to the start of hydrocarbon activities. This was done without consulting the communities. Consequently, the leaders were dismissed and

replaced, and the agreement was not recognized. In 2006, there was a confrontation between Shuar communities, for and against oil exploitation, which led to the destruction of 4 houses and the evacuation of 80 people from the Wamaim and Shiarentsa communities (García & Sandoval, 2007).

In 2008, Burlington sued Ecuador for alleged confiscation of assets by the State. In 2017, the latter reached an agreement for the payment of an indemnity of US \$380 million to the company (El Universo, 2017). The same year, the tribunal of the International Center for Settlement of Investment Disputes (ICSID) ordered Burlington to pay US \$41 million in compensation to Ecuador for environmental and infrastructure damage (Levine, 2017).

Another struggle of indigenous peoples has been demonstrated against Chevron, formerly called Texaco. In 1964, this company acquired territory to exploit. In 1993, a group of indigenous people filed a lawsuit against it for environmental damage. In 1995, the company signed a "Remedial Action Plan" to clean 162 pools. These were covered with a superficial layer, leaving them in the same polluting state. However, in 1998, the government of Jamil Mahuad signed a Deed of Settlement that freed Texaco from any demand of the Ecuadorian State after the "environmental remediation". This agreement terminated the relationship between the State and Texaco. In 2003, those affected by the pollution filed a lawsuit in the Superior Court of Nueva Loja to obtain compensation (Observatorio del Sur, 2015).

In 2009, Chevron filed a claim for international arbitration against Ecuador, in accordance with the Bilateral Investment Treaty with the US, because it failed to comply with the 1998 agreement. In 2011, the company was ordered to pay more than US \$19,000 million. Then, Chevron included, in its 2009 claim, the denial of justice that occurred through the fraud and corruption of the Ecuadorian court during the litigation and the fraudulent judgment in 2011. Finally, in 2018, the Permanent Court of Arbitration ruled in favor of the enterprise. According to the award, Ecuador must pay a compensation for damages for having violated Article 2 of the Bilateral Treaty for the Protection of Investments between Ecuador and the United States (Chevron, 2018).

Having signed these contracts without prior consultation with the communities, the governments violated Convention 169 of the International Labor Organization (ILO), according to which the right to prior consultation of the peoples must be complied with (García & Sandoval, 2007). Even the Bruntland Commission recognizes that “*communal rights in particular must be respected*” (WCED, 1987). Also, Agenda 21 states that the communities must participate in the development decisions and the establishment or management of protected areas (UN, 1992). In this regard, the Ecuadorian Constitution establishes in Article 57 that indigenous communities have the collective right to participate not only in the administration and conservation of renewable natural resources on their lands, but also in prior, free, and informed consultation on prospecting, exploitation, and commercialization programs for non-renewable resources found on their lands (Asamblea Nacional, 2008).

In this way, in 1990, young Waorani leaders created the Waorani Nationality of Ecuador (NAWE). In 2005, the Waorani Women's Association of the Ecuadorian Amazon (AMWAE) was also founded. Later, NAWE joined the Confederation of Indigenous Nationalities of the Ecuadorian Amazon (CONFENIAE) and the Confederation of Indigenous Nationalities of Ecuador (CONAIE). These indigenous organizations are still struggling to defend their territories (Almeida & Proaño, 2008). This is the case of Nina Gualinga, an Ecuadorian indigenous activist, who has represented her and other indigenous communities at the IACHR, CP21, CP22, and CP23 (EXPRESO, 2018).

These social agents play an important role both in the questioning of oil exploitation in biodiverse territories and inhabited by traditional peoples, as well as in the configuration of a solution, inserting projects such as the Yasuní-ITT Initiative into the public policy agenda. In this regard, *Acción Ecológica* organization was one of those responsible for the design and formalization of the initiative, and its position within the Oilwatch helped facilitate the international dissemination of the proposal (Almeida & Proaño, 2008). However, the project failed and the Assembly authorized in 2013 the exploitation of blocks 31 and 43 in 1,030 hectares, declared of national interest (Pacheco, 2017).

On the other hand, since 1997, the Pachamama Foundation has worked with nine indigenous federations in Ecuador and other organizations to defend the rights of indigenous peoples and nature (Pachamama Alliance, 2017).

In this regard, oil extraction implies a vision different from that of the Sumak Kawsay. The latter means leading a sustainable life, where the human being organizes its activities and its economy based on a respectful interaction with nature (Lalander & Merimaa, 2018). Indeed, Article 275 establishes that:

“The development regime is the organized, sustainable and dynamic set of economic, political, socio-cultural and environmental systems that guarantee the realization of good living, of the Sumak Kawsay (...). This will require that people, communities, peoples and nationalities effectively enjoy their rights, and exercise responsibilities within the framework of interculturality, respect for their diversity, and harmonious coexistence with nature” (Asamblea Nacional, 2008).

Although Ecuador establishes, since 2008, the constitutional protection of nature, the aforementioned events illustrate the complexity of implementing reforms to achieve the transition to Good Living by means of sustainable development (Lalander & Merimaa, 2018). This occurs partly because Article 407 of the Constitution allows the executive, after declaration of national interest, exceptionally to go against declarations of intangibility in protected areas and exploit their non-renewable resources. That is why it is necessary to reform this article, in a way that responds coherently to the spirit of the Constitution, by prohibiting extractive activity of non-renewable resources in protected areas and in areas declared as intangible (Guambuete, 2016).

In this way, with the facts described through this section, the second chapter is concluded and the first specific objective of this dissertation that sought to determine the impact of climate change on economic, social, and environmental development worldwide and in Ecuador was met. In fact, this section analyzes its impact on Ecuador, its energy matrix, the need for a transition from an oil-dependent energy matrix to one with greater use of renewable energies, the regulations for renewable energy projects, and the impact of the energy industry on national communities.

CHAPTER III

BUSINESS MODEL

After having studied the history of climate change and its impacts worldwide and in Ecuador, this chapter aims to design a business model with sustainable development elements for Kara Solar's project in the Achuar communities of Pastaza and determine the profitability and competitiveness thereof. For this purpose, Kara Solar's project and the Achuar community organization will be reviewed and the Lean Startup and Business Model Canvas methodologies will be used to design the business model.

As part of Lean Startup, the Build-Measure-Learn Wheel will be employed and a survey with potential clients will be conducted to determine the needs of the Achuar communities. This information will also serve to fill the blocks of the Business Model Canvas. Finally, the researcher will make a business feasibility and profitability for the entrepreneurship with the help of the Manual for the preparation of industrial feasibility studies from Behrens and Hawranek (1991). In this way, the student will answer the last two research questions related to the design of the business model with sustainable development elements that make the business plan competitive and profitable.

3.1. Kara Solar in the Achuar communities

In this subchapter, a description of the Achuar community in the Amazon region and the history and situation of the Kara Solar project in 2018 will be described in order to have the necessary information to design the business model. The researcher chose the nine Achuar communities of the province of Pastaza to carry out the study because these are the ones which are part of Kara Solar's project from 2011 to the present.

3.1.1. Achuar community organization in the Amazon region

The Achuar population is part of the Jibaroan ethnic group. They are settled in a vast territory in the south of the Ecuadorian Amazon. The totality of

forest and has not yet been affected by logging, mining, or oil extraction. Two main reasons may explain the absence of extractive companies in this ground. First, the difficult access to these lands by road does not facilitate the entry of companies, which continue to operate in Sucumbíos and Orellana. Second, although the oil companies have been pressuring since the 1990s, the Achuar are opposed to the exploitation of their natural resources (Carpentier, 2014).

The communities do not maintain the totality of traditional customs as a product of colonization and influence of the Catholic and evangelical religions. However, they preserve their well-founded culture and identity. The god Arutam represents the “*maximum energy*” and takes care of the jungle. The knowledge about the natural environment is thorough. In addition, the customs still in force are the language, the continuous and massive drink of *chicha de yuca* and *wayusa*, the painting of the face at parties, and official presentations. For the Achuar, the territory is intangible and the basis of the structure of human life. Their culture focuses on the importance not only of knowledge about nature, but also of dreams and visions, and their remote location has allowed them to preserve their lifestyle (MCDS, 2018).

Some of their moral principles are honesty, solidarity, sincerity, strength, and determination (MCDS, 2018). In this way, the Achuar indigenous peoples of Ecuador partnered with the Pachamama Alliance to stand up for the preservation of their culture and identity since the Sumak Kawsay is embedded in their ethical values. For them, Sumak Kawsay is a “*way of living in harmony within communities, ourselves, and most importantly, nature*” (Pachamama Alliance, 2011). For the Achuar, this term is translated as “Shiir Waras”, but it has the same principles and values (DeLoughrey, Didur & Carrigan, 2015). They also want to take advantage of the fact that this concept was incorporated into the 2008 Constitution to express their relationship with nature, which personifies the opposite of utility and commodification. In this case, development has a reduced emphasis the economy and a strong focus on human development. They want to do this through the enrichment of their fundamental values, spirituality, ethics,

and the deepening of the connection with the Pachamama³⁹ (Pachamama Alliance, 2011).

Likewise, in 2016, the president of the Achuar Nationality, Agustín Tentets, and the director of the World Wildlife Fund in Ecuador, Hugo Arnal, signed an inter-institutional cooperation agreement to promote the sustainable development of the Achuar communities and the conservation of their territory. This deal seeks to strengthen the protection of the Achuar System of Ecological Conservation and Reserves through the promotion of responsible and sustainable use of resources, ecotourism, and the restoration of the ecosystems of the Sacre territory located in the basin of the Pastaza River (La Hora, 2016).

This is related to the Good Living principle of relationality because, although sustainable development is other concept, both approaches can be complementary (Hernández & Santiago, 2016). In this way, relating or identifying with the feeling of the other in all possible ways is necessary. Otherwise, they would individualize themselves (Rodríguez, 2016). However, the Achuar peoples have insisted that the countries of the North should also work within their own "modern" culture to transition from an excessive consumerism to a sustainable model (Pachamama Alliance, 2011).

3.1.2. Description of Kara Solar project

According to an Achuar legend, 50 years ago during a *guayusada*, a ritual where the elderly drink guayusa and tell stories, they had shared a dream: through the brown waters of the Capahuari River they saw "a fire ship". This was called *Tapiatpia*, a giant electric fish that transported the animals of the jungle. It was so large that each river animal such as boas, crocodiles, tortoises, serpents, and fish were part of it in the form of a seat. They were all on the back of the eel, allowing the animals of the forest to travel by water. In 2011, with the support of Oliver Utne, the Achuar Nationality of Ecuador and the Latin American Association for Alternative Development Foundation (ALDEA)

³⁹ Mother Earth

forged an alliance and the project was called Kara Solar. It aims to build a fluvial solar transport system in the Amazon. They managed to design a boat prototype with the help of engineers from the Massachusetts Institute of Technology (MIT) (BBC, 2018).

In addition, they won the IDEAS Energy Innovation Contest of the Inter-American Development Bank (IDB) to get funds and can carry out some activities of the project. For this purpose, the communities managed to collect US \$ 60,420 through crowdfunding and the other half would be given by the IDB. Subsequently, with part of this money they built the solar boat prototype and traveled through the Amazon River (Kara Solar, 2018).

Among the concerns of the residents, we have that gasoline can only get there by plane so it costs up to five times more than in the rest of the country. That makes it a luxury that not everyone can afford. Also, there is the threat of construction of roadways in that territory, one of the places with the greatest biodiversity in the world. Road construction would mean its destruction and would have a strong impact on their culture (Kara Solar, 2018).

Thus, this model of sustainable transport that would travel through ancestral routes and rivers not only materializes an old dream, but also responds to the deep desire of this culture to live in harmony with nature. It also constitutes an alternative to an ecosystem threatened by oil exploitation and whose future also depends on the climate of the planet (BBC, 2018).

Kara Solar aims to benefit 1,100 people from 9 Achuar communities: Shuinmamus, Sharamentsa, Napurak, Sua, Kapawi, Wachirpas, Ishpingo, Kusutkau, and Wayunsentsa. Their territory extends along 67 km of the Pastaza and Capahuari rivers (Kara Solar, 2018).

“This is the first step towards a new model of infrastructure for the Amazon, designed not for but with local communities” (Kara Solar, 2018). In the Achuar populations of Ecuador and Peru, "kara" means "a dream that comes true" which is being built in the present. Since 2012, a group of professionals in

engineering, design, leaders, and members of the Achuar communities have worked together in this shared dream (Kara Solar, 2018). In fact, every two weeks, the ALDEA Foundation, Plan Junto, and representatives of the NAE board of directors and from the 9 communities meet in local assemblies to talk about the project in order to continue not only with the design of its operation mode, but also with the process of construction of the management and local transportation governance system and obtain feedback from the ship's potential customers (PlanJunto, 2016).

In 2016, the communities elected 4 representatives to form a committee that would accompany the entire decision-making process around the project, and each community appointed a representative for local coordinator and motorcyclist, shaping the delegation that would participate in the training (PlanJunto, 2017). Also, any person who is interested in the whole process is welcome to be part of every assembly. Furthermore, every community has their own assembly each week, and talking about the Kara Solar project is part of their activities. In this way, representatives take this feedback to the assemblies with ALDEA, NAE, and Plan Junto (Kara Solar, 2018).

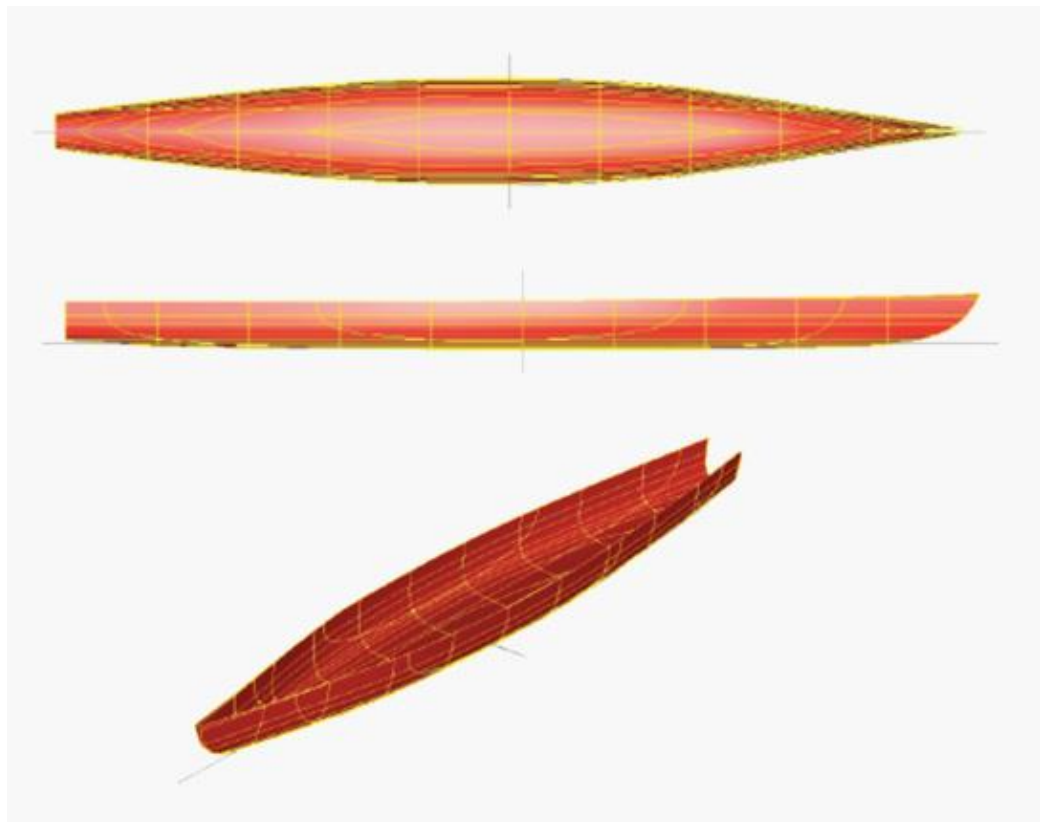
Correspondingly, the communities have suggested that the price of the trip in the solar canoe should cost the passengers US \$1 for each person per stop. This cost is low unlike the more popular gasoline canoes called *peque peques* whose captains charge US \$5-10 for the same trip. Gasoline costs five times more in the Amazon than in Quito because there are no roads and it needs to be transported by plane, at an approximate cost of US \$300. Another advantage is that the boat will not produce noise and or disturb the animals (BBC, 2018).

Among the objectives that Kara Solar aims to achieve, described by Oliver Utne (2018), we have: to face climate change, reduce pollution, develop an alternative to road construction and the prices of trips by small plane or by conventional canoes, and contribute to the reach of sustainable development.

3.1.3. Description of the solar boat

The Tapiatpia, a prototype boat, was built jointly with the communities. Representatives of each of them learned about the design, operation, installation, and maintenance of solar panels, motors, and batteries. As for the design of the boat, it has a roof of 32 solar panels mounted on a traditional canoe of 16m long and 2m wide. In addition, this ship can carry 18 passengers besides the captain and the pilot. The Tapiatpia embodies the fusion of modern technology with ancestral knowledge given that it has the design of the typical canoe of the Cofan Indians of the northern Ecuador, as can be seen in Image No. 6. Its fiberglass structure, instead of wood, extends its useful life to 30 years. After several studies of navigability it turned out to be the model that best adapts to the Amazonian conditions (Kara Solar, 2018).

IMAGE No. 6
Solar boat

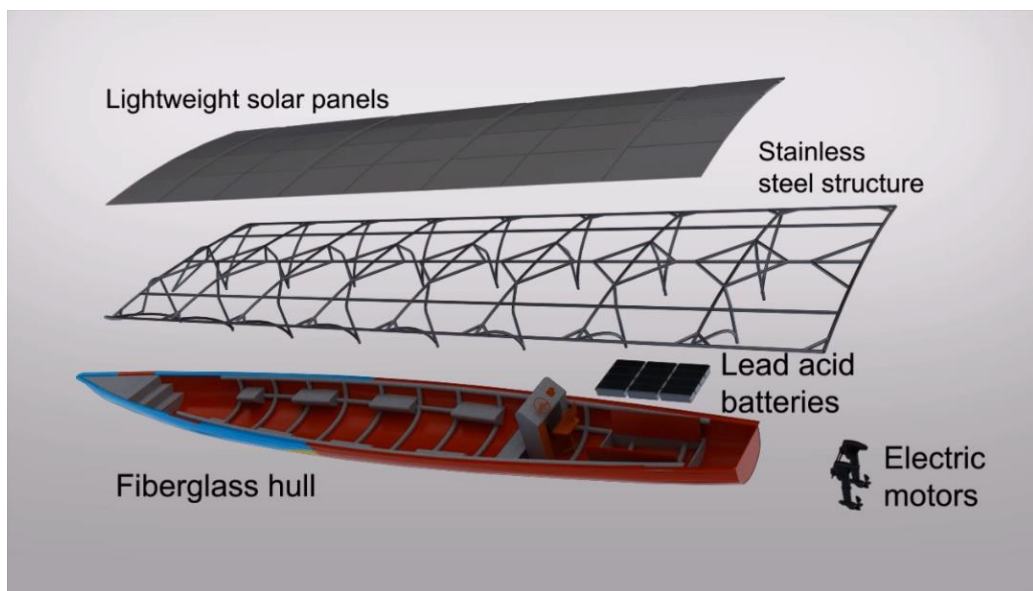


Source: Kara Solar (2018)

Besides lightweight solar panels, the boat consists of two electric motors of 7.5kW, a stainless steering structure, a hull made of fiberglass, and twelve lead acid batteries (Kara Solar, 2018).

In terms of operation, the lightweight solar panels on the stainless steel roof transform sunlight into electricity. The latter is stored in lead-acid batteries on board. The batteries are connected to two electric motors, which are driven by a steering wheel in the driver's console (BBC, 2018). This structure will take advantage of the radiation levels in the Amazon, which oscillate between 3.35 kWh/m² in May and 4.33 kWh/m² in September (CONELEC, 2013), as explained in Chapter II.

IMAGE No. 7
Solar boat structure



Source: Kara Solar (2018)

In this way, on a cloudy summer day, solar panels receive up to 80% of the solar radiation they would receive on a sunny day, as it also takes advantage of the diffuse radiation reflected by the clouds. On the contrary, on a cloudy winter day, it receives 60% of the radiation compared to a sunny day. In this way, the canoe operates between 3 and 6 hours of travel, which are necessary to go through the route they have from Shuinmamus to Ishpingo and the other way around as the panels are recharged during the trip (Utne, 2018).

The next map highlights the possible route that the solar boat can take. It also shows the schools in each community, a high school, three medical centres, three local Shamans⁴⁰, three airstrips except in Sua and Wayusentsa, and two ecolodges⁴¹ (Kara Solar, 2018).

IMAGE No. 8
Map of Kara Solar's routes in Achuar territory



Source: Kara Solar (2018)

"Having no roads helps us maintain our culture and have the wisdom not to forget what the Achuar culture really is" says René Canelos, a 27-year-old from Sharamentsa, one of the villages where the canoe aims to function (BBC, 2018). Indeed, this solar boat will help strengthen the resilience of the community against road construction. Another comment that needs to be highlighted is that of Nantu Canelos, who said that:

"This alternative is a way of saying no to extractivism and consumerism. I want my children to preserve the jungle and teach the same to my grandchildren. I hope that this area remains intact for future generations to continue with this pace of life, taking care of this place as their grandparents did." (BBC, 2018).

They seek the well-being of present and future generations in harmony with nature (WCED, 1987). Furthermore, people acquire knowledge through the

⁴⁰ Traditional healer

⁴¹ Ecotourism enterprises

ALDEA foundation, which trains people about the construction and operation of the boat that will improve their quality of life. Also, this combines technology, innovation, and ancestral knowledge while keeping their identity alive (Kara Solar, 2018).

As seen in chapter II, according to the IPCC's Guidelines for the National Inventories of Greenhouse Gases, a river transport unit requires 4,200 gallons of fossil fuels for its annual operation generating 38 tons of CO₂ (INER, 2015). Unlike the *peque peques*, Kara Solar does not produce the pollution generated by the use of gasoline or diesel (BBC, 2018).

However, before acquiring solar panels, people should take into account that these contain silicon, which is not intrinsically harmful, but some parts of the manufacturing procedure include toxic chemicals. For example, crystalline silicon is manufactured using silane gas, whose production generates toxic silicon tetrachloride. Sulfur hexafluoride is also used to clean the reactor for the production of silicon. If it escaped, it would be a potent greenhouse gas (CAT, 2017). Also, the lifespan of solar panels is generally 30 years (CAT, 2017), and the current recycling technology allows to recover more than 88% of the materials contained in a photovoltaic panel, such as aluminum and glass (Tsolar, 2017). However, scientists are experimenting with perovskite, a mineral that absorbs more energy than silicon. Unlike the latter, perovskite does not require chemical procedures to work as part of the photovoltaic cells (SINELEC, 2017). The company can reconsider this option of perovskite materials in the future or make sure that their suppliers take into account this process of solar panels manufacturing.

3.2. Lean Startup and Business Model Canvas

Lean Startup is a method developed by Eric Ries (2011) to move from project to company, focusing on customer needs, receiving feedback, and modifying the product or service to develop the final version. On the other hand, the Business Model Canvas (BMC) is a tool that was developed by Alexander Osterwalder and Yves Pigneur (2010) and described in their book "*Business*

Model Generation". This canvas is divided into nine blocks and each of them is the piece that startups or companies need not only to obtain income, but also to design, describe, and innovate on their business models.

The BMC provides the structure of a business plan without the need to write a traditional hundred-page business plan that details every aspect of a company that has not yet been created (Hustle to Startup, 2017). Thus, the structure designed for Kara Solar will be the business model and the business plan at the same time.

Throughout this section, the principles of sustainable development are taken into account as a guide for the elaboration of the business model because the Achuar communities want to contribute to the achievement thereof, which will be supported by the Social Market Economy and Human Development, as part of the theory methodology of this thesis. Also, the principles of Good Living are considered because it is the basis of the Achuar identity.

3.2.1. Methodology steps

First, the student will analyze the situation of the project through the Eric Ries's Build-Measure-Learn Wheel of the Lean Startup method in order to know the stage of the project and the next step that should be taken.

Second, as part of the Build-Measure-Learn Wheel, an interview will be conducted to the inhabitants of the Achuar communities to validate the business idea of Kara Solar with questions based on information obtained through interviews with Oliver Utne and Mónica Hernández of the ALDEA Foundation, and the one obtained on the Kara Solar website.

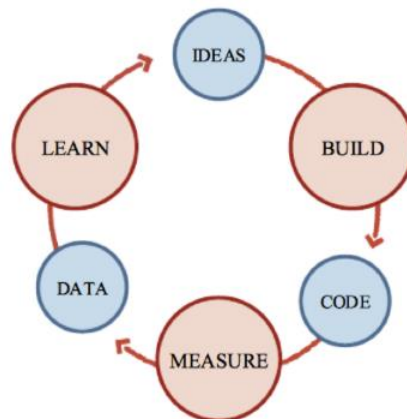
Third, all the information gathered will be analyzed and put into the nine blocks of the Business Model Canvas to determine the consumers, the offering, its infrastructure, and the financial feasibility, allowing the creation of new solutions to climate change and alternatives to oil extraction or construction of roads that threaten the identity of the Achuar people.

3.2.2. Lean Startup

The Lean Startup method is based on satisfying the specific needs of the consumer and knowing how to do it, using the minimum amount of resources. By knowing what the customer needs, startups stop investing in production processes or innovations that are not in the client's interest, which they do not request. That is, processes that do not have a place in the market (Ries, 2011).

This method focuses on 3 steps set in an endless circle and in constant movement. Entrepreneurs begin by creating a product or service, measuring the results of what was created, and then using the learning of what was measured to start creating again (Ries, 2011), as shown in the following graphic:

GRAPHIC No. 7
Build-Measure-Learn Wheel



Source: The Lean Startup (2011)

Build

When launching a startup, entrepreneurs do not have enough market data to create a product completely adjusted to the needs of the potential customer. Under these circumstances, the need to start creating what entrepreneurs want, and put this product on the market, arises. Since it is complicated to have a final product completed, the ideal is to create the Minimum Viable Product (MVP) with sufficient characteristics to make it known in the market. This product,

without being entirely complete, is useful to begin to gather data, know what improvements need to be implemented and define customers (Ries, 2011).

In this case, a prototype of the service delivery product was already created, and it is a canoe called Tapiatpia. For this purpose, the NAE and Oliver Utne asked ALDEA Foundation for support to develop their idea. They accepted and Kara Solar was the name they gave to their project. Regarding the design of the boat, they were supported by engineers of the MIT and the Polytechnic School of the Littoral of Ecuador (ESPOL). They studied 200 kilometers of Amazonian rivers, their widths, currents, depths, and obstacles to make the study of navigability. They concluded that, of the many shapes and types of boats, the Amazon canoe was the ideal to navigate those waters. In addition, the prototype is not made of wood, but of fiberglass to last longer (El Espectador, 2018).

Measure

The second step is to measure the needs of potential customers so that the product is adjusted to what is expected or wanted from it. Knowing what customers expect and want, the final product can be elaborated. In 2011, a pilot survey was carried out to 60 people from Pastaza Province. However, since then, they have not conducted another survey to validate, with the Achuar communities, the design of the prototype boat built in 2016 and the objectives the aim to achieve. That is why a survey will be conducted in order to measure the needs of the communities.

Learn

The third step of the Lean Startup methodology is for the company to learn from the data collected and the product created. It is based on learning personally from the experience of having created the product and knowing the needs of the market. In this way, entrepreneurs avoid creating a product or service that nobody wants. The objective is to create a product that solves a real problem, and which users are willing to pay for. In addition, it maximizes learning with respect to clients with minimal investment (Ries, 2011).

In this way, what is learned must be applied to a new process that begins again: new information is applied, an improvement of the first product or service is recreated, making the circle of creating, measuring, and learning start again (Ries, 2011).

Thus, at the end of the survey, the answers obtained will be a means to learn and apply what has been learned to improve what has already been developed, and launch it to the market or start again and continue working in the circle of Lean Startup, generating more ideas.

3.2.2.1.The Survey

The survey will be used to validate the business idea, analyzing comments and suggestions that the Achuar communities give. The objective of the investigation is to identify clients' needs and obtain information to define the nine blocks of the Business Model Canvas.

3.2.2.2.The Survey definition

The survey will be conducted to three people for each of the nine Achuar communities, including their leader, in order to evaluate the possible acceptance of the business. The number of people interviewed totaled 27, which was calculated through a formula, as described in the following paragraphs. People surveyed correspond to 9 community leaders and two more people who belong to each community. The results expected with this method offer a general point of view about the preferences of the target consumer. The reference market is defined as those potential clients who meet the following profile: men and women who live in the Achuar communities of Pastaza Province.

3.2.2.3. Sample size calculation

The sample for the survey will include the population from the nine Achuar communities: Shuinmamus, Sharamentsa, Napurak, Sua, Kapawi, Wachirpas, Ishpingo, Kusutkau, and Wayunsentsa because this will be a community enterprise. The interviewees belong to different economic status. Also, the number of inhabitants has been taken from the information gathered by INEC (2010), in its last "Population and Housing Census", according to which there are 1,100 people between the ages of 5 and older. Thus, in order to analyze the client, the student used the quantitative method to calculate the sample size with the following formula:

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

The information required for the calculation is the following:

TABLE No. 4
Sample size calculation data

Symbol	Meaning	Number
N	Number of elements in the sample	27
Z	Confidence level	1.75
N	Population size	1,100
P	Acceptance percentage	0.94
Q	Rejection percentage	0.06
E	Margin of error	0.08

Elaborated by: Priscila Alvarado

The values of "p" and "q" correspond to a previous pilot survey conducted by ALDEA (2011), with which the acceptance of the service was measured. This was attended by 60 people, from which 94% agreed to be willing to use the service, while 6% did not agree. This corresponds to p = 0.94 and q = 0.06, respectively. Also, Z = 1.75 is the constant to express a level of confidence of 92%, and the margin of error is 8%.

$$n = \frac{1.75^2 * 1,100(0.94 * 0.06)}{0.08^2(1,100 - 1) + 1.75^2(0.94 * 0.06)}$$

$$n = 26.37$$

$$n = 27$$

The result was 27 people to survey.

Among the reasons why 6% of people said that they would not use the service were: some inhabitants already had canoes that run on diesel or gasoline engines, people did not know how solar panels work, they did not have money for those types of boats, and there was a risk that communities lose their identity through the use of new technology (ALDEA, 2011). This will be taken into account when developing the business model because, as mentioned in the first chapter, there are risks when the concept of "sustainable development" is taken as synonymous with "sustainable economic growth" and applied with a western worldview (Daly & Townsend, 1993). Indeed, this could be used to serve individual interests, build mercantile societies based on excessive consumption, or make territories compete to offer better conditions for multinationals to settle (Latouche, 2006). The term "sustainable development" should be understood as development without economic growth (Daly & Townsend, 1993).

It must also be remembered, as mentioned in chapter I, that sustainable development is only a complement to the vision of the communities. Thus, both approaches can be complementary: their worldview, Sumak Kawsay, must be maintained, while sustainable development is a guide to achieve sustainability (Hernández & Santiago, 2016).

3.2.2.4.Survey information

In order to gather the information for the survey, a nonprobability sampling technique called "convenience sampling" was applied. This consists of selecting the individuals that are convenient for the researcher to be part of the sample. This convenience arises because the researcher finds it easier to examine

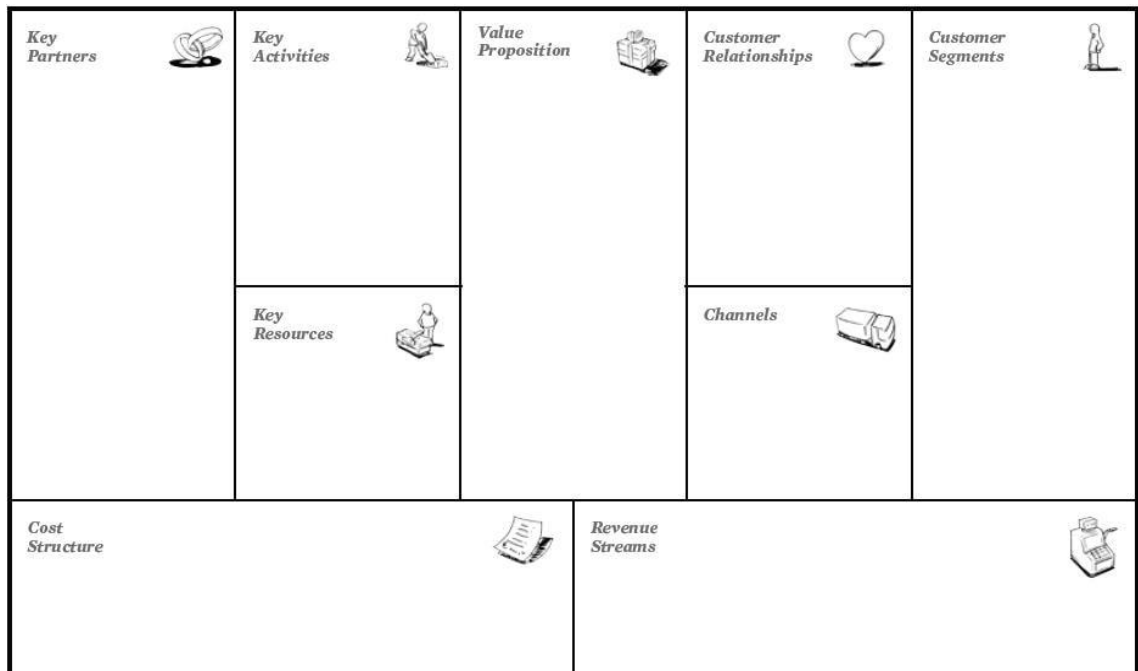
these subjects for data gathering (Given, 2008). Therefore, the application of the convenience sample was directed to the leader and two more members of any family from each community. Since the participation of 27 people was required, these people were the object of study and to whom the survey was applied.

The survey was conducted in Spanish since they speak Achuar and Spanish. It aimed to gather variables such as age, means of transportation used, knowledge of the service that Kara Solar wants to provide, needs of the communities, spending on transportation, and means preferred to obtain more information. Appendix No. 2 contains the survey format with the questions that people had to answer.

3.2.3. Business Model Canvas and Survey Findings

The Business Model Canvas, developed by Alexander Osterwalder and Yves Pigneur (2010), is a method used to organize and analyze the results obtained. This is a strategic management tool and a zero start template for documentation and the development of new or existing business models. This allows iterating the business model to be designed thanks to the validation obtained through the market feedback. This canvas can be divided into four macro-elements: consumers, offering, infrastructure, and financial feasibility. The first refers to the blocks located on the right, including the customer segment, customer relationships, and channels to be used, as can be seen in Graphic No. 8.

GRAPHIC No. 8
Business Model Canvas



Source: Business Model Generation (2010)

The second refers to the value proposition. The third refers to the blocks on the left: key activities, key resources, and key partnerships, which focus on the internal aspect of the company's operation. The fourth comprises the income sources and cost structure, which allude to the financial aspect of the organization. In the following paragraphs the student will use the BMC to place the information obtained through the survey.

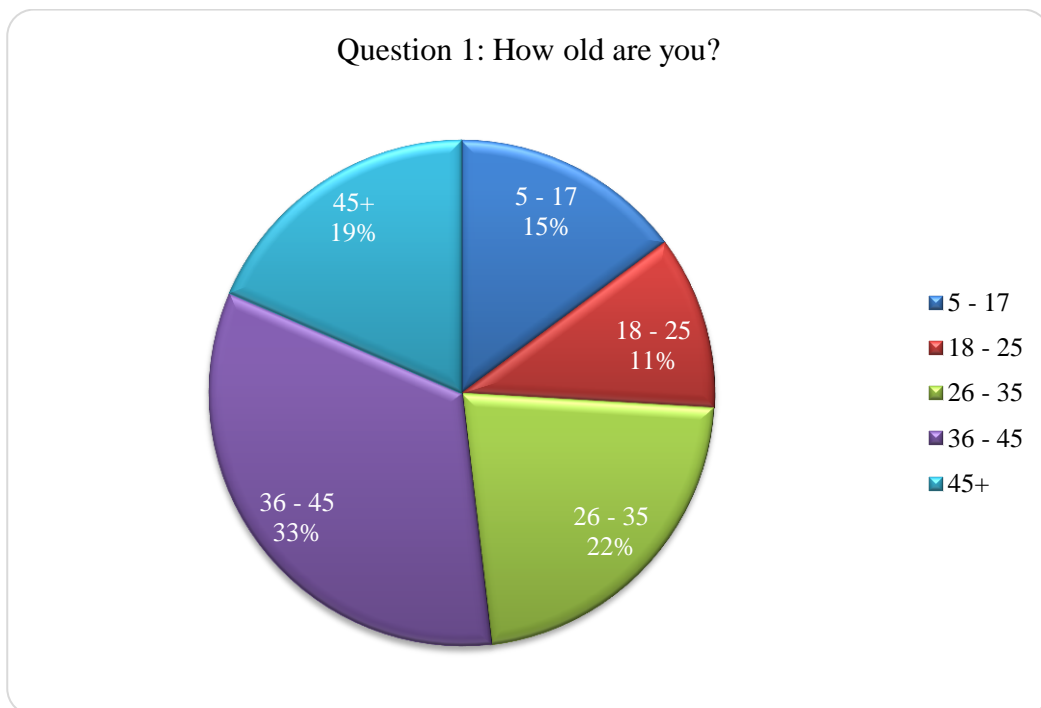
3.2.3.1. Customer Segments

The customers are the potential for a company to remain standing for a long time. Each market segment varies between needs, satisfaction, behaviors, or different attributes, so that a business model can reach one or several of them. However, companies must decide and select those that are profitable for their business model in order to direct their business to improve the specific needs of that target customer (Osterwalder & Pigneur, 2010).

Therefore, regarding the survey, question # 1 was “How old are you?” The objective was to know the diversity of the sample and to have a clear picture

of the generational characteristics of the interviewees. As shown in Chart No.14, 33% of the participants were between 36 and 45 years old, 22% were 26 and 35 years old, 19% was more than 45 years old, 15% were 5 to 17 years old and 11% were 18 to 25 years old. Therefore, the sample contains opinions from the following main markets: adults (33%) and young adults (22%).

CHART No. 14
How old are you?

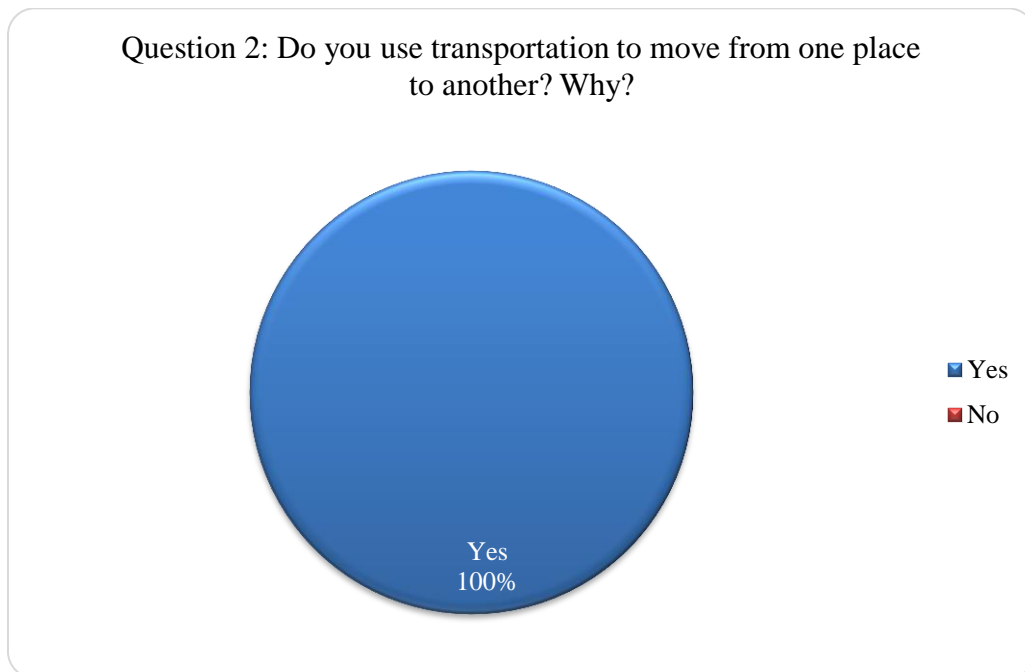


Source: Survey

Produced by: Priscila Alvarado

On the other hand, as can be seen in Chart No. 15, 100% of people use a means of transportation to get around.

CHART No. 15
Do you use transportation to move from one place to another? Why?



Source: Survey

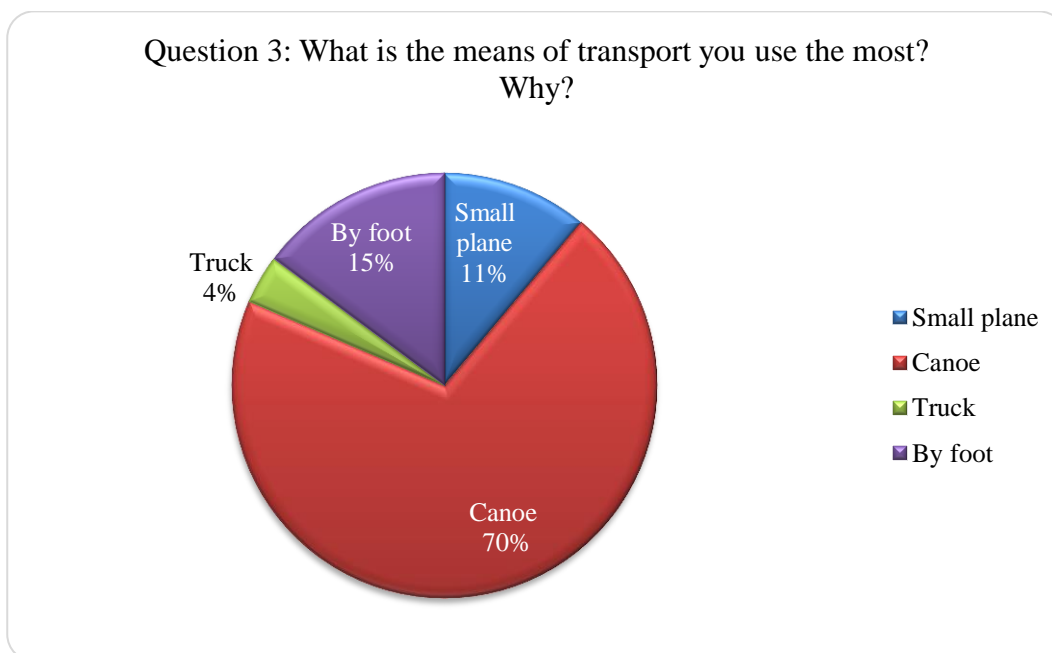
Elaborated by: Priscila Alvarado

Since all of the survey respondents that need transportation for their daily activities belong to the Achuar communities, the entrepreneurship will focus on the specific needs of a fraction of the market. Thus, the type of segmentation that applies to this business is the niche market.

Some interviewees answered that they do not do it all the time, but if they do it is to go to the hospital, to school, to high school, to the local assemblies, to sell products, or to go to other provinces. In this way, we can get a specific profile of the client to appeal to them with a message that calls to their interests. Therefore, through this service people could access to basic resources, education, health services, food, housing, and employment (UN, 1986) to meet their essential needs (WCED, 1987). The inhabitants would also harness these capabilities to turn them into functionalities such as being able to work, being literate or healthy, and being part of a community (Sen, 1999).

Regarding the next chart, Question # 3 was “What is the means of transportation you use the most? Why?”

CHART No. 16
What is the means of transport you use the most? Why?



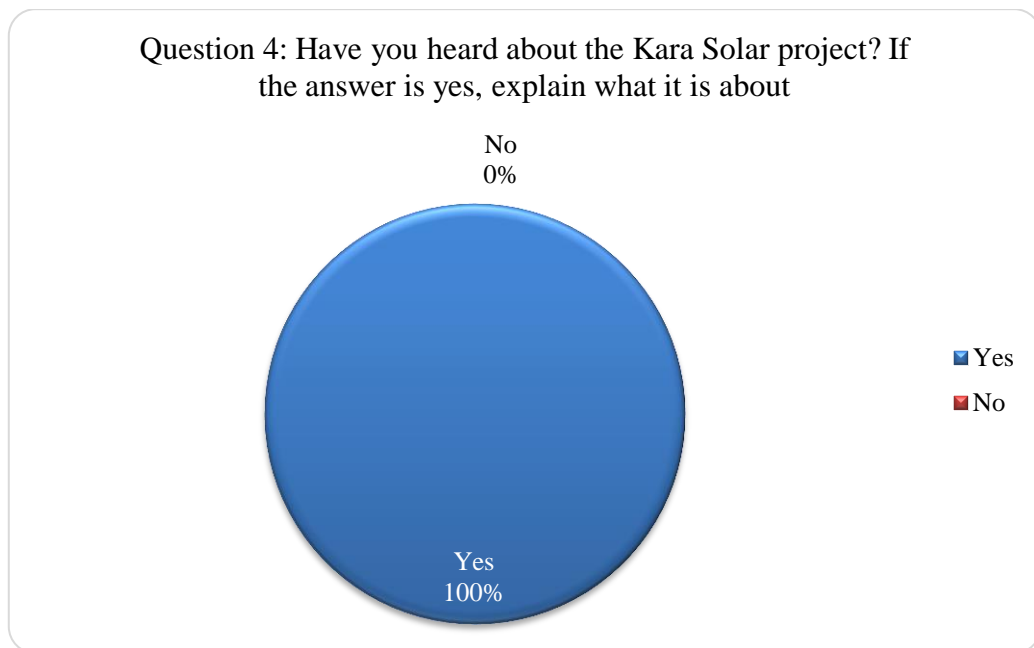
Source: Survey

Elaborated by: Priscila Alvarado

The objective of this question was to know the means of transport most used by people and determine if they would use Tapiatpia or other alternative means of transport more. Among the reasons why they use canoes, the most is because the price of travelling by small plane is expensive or because it's the cheapest way to travel.

The Tapiatpia is an alternative to the use of canoes that work with a diesel or gasoline engine. In this way, the resource base is conserved and improved (WCED, 1987) through citizen participation (UN, 1992) to avoid pollution of the river and air, eliminate the noise generated by the boats, and improve access to resources (Kara Solar, 2018). The less it contaminates the better because protection and respect for nature is part of their lifestyle.

CHART No. 17
Have you heard about the Kara Solar project? If the answer is yes, explain what it is about



Source: Survey

Elaborated by: Priscila Alvarado

According to the answers to Question # 4, 100% of people knew about Kara Solar and the service it aims to provide through solar boats. However, 6 people, 22.22%, have not yet traveled on the prototype boat because there are also some gasoline boats around or that belong to a family and they would not need a solar boat. Also, they know exactly what Kara Solar is about because they have worked on this project or heard about it in the local assemblies, contributing to the development of the project all together.

These results corroborate the information given by Oliver Utne, and the found in different sources of information, that the "Build" step of the Lean Startup Methodology was carried out jointly with the community. Thus, according to the results shown in the Charts No. 16 and 17, 70% of people use canoe to carry out their activities, and 100% of the surveyed population knows about the Kara Solar project. This means that the local assemblies, in which the communities meet and discuss about this, are working. This type of decision is related to the integration of the environment into the governmental decision-making process (WCED, 1987).

These assemblies show that communal rights are being respected (WCED, 1987). Indeed, the communities participate in the development decisions and the establishment or management of protected areas (UN, 1992), and regarding Article 57 of the Constitution, they are being part of the decision process about the management of their resources (Asamblea Nacional, 2008).

The principle of reciprocity is also reflected because, according to the Good Living, this allows the community to be built through relationships of help or solidarity (Rodríguez, 2016). Likewise, according to the principle of solidarity of the Social Market Economy, the community helps everyone to gain access to equal opportunities (Müller-Armack, 1956). People are responsible at the individual and group levels of the concerns and needs that they have found in their territory (Auping, 2004).

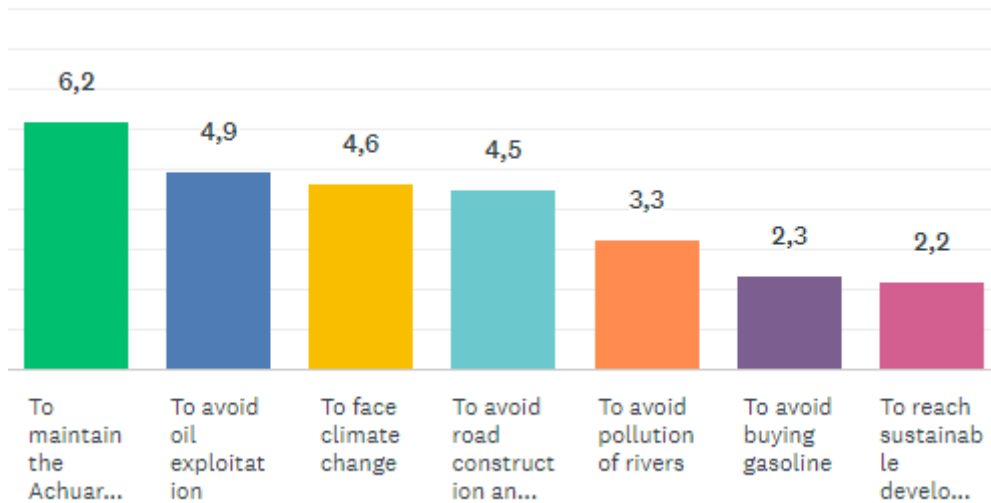
3.2.3.2. Value Propositions

The value proposition must be a clear and concise statement that highlights the greatest differential factor of the service, which is perceived by the client as a high value benefit that solves a problem (Osterwalder & Pigneur, 2010). In this case, there are several problems to be solved such as the high price of gasoline used for canoes, the use of *peque peques* that pollute rivers, oil exploitation, Achuar's identity degradation, and the possible construction of roads for mobilization (Kara Solar, 2018).

Therefore, some questions in the survey were key to potential clients. This was open to all communities so that we could obtain a general idea of the possible market segment that may be of most interest to them. The results of Question # 5 reveal that the main reason why villagers would use a solar boat is to keep their identity alive. The purpose of this question was to measure their needs. People could order from seven alternatives from 1 to 7. Results show that Achuar people consider the following order to acquire this service:

CHART No. 18

Which of the following options would you consider when using the Tapiatpia? Please put your preferences in order 1-7 (1=first to consider, 7=last to consider)



Source: Survey

Elaborated by: Priscila Alvarado

1. To maintain the Achuar identity
2. To avoid oil exploitation
3. To face climate change
4. To avoid road construction and deforestation
5. To avoid pollution of rivers
6. To avoid buying gasoline
7. To reach sustainable development

This indicates that the inhabitants mainly seek to maintain their identity and worldview by using this service. Moreover, Hilario Saant (2018), one of the respondents, emphasized that the term "*sustainable development*" is known and has been coined by the community leaders through meetings with other nationalities in different provinces, local assemblies with the ALDEA Foundation, and meetings with the GADs and the national government.

In this case, one of the value propositions is a canoe that operates on the basis of solar energy, which helps maintain the identity of these communities,

avoiding roads construction, protecting the environment and the peoples, allowing them to be in harmony with nature.

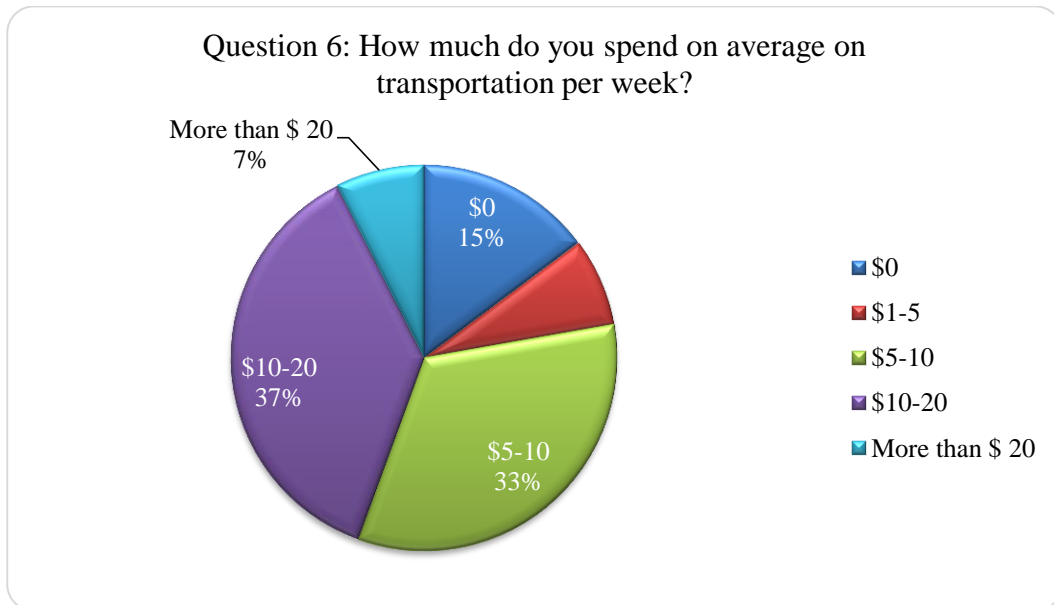
Respondents were also asked if they would add some other reasons to support this project, and one of them said that they hope to connect not only with the rest of the Achuar communities of Ecuador, but also with those of Peru to strengthen the ties between the same indigenous people divided by a state border (Saant, 2018). According to the Lean Startup, all new information is important and entrepreneurs must learn from this data to know whether this should be added to the current business model, or invest in this in the future (Ries, 2011).

Among the secondary characteristics of the Tapiatpia, this boat has photovoltaic panels and a lead-acid engine that, unlike traditional boats, does not cause noise, and whose environmental footprint is minimal. Another feature of this service is that it is novel because it does not imply a high environmental impact. Indeed, it generates less noise and pollution, contributing not only to the well-being of people, but also to maintaining nature.

This service is adapted to the specific needs and local conditions of the Achuar communities because it responds to their concerns such as impact on the environment of boats that operate through diesel, the possible creation of roads by the government destroying their forests, the high price of gasoline in the Amazon, which is 5 times more expensive than in other parts of the country, the oil exploitation, and above all, the loss of cultural identity.

Regarding the price of this service, the ticket for travel will cost US \$1, which is accessible for people taking into account that a normal boat charges from US \$5 to 10 (El Universo, 2018). Question No. 6 gives us some hints to proposing this price because 37% of people have to pay between US \$10 and \$20 per week just for transportation. Even 7% pay more than US \$20. This means that the cost of transport in Achuar territory is expensive. This makes sense given the high price of gasoline that translates into expenses for people who want to go from one place to another.

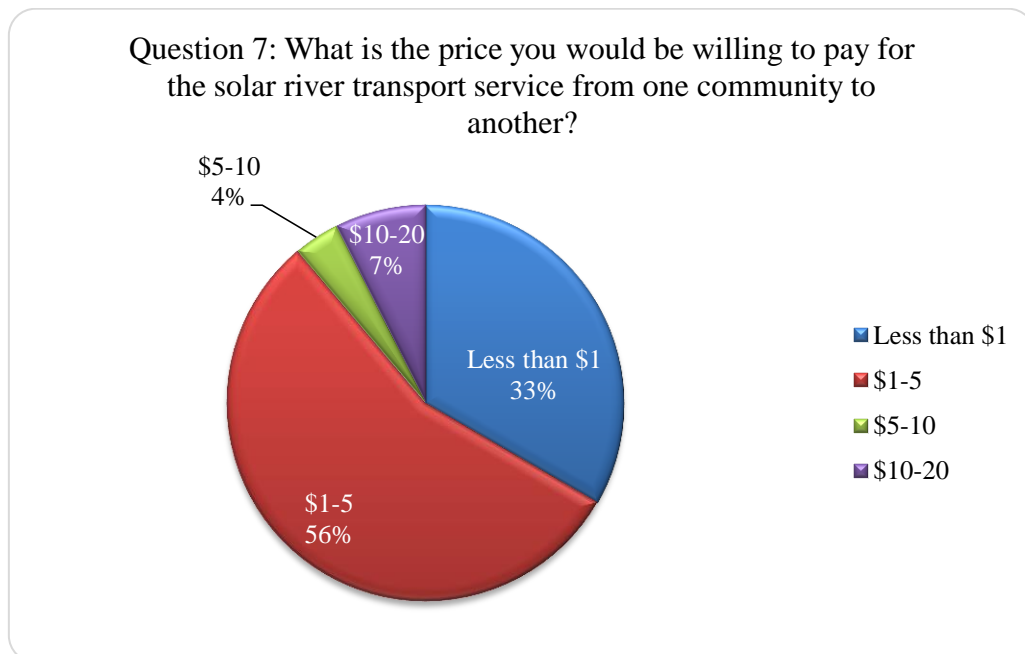
CHART No. 19
How much do you spend on average on transportation per week?



Source: Survey
Elaborated by: Priscila Alvarado

This proposed price of US \$1 also responds to the 56% of people who would prefer to pay a low cost between US \$ 1-5, as detailed below.

CHART No. 20
What is the price you would be willing to pay for the solar river transport service from one community to another?



Source: Survey
Elaborated by: Priscila Alvarado

This proposed price is low because this project seeks to respond to the needs of the Achuar population (UNEF, 2017). It focuses on improving the well-being of people, and income is seen as a means to development, rather than as an end (UNDP, 2016).

Furthermore, a solar boat reduces the risk of shortage of diesel and gasoline in the case that the planes could not bring these products. Likewise, it minimizes costs since it does not require fuel to function or the maintenance of a boat with gasoline engines. This also reduces the risk of boats that throw 20 to 30% of their combustion into the sea (BBC, 2018).

Before, communities did not have access to this type of technology, but now they can merge their ancestral knowledge such as navigation and design of canoes with solar technology so that their cultural identity is not lost. Moreover, the self-sufficient system that will be inherited by the following Achuar generations, is adapted to the concerns of this niche market. They reoriented technology towards innovation and exchange of knowledge to increase capabilities to improve people's quality of life and the quality of the air they breathe (WCED, 1987).

This participation of the community in its own economy is related to the principle of individuality of the Social Market Economy because individuals must have economic freedom (Tietmeyer, 2001). In this way, the Achuar peoples want to generate a community economy based on sustainability (Godoy, 2018). However, there is no denying the risk that some people could put the economy above well-being, the principles of the Achuar, and nature. That is why the community's vision is part of the added value, so that their principles be applied in the creation of the company, complemented by those of sustainable development to face a global problem: climate change. Therefore, before, during, and after the creation of the company, its operation and improvement will be based on the assemblies that are held every month.

Regarding the sustainable development goals, the value propositions described are related to the aim of promoting "wellbeing", reducing illnesses and

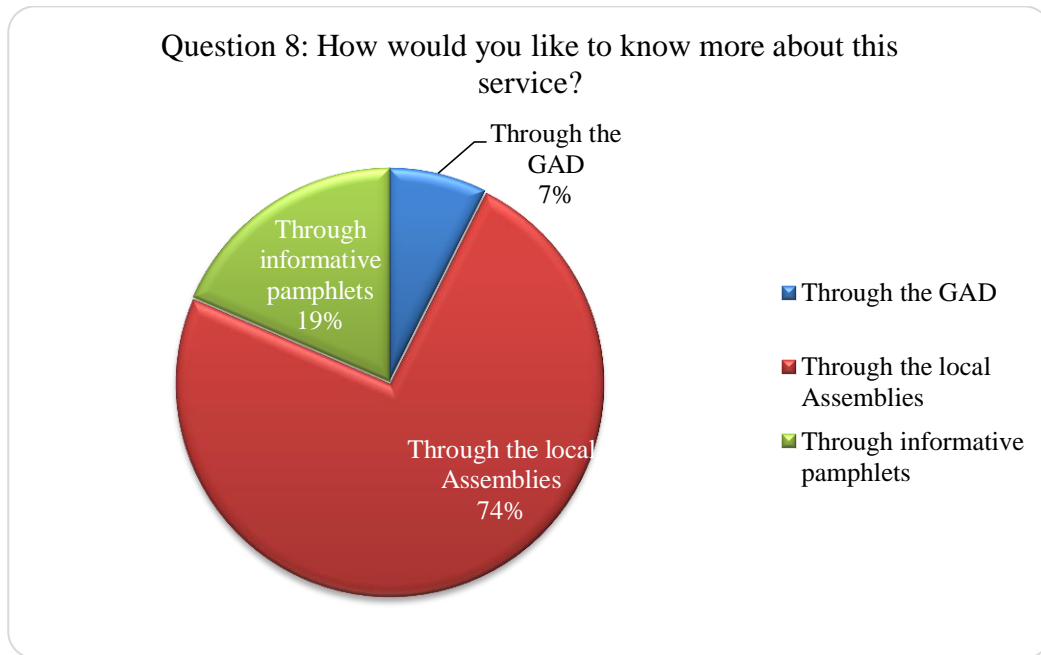
death from pollution; “quality education”, providing equal access to affordable technical education; “climate action”, raising awareness and improving human capacity on climate change mitigation; “life below water”, conserving and sustainably using the seas; “life on land”, halting deforestation, protecting biodiversity and natural habitats, and increasing financial resources; and, “partnerships for the goals”, enhancing not only international cooperation with the Inter-American Development Bank and the MIT, but also encouraging public-private partnerships like the one between the NAE and the ALDEA Foundation.

3.2.3.3.Channels

In this block, Osterwalder states that the company connects with the market segments to provide them with the value proposition through the channels. These are paramount since they influence the consumer's experience when purchasing the product or service (Osterwalder & Pigneur, 2010).

In order to deliver its value proposition, this entrepreneurship will reach its customer segments not only through the use of the service, but also through the community leaders who meet twice a month with the ALDEA Foundation and Plan Junto and individually with their communities each week. In this way, they create awareness about the value propositions of the community enterprise and through their comments and debates they can evaluate and improve it. Thus, Kara Solar will rely on community leaders and local assemblies to know what people think about the proposal. According to the survey results, 74% of people prefer to obtain information through the assemblies, and 19% prefer informational pamphlets, and 7% would like to know more through the GAD.

CHART No. 21
How would you like to know more about this service?



Source: Survey
Elaborated by: Priscila Alvarado

3.2.3.4. Customer Relationships

According to Osterwalder and Pigneur (2010), it is essential that companies specify the type of relationship they want to establish with their clients. In this case, Kara Solar cares about its customer relationships, which will be delivered through personal assistance, community generation, and co-creation. First, customers will have a person who details the route. This person could also tell legends in Achuar during the trip so that so that the memory of these peoples is replicated even for new people who visit the communities. Second, Kara Solar is directly involved with the 9 Achuar communities of Pastaza and has continuous local assemblies with leaders and members, which facilitates the implementation of the service and improves the user experience.

Moreover, community leaders meet twice a month to evaluate the implementation and performance of the service. The captains’ assistants should be aware of any comments and should give people openness to say what they think about the service. Besides, Kara Solar constantly trains representatives of the communities in the construction, design, operation, and maintenance of the

canoe. This is related to the role of education mentioned by Ulrich van Lith. On the one hand, the main task of education provided by the government is to communicate the values, attitudes, knowledge, and skills that society needs for its community existence. On the other hand, companies must offer training to their employees and finance the costs of it (Konrad-Adenauer-Stiftung, 2008). In this case, Kara Solar will manage to combine these characteristics, so that all company members are continuously trained in the assemblies to convey their knowledge and values in their community entrepreneurship.

Third, from the beginning, Kara Solar and the Tapiatpia were created jointly with the community. Therefore, when they become the entrepreneurship, it must always have this openness for the design and functionality of the machinery in conjunction with the communities, providing training, materials, and logistics in order to maintain this good synergy between technology and ancestral knowledge. According to Sen (1999), development should be evaluated not based on income or resources that people have, but from what they are capable of doing and being with their lives, and the Achuar are expanding these capabilities with Kara Solar through training and community management.

3.2.3.5. Revenue Streams

In order to determine the "*Revenue Streams*", it is necessary to perform an analysis of the clients and understand how much they are willing to pay for a specific product or service. In this case, the main source of income for the Achuar communities is ecotourism, livestock, hunting, and fishing (Ikiam, 2018). Thus, the average income of households is US \$567 and the average current household expenditure is US \$526 (INEC, 2018). Therefore, the price of US \$1 per person and per trip is affordable for the communities' inhabitants.

Kara Solar's source of income will be "*usage fee*", which is the number of times the service is projected to be used. We will use fixed pricing, given that the business model is customer segment dependent. Therefore, the price of the service is fixed in relation to the purchasing power of the communities.

As part of the navigability study, the Tapiatpia picked up passengers who agreed on paying \$1 per stop. The average number of passengers the boat had per day was 30, and the average number of round trip stops were 4 (Utne, 2018), generating a daily income of US \$120. This information is useful for projecting the annual average of income as shown in the following table.

TABLE No. 5
Kara Solar's average daily income

Sales	
Passengers	30
Average number of stops (round trip)	4
Total income (US \$)	120
Day (US \$)	120
Month (US \$)	2,640
Year (US \$)	31,680

Source: Kara Solar (2018)

Elaborated by: Priscila Alvarado

The company's income in the first year of its operation is valued at US \$31,680. Revenues are estimated based on assessed annual sales, which were established grounded on potential customers and the average number of stops they use. However, for the projection, the price of the ticket has been projected according to the estimated annual inflation, that is, the average inflation of the last 5 years for Ecuador (1.8494) (Banco Central, 2017).

TABLE No. 6
Estimated revenue budget

Year 2019 – 2028										
Year	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Number of stops	31,680	34,848	38,016	41,184	44,352	47,520	50,688	53,856	57,024	60,192
Price per stop (US \$)	1.00	1.02	1.04	1.06	1.08	1.10	1.12	1.14	1.16	1.18
Total income (US \$)	31,680.00	35,492.48	39,435.14	43,511.49	47,725.13	52,079.74	56,579.10	61,227.06	66,027.59	70,984.75

Source: Kara Solar (2018)

Elaborated by: Priscila Alvarado

As for the payment system, this will only be in cash and, if the possibility is long seen, the payment through barter, also known as *trueque*⁴², could be added. The latter is under study as this would make it possible to reinforce one of the traditions of the communities (Hernández, 2018).

3.2.3.6.Key Resources

The key resources could be financial, physical, intellectual, or human elements, which allow creating the value proposition (Osterwalder & Pigneur, 2010). In this case, the key resources needed to carry out the key activities adequately are:

- **Physical Resources:** panels, motors, batteries, and a canoe make it possible to carry out a correct operation of the business.
- **Human Resources:** the company depends on the captain, the pilot, the coordinator, and a transport and logistics employee. Everyone must be prepared for the implementation of the service and the maintenance and constant improvement of the boat.

3.2.3.7.Key Activities

Osterwalder (2010) asserts that it is necessary to specify the essential actions of the company so that the business model works. In order to carry out the value proposition, Kara Solar requires the boat maintenance and knowledge management. Therefore, the leaders and other representatives of each community are trained in the construction and maintenance of the boat.

The platform for service provisioning will be the solar boat. Also, the networks are built through the meetings between the communities, which are held twice a month and within them each week, legitimizing the use of this

⁴² Trueque is a cultural manifestation that is practiced in some communities of Ecuador. This is a non-monetary exchange transaction between residents, merchants, farmers, and families, who agree to give one thing and receive another in exchange of products without the intervention of money

service. In this way, the problems mentioned in previous blocks are taken into account, which represent the needs of the communities. For example, reduce pollution, protect nature and their indigenous worldview, reduce the use of *peque peques*, and provide a transport service that connects to communities so that they perform their different activities.

3.2.3.8.Key Partnerships

The key associations describe the network of suppliers and partners of the company. The latter must create partnerships to optimize its activities, obtain resources, and reduce any type of risks (Osterwalder & Pigneur, 2010). Therefore, Kara Solar, as a company will have strategic partnerships with the Achuar Nationality of Ecuador, ALDEA Foundation, Plan Junto, IDB Multilateral Investment Fund, Charity Pot, Empowered by light, Global Greengrants Fund, Pastaza Prefecture, Solar Electric Light Fund, and Pachamama Alliance through which they get funds and a place to settle (Kara Solar, 2018).

Also, the company will forge partnerships with companies such as Torquedo, Hanergy, and Enercity to obtain the motors, batteries, and custom panels for the boat at a low cost. All these alliances aim to optimize the allocation of resources and activities. For example, non-profit organizations contribute with knowledge and funds, while companies contribute with the donation of physical materials for the canoe's construction and maintenance or low prices, acting as sponsors (Kara Solar, 2018).

The ALDEA Foundation, NAE, and Pachamama Alliance obtained funds through crowdfunding for the project, a total of US \$60,420 in cash. This is the money that will be used to create the community enterprise (ALDEA, 2017). These organizations usually submit the project to contests in order to obtain more funds. These could be used in case of a need or a problem with the boat or the management of the company. On the other hand, ALDEA plans to build another boat and solar charging systems in each community so that their electricity comes from clean energy. But they want to achieve this with future

funds (ALDEA, 2017). Therefore, the community can rely on this Business Model Canvas to make future changes if they require it.

However, the company runs the risk of relying too much on external revenues obtained through its allies. That is why the project coordinators and the communities should talk about this risk because if they no longer get this help, they could go bankrupt. That is why the ship that will be built, which will be a different one from the prototype, but the one that will be on the market, must reduce the risk of it getting damaged. Other way to diminish risk is through the knowledge that is given to the communities about the construction and maintenance of the boat because they can have better ideas and be ready for any adverse event.

3.2.3.9. Cost Structure

The last block includes all the costs incurred by the company in each process, from production to their relationship with customers. Although companies should focus on minimizing costs, there are some that opt for a low cost structure. They focus on offering a value proposition by reducing its costs. On the other hand, there are companies that operate under value structures, and costs are not their main focus. Indeed, they prefer to work on the creation of the value proposition in terms of quality, personalization of products, or belonging to a status. In this way, fixed costs do not change according to the amount of production of goods or services. Regarding variable costs, these vary depending on the volume of services or goods produced (Osterwalder & Pigneur, 2010). In this case, Kara Solar has the following fixed and variable costs:

TABLE No. 7
Fixed costs

Particulars	Amount (US \$)
Wages	24,338.28
Administrative expenses	1,206.00
Constitution	415.00
Trademark registration	208.00
Licenses	500.00
Insurance	680.57
Financial expenses	2,397.88
Vehicle	
Machinery and equipment	
TOTAL FIXED COSTS	29,745.73

Elaborated by: Priscila Alvarado

TABLE No. 8
Variable costs

Particulars	Amount (US \$)
Repair and maintenance	1,939.16
Stationery and office supplies	50.00
Materials and supplies	
TOTAL VARIABLE COSTS	1,989.16

Elaborated by: Priscila Alvarado

The costs add up to a total of US \$31,734.89. These do not include the price of the boat, machinery and equipment, materials and supplies because ALDEA will transfer its ownership of a boat and equipment to the company.








Since Kara Solar, as a project, has focused on building a boat prototype along with the communities and training them on solar energy topics, the company will also invest in face-to-face training of those who will manage the boat and be in charge of the enterprise. Therefore, Kara Solar, as a company, intends to enter the market with a value proposition based on the quality of the service, which at the same time is based on the ancestral culture of the Achuar people and sustainable development. In this regard, this will be an entrepreneurship that works mainly under value structures, in which costs are

not their main focus, but the creation of the value proposition, in terms of quality and personalization of the service.

However, it is difficult to reduce costs as much as possible because the materials to build the boat are expensive. This is where the company will take advantage of alliances to opt for donations and price reduction. Thus, the structure of low costs does not tend to be their priority in the business model.

This information was portrayed in the Business Model Canvas Template:

Table No. 9
Business Model Canvas for Kara Solar

 <p>Key Partners</p> <ul style="list-style-type: none"> - Non-government organizations NAE ALDEA Foundation Plan Junto Charity Pot Empowered by light Global Greengrants Fund Solar Electric Light Fund Pachamama Alliance - Government organizations Pastaza Prefecture - Financial organizations IDB - Research Institutes MIT - Specialized technology suppliers Torquedo Hanergy Enercity 	 <p>Key Activities</p> <ul style="list-style-type: none"> - Provide transportation - Trainings - Boat maintenance - Participation in the assemblies 	 <p>Value Propositions</p> <ul style="list-style-type: none"> - Sustainable transport - Affordable price - Cultural understanding and sensibility - Ability to customize the service with customers - Redistribution of the company's profits among the community 	 <p>Customer Relationships</p> <ul style="list-style-type: none"> - Personal Assistance - Community Generation - Co-creation 	 <p>Customer Segments</p> <ul style="list-style-type: none"> - Achuar communities (9 from Pastaza Province)
 <p>Cost Structure</p> <ul style="list-style-type: none"> - Fixed costs: wages, administrative expenses, machinery and equipment, constitution, trademark, licenses, insurance, financial expenses - Variable costs: repair and maintenance, stationery and office supplies, materials and supplies 		 <p>Revenue Streams</p> <ul style="list-style-type: none"> - Usage fee - Fixed pricing of \$1 		

Elaborated by: Priscila Alvarado

3.3. Financial study

In this subchapter, the assets the company should start with are detailed, such as administrative and operational expenses, depreciation and amortization of assets. In addition, the investment will be calculated in order to know the amount of money the entrepreneurship needs to start its operations through a projected production cost, the income statement, and the balance sheet. Subsequently, the cash flow will be projected and from which the following economic indicators will emerge: Break-even point, Net Present Value (NPV), Internal Rate of Return (IRR), and Investment recovery period through which the possibility of creating the company and profitability will be evaluated.

This financial viability will be carried out not only with the data obtained through the survey, but also with information provided by the suppliers on prices of solar canoe components established during the project and the budget for the creation of the community enterprise. The methodology to carry out this step will be the standard proposed by the United Nations Organization for Industrial Development (Behrens & Hawranek, 1994) for the formulation and evaluation of investment projects.

3.3.1. Production cost

In order to calculate the production cost, accounts, such as direct labor, administrative, manufacturing, financial, operating, and insurance expenses will be taken into account.

TABLE No. 10
Operating expenses

Particulars	Quantity	Monthly payment (US \$)	Annual payment (US \$)
Employees			
Pilots	3	418.73	15,074.28
TOTAL			15,074.28

Source: Ministerio del Trabajo (2018)

Elaborated by: Priscila Alvarado

TABLE No. 11
Administrative expenses

Particulars	Quantity	Monthly payment (US \$)	Annual payment (US \$)
Employees			
Coordinator	1	386.00	4,632.00
Transport and logistics employee	1	386.00	4,632.00
Trainings	3	50.00	150.00
Stationery and office supplies	1	30.00	50.00
Food expenses	5	17.60	1,056.00
TOTAL			10,520.00

Elaborated by: Priscila Alvarado

In order to calculate the repair and maintenance, the costs of the solar boat, the machinery, and the materials that will be donated to the company are detailed in order to calculate the depreciation and the cost of repair and maintenance.

TABLE No. 12
Solar boat cost

Particulars	Quantity	Unit Cost (US \$)	Total cost (US \$)
FIXED ASSETS			
Fiberglass canoe	1	4,000	4,000
Stainless steel structure	1	600	600
Electric motor	2	1,090	2,180
Lead acid battery	12	300	3,600
Solar panel	32	420	13,440
TOTAL			23,820

Elaborated by: Priscila Alvarado

TABLE No. 13
Machinery and materials

Particulars	Quantity	Monthly payment (US \$)	Annual payment (US \$)
Machinery and equipment			
Computing equipment	2	180.00	360.00
Walkie-talkie radio	2	60.00	120.00
Materials and supplies			
Lead-acid battery charger	1	30.00	30.00
Solar panel	4	90.00	360.00
TOTAL			690.00

Elaborated by: Priscila Alvarado

TABLE No. 14
Depreciation

Particulars	Investment	Lifespan (Years)	Amount (US \$)
Depreciation			
Vehicles	23,820.00	30	794.00
Computing equipment	360.00	5	72.00
Machinery	510.00	10	51.00
TOTAL			917.00

Elaborated by: Priscila Alvarado

TABLE No. 15
Repair and Maintenance

Particulars	Amount	Percentage	Annual payment (US \$)
Repair and Maintenance			
Vehicles	23,820.00	6%	1,886.96
Machinery and Equipment	480.00	6%	28.80
Materials and supplies	390.00	6%	23.40
TOTAL			1,939.16

Elaborated by: Priscila Alvarado

In addition, the company will acquire a loan to cover the costs required to start. This loan is necessary for members to be responsible for at least a part of

the company's constitution monetarily. This will be paid in five years with an annual interest rate of 11.83% (BanEcuador, 2018). The annual payments are amortized in the following table:

TABLE No. 16
Amortization

Particulars	Loan	Lifespan (Years)	Annual Interests	Amount (US \$)	Annual Payment
Amortization					
Deferred assets	1,803.57	5	11.83%	2,397.88	
Subtotal				2,397.88	
TOTAL				2,397.88	479.58

Elaborated by: Priscila Alvarado

Although the company will consist of three pilots, a coordinator, and a transport and logistics employee, ALDEA and Plan Junto will be in charge of training the representatives of the communities in captaincy, piloting, public relations, and accounting. This will be done not only because in the future they hope to build a few more boats, only if this is required, but also because all those who want have the right and freedom to be trained, learn, and expand their capabilities. That is why an amount of the budget will be assigned for trainings every four months. ALDEA Foundation will provide them with professionals.

Likewise, the company will not have many employees at the beginning not only because of the investment required, but also because Kara Solar does not want to remove the source of income from other people who already have their boats. The communities need time to transition. That is why, if the company has more profits, more people will be hired to leave their boats that runs on diesel and join the community enterprise. The latter will focus on improving the well-being of people, and income is seen as a means to development, rather than as an end (UNDP, 2016).

In this way, the total cost of production of the company, during the first year, will be US \$ 29,816.6, which is described in the following table.

TABLE No. 17
Total cost of production

Particulars	Year 1
Administrative expenses	10,520.0
Operating expenses	17,013.4
Insurance expenses	680.6
Financial expenses	479.6
Intangibles	1,123.0
TOTAL COST	29,816.6

Elaborated by: Priscila Alvarado

It includes the loan and the interests, which need to be paid the first year, for is US 479.58\$.

3.3.2. Investment

The investment that will be made during the first year will be calculated through the sum of all of the costs and expenses which Kara Solar should start with. Subsequently, the Income Statement and the Balance Sheet will be calculated during the first year of investment.

3.3.2.1. Projected production cost

In order to make the projection table of costs for the following ten years, the average value of the inflation rate from the last 5 years, that is 1.84%, will be used. For the calculation, the information from previous tables was taken into account.

TABLE No. 18
Projected production cost

YEAR	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
Tickets to sell	31,680	34,848	38,016	41,184	44,352	47,520	50,688	53,856	57,024	6,0192
PARTICULARS										
Administrative expenses										
Wages	9,264.00	9,435.33	9,609.83	9,787.55	9,968.56	10,152.92	10,340.69	10,531.93	10,726.71	10,925.08
Trainings	150.00	152.77	155.60	158.48	161.41	164.39	167.43	170.53	173.68	176.90
Office supplies	50.00	50.92	51.87	52.83	53.80	54.80	55.81	56.84	57.89	58.97
Food expenses	1,056.00	1,075.53	1,095.42	1,115.68	1,136.31	1,157.33	1,178.73	1,200.53	1,222.73	1,245.35
Operating expenses										
Wages	15,074.28	15,353.06	15,637.00	15,926.19	16,220.73	16,520.72	16,826.25	17,137.44	17,454.38	17,777.18
Repair and Maintenance	1,939.16	1,975.02	2,011.54	2,048.75	2,086.64	2,125.23	2,164.53	2,204.56	2,245.33	2,286.86
Depreciation		917.00	933.96	951.23	968.82	986.74	1,004.99	1,023.58	1,042.51	1,061.79
Insurance expenses										
Prepaid insurance	680.57	693.16	705.98	719.03	732.33	745.88	759.67	773.72	788.03	802.60
Financial expenses										
Deferred assets	479.58	488.45	497.48	506.68	516.05					
Intangibles										
Constitution	415.00									
Trademark Registration	208.00									
Licenses	500.00									
SUBTOTAL	29,816.58	30,141.24	30,698.67	31,266.42	31,844.66	31,908.00	32,498.11	33,099.13	33,711.26	34,334.72
Tax on income (0%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL PRODUCTION COST	29,816.58	30,141.24	30,698.67	31,266.42	31,844.66	31,908.00	32,498.11	33,099.13	33,711.26	34,334.72
UNIT COST	0.94	0.86	0.81	0.76	0.72	0.67	0.64	0.61	0.59	0.57
SALE PRICE	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
TOTAL REVENUES	31,680.00	34,848.00	38,016.00	41,184.00	44,352.00	47,520.00	50,688.00	53,856.00	57,024.00	60,192.00
Difference margin (%)	6.25	15.62	23.84	31.72	39.28	48.93	55.97	62.71	69.15	75.31
Number of monthly passengers	660				924					1,188

Elaborated by: Priscila Alvarado

For the first year, a sale of 2,640 monthly tickets or stops is obtained with a profit margin of 6.25% for each ticket sold, having an average of 660 passengers per month. While for the tenth year, a sale of 5,016 monthly passages is projected, and the profit margin per unit sold is 75.31%. Also, it is projected that around 832 to 1188 people will be transported every month. This table also

shows that the total revenue in the first year will be US \$31,680, while the total production cost is US \$29,816.58. That is, the profits outweigh the costs.

It is important to mention that the company will not pay the income tax because, as seen in chapter II, the Article 26 of the "*Organic Law for the promotion of production, attraction of investments, and generation of employment*" establishes that productive investments in prioritized sectors will enjoy a tax exemption on income, and its advance, for 12 years counted from the first year in which income is generated (MICEI, 2018). In addition, it will not pay for rent, basic services, or internet because the entrepreneurship will have an alliance with the Pastaza Prefecture, and it will use its installations located in Shuinmamus (ALDEA, 2011).

3.3.2.2. Income Statement

The income statement is a financial report that shows in detail the income obtained, the expenses, and the profit or loss that the company has generated over a period of time. It also provides information on the performance of the entity that is useful for predicting future results, as shown in the following table:

TABLE No. 19
Income Statement

Particulars	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
Units sold	31,680	34,848	38,016	41,184	44,352	47,520	50,688	53,856	57,024	60,192
Gross Profit	\$1 31,680.00	34,848.00	38,016.00	41,184.00	44,352.00	47,520.00	50,688.00	53,856.00	57,024.00	60,192
(-) Wages	24,338.28	24,788.39	25,246.83	25,713.74	26,189.29	26,673.64	27,166.94	27,669.37	28,181.08	28,702
(-) Administrative expenses	1,256.00	1,279.23	1,302.89	1,326.98	1,351.52	1,376.52	1,401.98	1,427.90	1,454.31	1,481
(-) Operating expenses	1,939.16	1,975.02	2,011.54	2,048.75	2,086.64	2,125.23	2,164.53	2,204.56	2,245.33	2,287
(-) Insurance expenses	680.57	693.16	705.98	719.03	732.33	745.88	759.67	773.72	788.03	803
(-) Depreciation	-	917.00	933.96	951.23	968.82	986.74	1,004.99	1,023.58	1,042.51	1062
(-) Amortization	479.58	488.45	497.48	506.68	516.05					
(-) Intangibles	1,123.00									
(=) Operating Income	1,863.42	4,706.76	7,317.33	9,917.58	12,507.34	15,612.00	18,189.89	20,756.87	23,312.74	25,857
(-) Tax on income	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Donations and Capital Legacies	24,690.00	24,690.00	24,690.00	24,690.00	24,690.00	24,690.00	24,690.00	24,690.00	24,690.00	24,690
(=) Net Income	26,553.42	29,396.76	32,007.33	34,607.58	37,197.34	40,302.00	42,879.89	45,446.87	48,002.74	50,547.28

Elaborated by: Priscila Alvarado

Given that ALDEA will transfer the ownership of a solar boat and machinery to the company, it counts as income and not as an investment. In addition, ALDEA is a nonprofit foundation and the members do not expect any payment in exchange. This initial balance does not show the investment that must be made. Therefore, the following section elaborates a production cost table to know the amount of money that must be invested in the first year.

3.3.2.3. Balance sheet

The following table summarizes the financial situation of the company and reflects the total of assets and liabilities before operations, which allows corrective policies to be taken in case of deficit.

TABLE No. 20
Balance Sheet

Assets										
Current Assets										
Cash	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00
Bank	31,656.93	30,141.24	30,698.67	31,266.42	31,844.66	31,908.00	32,498.11	33,099.13	33,711.26	34,334.72
Total Current Assets	32,656.93	31,141.24	31,698.67	32,266.42	32,844.66	32,908.00	33,498.11	34,099.13	34,711.26	35,334.72
Non-current Assets										
(-)Accumulated Depreciation		917.00	1,850.96	2,802.19	3,771.01	4,757.76	5,762.75	6,786.32	7,828.83	8,890.61
Total Non-current assets	0.00	917.00	1,850.96	2,802.19	3,771.01	4,757.76	5,762.75	6,786.32	7,828.83	8,890.61
TOTAL ASSETS	32,656.93	32,058.24	33,549.63	35,068.61	36,615.67	37,665.75	39,260.85	40,885.45	42,540.09	44,225.33
Liabilities										
Long-term liability	479.58	488.45	497.48	506.68	516.05					
Equity	32,177.35	31,569.80	33,052.15	34,561.93	36,099.62	37,665.75	39,260.85	40,885.45	42,540.09	44,225.33
TOTAL LIABILITIES + EQUITY	32,656.93	32,058.24	33,549.63	35,068.61	36,615.67	37,665.75	39,260.85	40,885.45	42,540.09	44,225.33

Elaborated by: Priscila Alvarado

The Balance Sheet shows that the company will always have US \$ 1,000 in cash in case they have to incur any cost. While the initial capital required for the investment adds up to US \$ 32,656.93.

3.3.3. Profitability

Since data like initial investment and costs have been calculated, it is necessary to determine the profitability of the project by calculating indexes

such as the Break-even point, Net Present Value, and the Internal Rate of Return on investment.

3.3.3.1. Break-even point determination

The break-even point considers both fixed and variable costs. For this case, it is based on the production of the first year for which the following formula is used:

$$\text{Break-even point} = \frac{\text{Fixed costs}}{1 - \frac{\text{Variable costs}}{\text{Total income}}}$$
$$\text{BP} = \frac{29,745.73}{1 - \frac{1,989.16}{31,680}}$$

$$\text{BP} = 31,738.57$$

These results mean that the company will obtain profits after the sale of the ticket # 31,738.57.

3.3.3.2. Net Present Value Calculation

The Net Present Value (NPV) represents the amount that will be received at the end of the project. In this case it should be after 10 years. For this purpose, the Weighted Average Cost of Capital (WACC) and the Net Cash Flow need to be calculated.

First, the WACC is the discount rate that measures the cost of capital. It is the weighted average between the proportion of own resources and the proportion of other resources (Guerrero, 2014). In this way, the company must obtain a rate of return equal to or greater than the discount rate if it wants to cover the profitability expectations that its different investors or funding sources expect (CCPM, 2014). In this case, the data used to calculate the WACC was the interest rate that is applied to finance the project (11.83%) (BanEcuador, 2018)

and the passive rate (5.11%) (BCE, 2018). The weight for each one is the ratio between the source and the total value of the project.

TABLE No. 21
Discount rate

Source	Input (US \$)	%	Capital cost	Weighting
Own resources				
Contribution of Partners	29,816.58	91.30%	0.0511	0.05
External resources				
Bank Loan	2840.34	8.70%	0.1183	0.0103
Total investment	32656.93	100%		5.69%
	Weighted Average Cost of Capital (WACC)			5.69%
	Country risk rate			6.27%
	Inflation rate			1.84%
	Discount rate			13.80%

Elaborated by: Priscila Alvarado

Although the communities have US \$60,420, they would invest US \$32,656.93, which is the amount of money required in the first year to cover the costs, including \$1,000 in cash. As a result, the WACC is 5.69%. To this, it is added the country risk rate, the inflation rate, and the discount rate, adding up to 13.80%. Meanwhile, projections of the net flow are made with this data:

TABLE No. 22
Net cash flow projection

Year	Income	Costs (US \$)	Net Flow (US \$)	Accumulated Net Flow(US \$)
1	31,680.00	29,816.58	1,863.42	1,863.42
2	34,848.00	30,141.24	4,706.76	6,570.17
3	38,016.00	30,698.67	7,317.33	13,887.50
4	41,184.00	31,266.42	9,917.58	23,805.08
5	44,352.00	31,844.66	12,507.34	36,312.43
6	47,520.00	31,908.00	15,612.00	51,924.43
7	50,688.00	32,498.11	18,189.89	70,114.32
8	53,856.00	33,099.13	20,756.87	90,871.20
9	57,024.00	33,711.26	23,312.74	114,183.94
10	60,192.00	34,334.72	25,857.28	140,041.22

Elaborated by: Priscila Alvarado

The Net Cash Flow is the difference between the cash inflows and outflows of an enterprise in a given period. Thus, the projected net cash flow is a basic tool for financial management for companies to plan the efficient use of cash, maintaining balances reasonably close to the permanent cash needs. It helps avoid risky changes in the cash situation that can jeopardize the credit of the company to its creditors (FAO, 2014).

Table No. 22 shows that the first years will be characterized by small cash flow, which reduces the availability of funds for maintenance. At the end of around 5 years it will be possible to obtain profits because the investment is recovered. The company will be able to think about investing in a new boat or focus on other community needs and redistribute a percentage of the profits.

On the other hand, given that the initial investment will be US \$32,656.93, the NPV is calculated:

TABLE No. 23
Net Present Value

Year	Calculation	Total (US \$)
0	-32,656.93	-32,656.93
1		1,637.38
2		3,634.15
3		4,964.49
4		5,912.46
5		6,551.92
6		7,186.25
7		7,357.24
8		7,377.13
9		7,280.47
10		7,095.61
	NPV	26,340.17

Elaborated by: Priscila Alvarado

According to the theory, NPV must greater than zero for a project to be considered profitable (Gutiérrez, 2017). Since this is US \$ 26,340.17, the project is acceptable.

3.3.3.3. Internal Rate of Return on investment calculation

In the case of the Internal Rate of Return on investment (IRR), if this is greater than or equal to the discount rate, the project is accepted because the rate of return will exceed its costs. Otherwise, it will be rejected because it is more profitable to have the money in a savings account.

TABLE No. 24
Internal Rate of Return on investment

	IRR	26%
-32,656.93		
1,863.42		
4,706.76		
7,317.33		
9,917.58		
12,507.34		
15,612.00		
18,189.89		
20,756.87		
23,312.74		
25,857.28		

Source: Oliver Utne (2018)

Elaborated by: Priscila Alvarado

The IRR is the interest rate or return offered by an investment. Thus, it is the percentage of profit or loss that an investment will have for the amounts that have not been withdrawn from the project. This reflects an IRR of 26%, which is higher than the discount rate of 13.80%. Thus, it will be viable.

TABLE No. 25
Investment recovery period

	0	1	2	3	4	5
Net flow	-32,656.93	1,863.42	4,706.76	7,317.33	9,917.58	12,507.34
Accumulated flow	-32,656.93	-30,793.51	-26,086.75	-18,769.43	-8,851.84	3,655.50
Recovery period	4.707731809					
Investment recovery period	4 years, 8 months, and 12 days					

Elaborated by: Priscila Alvarado

Furthermore, this project can be recovered in a period of 4 years, 8 months, and 12 days approximately.

All in all, the amount of money that the communities have to start is US \$60,420.00, but only US \$32,656.93 will be invested. To this is added the loan of US \$ 2,840.34 they will receive to pay for machinery and supplements. Since the communities have US \$30,603.42 that will not be invested, they can use this money to keep it in a shared box and grant credits to small artisans. On the other hand, it could be invested in an accumulation policy, but since Good Living does not mean infinite economic growth (Consejo Nacional de Planificación, 2014), this issue should be addressed in the local assemblies.

If the company would like to invest in future years, the following table is projected:

TABLE No. 26
Projected production cost (Alternative 1)

YEAR	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10	YEAR 11	YEAR 12
Tickets to sell	31,680	34,848	38,016	41,184	44,352	95,040	95,040	95,040	95,040	95,040	95,040	95,040
Average number of passengers	30					60						
Average number of stops	4					6						
Revenues per day	120					360						
Employees	3 pilots 2 admin					6 pilots 4 admin						
PARTICULARS												
Administrative expenses												
Wages	9,264	9,435	9,610	9,788	9,969	20,306	20,681	21,064	21,453	21,850	22,254	22,666
Trainings	150	153	156	158	161	2,000	2,037	2,075	2,113	2,152	2,192	2,232
Office supplies	30	31	31	32	32	100	102	104	106	108	110	112
Food expenses	1,056	1,076	1,095	1,116	1,136	4,629	4,715	4,802	4,891	4,981	5,074	5,167
Transport						1,500	1,528	1,556	1,585	1,614	1,644	1,674
Travel expenses						800	815	830	845	861	877	893
Rent						350	356	363	370	377	384	391
Basic services						300	306	311	317	323	329	335
Operating expenses												
Wages	15,074	15,353	15,637	15,926	16,221	33,041	25,239	25,706	26,182	26,666	27,159	27,661
Repair and Maintenance	1,887	1,922	1,957	1,994	2,030	2,911	2,965	3,020	3,076	3,133	3,191	3,250
Machinery and equipment												
Vehicles						24,261						
Computational equipment	180					1,440	4,320					
Walkie-talkie radios	120					480	720					
Materials and supplies												
Lead-acid battery charger	30					120						
Solar panels	360					5,760	5,867	5,975	6,086	6,198	6,313	6,429
Insurance expenses												
Prepaid insurance	681	693	706	719	732	1,492	1,519	1,547	1,576	1,605	1,635	1,665
Financial expenses												
Deferred assets	156	159	161	164	168							
Intangibles												
Constitution	415											
Trademark Registration	208											
Licenses	500					500						
SUBTOTAL	30,110	28,821	29,354	29,897	30,450	99,990	71,170	67,353	68,599	69,867	71,159	72,475
Tax on income (0%)	0	0	0	0	0	0	0	0	0	0		
TOTAL PRODUCTION COST	30,110	28,821	29,354	29,897	30,450	99,990	71,170	67,353	68,599	69,867	71,159	72,475
UNIT COST	0.95	0.83	0.77	0.73	0.69	1.05	0.75	0.71	0.72	0.74	0.75	1
SALE PRICE	1	1.02	1.04	1.06	1.08	1.1	1.12	1.14	1.16	1.18	1.2	1
REVENUES	31,680	35,492	39,435	43,511	47,725	104,159	106,086	108,048	110,046	112,081	114,048	115,949
Difference margin (%)	5.21	23.15	34.34	45.54	56.73	4.17	49.06	60.42	60.42	60.42	60.27	60
Credit facility												
Bank	30,613	30,613	30,613	30,613	30,613	30,613	30,613	30,613	30,613	30,613	30,613	30,613
Interest	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Credit facility deposit	2,020.49	2,020.49	2,020.49	2,020.49	2,020.49	2,020.49	2,020.49	2,020.49	2,020.49	2,020.49	2,020.49	2,020
TOTAL REVENUES	33,700	36,868	40,036	43,204	46,372	112,900	112,900	112,900	112,900	112,900	112,900	112,900
Net Flow + Credit facility	3,884	6,750	9,385	12,009	14,600	7,411	24,583	32,668	31,318	29,887	29,448	27,849
REDISTRIBUTION							24,583	32,668	31,318	29,887	29,448	27,849

Elaborated by: Priscila Alvarado

As can be seen, after 5 years of being established and positioned in the company, the enterprise could invest in the following year with its own money in a new boat, hire 3 pilots and 2 more people for the administrative area. These could work on a second route: from Wayusentsa to Kapawi. In addition, if a new alliance could not be formed for new staff to settle in one of these points, the table also includes expenses for rent, basic services, training, and more repair tools such as solar panels. The number of passengers is around 60 and the average number of stops is 6. This number is frozen and does not increase in time because the next population census that will be carried out in 2020 is not yet available. Given that the communities suffer from several health problems, the population may have not increased in the last 10 years. Therefore, even if the company grows, it does not mean that the Achuar population will do so.

With this data, the 7-year financial ratios were calculated. It was taken into account seven years because according to the Article 26 of the "*Organic Law for the promotion of production, attraction of investments, and generation of employment*", productive investments in prioritized sectors will enjoy a tax exemption on income, and its advance, for 12 years (MICEI, 2018). Therefore, the NPV is US \$20,931.54 and greater than zero; the IRR is 15%, which is higher than the discount rate of 14.68%; and, the investment would be recovered at the end of 7 years. Thus, this investment is viable.

If the communities decide to invest in a certificate of deposit, Mutualista Pichincha (2018) offers an interest of 6.60% for investments higher than US \$ 25,000 and 6.50% for investments greater than US \$ 10,000. In addition, if the company decides to redistribute the money in the community, it is recommended to do so from the seventh year because the company will have higher profits from this year. They could also keep this money in a shared box and grant credits to small entrepreneurs.

The last option is for Kara Solar to establish itself as a Foundation, continue to position its name in the community, and obtain funds to build the boats in a given year. In addition, they can continue to obtain more information with the prototype boat such as: how many people carry out commercial

activities, how many times they need to go to the hospital each month, how many require transportation to attend class, and so on. With this information they can continue in the circle of Lean Startup, learning and improving before taking the company to the market. Once they have this information they could invest in a second alternative:

TABLE No. 27
Projected production cost (Alternative 2)

YEAR	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
Tickets to sell	126720	126720	126720	126720	380160	380160	380160	380160	380160	380160
Number of people per boat	20				40					
Total passengers	120				240					
Average number of stops	4				6					
Average number of daily stops	480				1440					
Average number of monthly stops	10560				31680					
Average number of anual stops	126720				380160					
	12 pilots				12 piltos					
	6 admin				6 admin					
PARTICULARS										
Administrative expenses										
Wages	37,056.00	37,741.31	38,439.30	39,150.20	39,874.24	40,611.68	41,362.75	42,127.71	42,906.82	43,700.34
Trainings	1,050.00	1,069.42	1,089.20	1,109.34	1,129.86	1,150.75	1,172.03	1,193.71	1,215.79	1,238.27
Office supplies	200.00	203.70	207.47	211.30	215.21	219.19	223.24	227.37	231.58	235.86
Food expenses	6,336.00	6,453.18	6,572.52	6,694.08	6,817.88	6,943.97	7,072.39	7,203.18	7,336.40	7,472.08
Operating expenses										
Wages	45,222.84	46,059.19	46,911.01	47,778.58	48,662.20	49,562.16	50,478.76	51,412.31	52,363.13	53,331.54
Repair and Maintenance	11,634.94	11,850.11	12,069.27	12,292.48	12,519.81	12,751.36	12,987.18	13,227.36	13,471.99	13,721.14
Depreciation		5,502.00	5,603.75	5,707.39	5,812.94	5,920.45	6,029.94	6,141.46	6,255.04	6,370.72
Insurance expenses										
Prepaid insurance	4,083.43	4,158.95	4,235.86	4,314.20	4,393.99	4,475.25	4,558.02	4,642.31	4,728.17	4,815.61
Financial expenses										
Deferred assets	1,918.31	1,953.78	1,989.92	2,026.72	2,064.20					
Intangibles										
Constitution	415.00									
Trademark Registration	208.00									
Licenses	500.00									
SUBTOTAL	108,624.51	114,991.64	117,118.30	119,284.28	121,490.33	121,634.79	123,884.31	126,175.42	128,508.91	130,885.56
Tax on income (0%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL PRODUCTION COST	108,624.51	114,991.64	117,118.30	119,284.28	121,490.33	121,634.79	123,884.31	126,175.42	128,508.91	130,885.56
UNIT COST	0.86	0.91	0.92	0.94	0.32	0.32	0.33	0.33	0.34	0.34
SALE PRICE	1.00	1.00	1.00	1.00	1.00	0.50	0.50	0.50	0.50	0.50
TOTAL REVENUES	126,720	126,720	126,720	126,720	380,160	190,080	190,080	190,080	190,080	190,080
Difference margin (%)	16.66	10.20	8.20	6.23	212.91	56.27	53.43	50.65	47.91	45.23

Elaborated by: Priscila Alvarado

With the second alternative, costs would increase mainly by salaries. But the investment would recover in five periods if by the fifth year the number of passengers per day increases to 40 per boat. The investment would be recovered in a period of 5 years, and from the sixth year, the company could reduce the price of the trip per stop to 0.50 cents.

In the different alternatives, the element that would cost the company the most is the salaries. These could not be reduced under any circumstance because the company will operate under value structures, and costs must not be their main focus.

With the previously obtained information of social and environmental impact, and now these data that show the profitability of the project, we can observe that Kara Solar demonstrates that the economic, social, and environmental dimensions could go hand in hand, and a project related to this concept can be implemented.

In this way, with the facts described and data obtained throughout this section, the third chapter is concluded and the last two specific objectives of this dissertation that sought to design a business model with sustainable development elements and determine the profitability and competitiveness of the business plan are met. To this end, Kara Solar's project and Achuar's notion of development were reviewed, and the Lean Startup and Business model Canvas methodologies were used to design the business model. A survey and interviews with potential clients were part of the Lean Startup method in order to find out what the Achuar communities seek from the fluvial solar transport service in order to determine if it would be able to prosper and how it would achieve its stability in the market. Finally, the researcher made a business feasibility and profitability for the entrepreneurship, determining that the project is viable.

VI. ANALYSIS

After the development of the research, the general objective of designing a business plan through the Lean Startup and Business Model Canvas methodologies for the creation of the fluvial transport company Kara Solar in Pastaza Province with positive social and environmental impact that generates competitiveness and profitability has been fulfilled. For this purpose, the steps of the Build-Measure-Learn Wheel of Lean Startup were applied, including a survey, whose information obtained also served to fill the Business Model Canvas blocks and design the business plan with sustainable development elements. But first, it was necessary to understand the principles and objectives of sustainable development. For this purpose, this theory is used in the three chapters, as explained below.

First, the researcher conducted a study of the global context in which the Kara Solar project was created, that is, the reasons why this initiative wants to face climate change. Thus, chapter I describes the history of climate change and its environmental, social, and economic impacts globally and in Ecuador in order to determine the scope of this phenomenon and how it is being faced. For this purpose, the theory of sustainable development is used because the international community has committed itself to tackle climate change by taking measures based on this theory since the publication of the Brundtland Report until the 2030 Agenda.

Indeed, during the past 800,000 years, the atmospheric concentration of CO₂-eq varied around 280 ppm, as a result of natural processes. However, according to NASA, it augmented since the industrial revolution, reaching unprecedented levels of 407 ppm in 2018 due to human activity like intensive agriculture, land use, deforestation, and exploitation of fossil fuels, altering the environment and accelerating a climate change. This has shown itself through increased temperature, sea level rise, the loss of ice, and extreme weather events, causing the displacement of 25 million people annually, reducing access to potable water, decreasing food security, and causing adverse effects on health. These impacts have cost US \$1,400 million per year or 1.6% of the world GDP.

After understanding the worldwide impacts of climate change, it was necessary to know the efforts of international public and private sectors on this phenomenon that the Achuar communities want to face and which is part of the survey. Regarding the efforts of the international community, the United Nations presented the concept of "*Sustainable Development*" through the "*Our Common Future*" Report in 1987, which was used in the drafting of the next UN resolutions and treaties. This concept seeks the fulfillment of the present generation's needs without compromising the capacity of future generations to meet their own needs, integrating three spheres of action: environmental, social, and economic. Accordingly, the economic and social dimensions have to be developed, while the environment must be sustained (NRC, 1999). However, economic growth is one of the objectives of the Report and many countries are thriving in terms of material growth, but failing to fulfil basic needs.

Therefore, this section also contains criticisms of the concept such as degrowth of Latouche and political ecology of Marcellesi, who criticize how economic growth and excessive consumerism are not sustainable. This is taken into account for the design of the business plan. In this regard, Daly and Townsend (1993) have stated that there must be sustainable development without growth. In addition, what must be sustained is nature and cultures, while the economy and institutions must be constantly developed (NRC, 1999).

Despite the criticisms, this concept was used as the cornerstone for the International Regime on climate action. In this way, the countries, through the IPCC, the UNFCCC, the Conference of the Parties, the Kyoto Protocol, the Paris Agreement, and the 2030 Agenda have set several targets to contribute to sustainable development and reduce GHG emissions. On the other hand, private initiatives have also arisen such as companies that not only seek economic gains, but mainly generate value for employees, customers, suppliers, the community in which they perform, and protect the environment in order to achieve sustainability in the business world.

Given that the company Kara Solar will be set up in Ecuador, it was required to analyze the impacts of climate change and their efforts to face it.

Indeed, Ecuador created a political framework, including specific references to climate change and sustainable development in the Constitution and in the National Plans for Good Living. Second, it declared the adaptation and mitigation to climate change as a State Policy and established public institutions to face this phenomenon. A key point of this structure is that the main objective is to achieve the Good Living or Sumak Kawsay through its principles complemented by those of sustainable development and human development. That is why this section also describes the principles of Good Living and Human Development. However, the government has also emphasized economic growth, allowing the exploitation of fossil fuels.

As part of these efforts, Ecuador pledged to diversify its energy production through increasing the share of renewable energies. Also, Kara Solar will harness the solar energy to deliver its service through a solar boat. That is why chapter II has an analysis of the Ecuadorian energy matrix, its renewable energy potential, institutional framework, and its impacts. As part of the efforts, the country aims to achieve sustainable development and tackle climate change through the diversification of its energy matrix and committed to generating 90% of electricity through renewables. Yet, this percentage was 51.5% in 2016 and the country does not have a target to replace the generation of primary energy, generating around 51,424.20 kton CO₂-eq annually.

Regarding the solar potential, the insolation levels in the territory vary around 3 and 4kWh/m²/d, sufficient for a solar boat to operate a minimum of 6 hours per day. In this regard, the government has tried to implement initiatives such as Euro-Solar in communities that do not have access to electricity, installing solar panels. However, there is no accompaniment and these projects do not try to empower communities with knowledge about design, installation, or repair of panels and equipment. This causes them to fail and not be long-term. All of these facts are taken into account to the elaboration of the business model of Kara Solar, trying to avoid those negative results. That is why the Human Development theory is also used to complement sustainable development because it explains how people can harness their capabilities to turn them into functionalities such as being able to work, being literate, and being part of a

community (Sen, 1999). Thus, as part of the key activities of Kara Solar, the continuous training of the communities will be considered so that people take advantage of their capabilities and prevent the project from failing.

Likewise, the government is not the only one that implements this type of initiatives. The private sector has also shown its interest in renewables and 17 private projects have been approved to generate a total of 290.7MW. In this regard, the theory of Social Market Economy was employed to analyze the conduct of the State towards the private initiative. This was paramount to know the advantages and obstacles of the government that Kara Solar would have to face before its establishment as a company. In this case, the State respects and does not interfere with competition (Auping, 2004: 78-79), but it is regulated. Therefore, the legal and institutional framework for renewable energy projects was described such as the "Organic Law for the promotion of production, attraction of investments" and the "Organic Law of Internal Tax Regime", which offer benefits of up to 12 years to investments in projects of renewable energy. For this reason, Kara Solar can harness these advantages.

The setback of the structure of the energy matrix is that to obtain energy, several hydroelectric plants have been built, causing the displacement of the inhabitants, deforestation, destruction of ecosystems, and loss of biodiversity. Another setback of the current energy matrix is that the government has granted oil blocks to obtain income and meet demand. This has been developed to the detriment of the inhabitants' health who suffer the consequences of illnesses to this day. That's why indigenous movements such as CONAIE have raised their voices for the implementation of the Good Living and sustainable development in a harmonious interrelation between the human being, nature, and society, as a basis to achieve better conditions of individual and collective life. Accordingly, it is important to note that the indigenous communities consider sustainable development as a guide whose principles can complement the ones of the Good Living (Hernández & Santiago, 2016).

In this way, chapters I and II give a context in which Kara Solar emerged, characterized by the exploitation of natural resources for economic and

energy needs, emission of GHGs, the displacement of communities, deforestation, and destruction of ecosystems. These chapters also describe and analyze the concept of sustainable development, its criticisms, and the principles of Good Living because, as mentioned above, it must be considered as a guide to the implementation of any initiative.

Subsequently, Chapter III contains an analysis of Kara Solar, a project of the Achuar communities, supported by the ALDEA Foundation, that look for alternatives to oil exploitation and road construction, achieve sustainable development, and tackle climate change. However, it does not have a business model or a business plan to transition from project to company. Thus, the Lean Startup method and the Business Model Canvas were used to elaborate it.

First, the Eric Ries' Lean Startup methodology (2011) has 3 steps known as the Build-Measure-Learn Wheel: entrepreneurs begin by creating a Minimum Viable Product (MVP), measure the results of what was created and the needs of the potential customers, and use the learning of what was measured to start creating again. It focuses on the consumer and knowing their true needs. Since the community has already built a solar boat prototype called Tapiatpia, the "Build" step was already done. This Minimum Viable Product was useful to begin to gather data and know what improvements need to be implemented. The second step was to "Measure" the needs of potential customers so that the service is adjusted to what is expected or wanted from it. Eric Ries recommends carrying out a survey.

Thus, a survey was developed and conducted to know the assessment that the inhabitants of the communities give to their needs. The number of people was calculated through a quantitative method. First, a formula of the "probability sampling" was used to define the sample size, and the "convenience sample" was used to select the individuals suitable for the researcher to be part of the survey. Hence, the entrepreneur has to "Learn" from the data collected. To this end, the information obtained through the survey and the first two chapters was detailed in the Business Model Canvas (BMC).

The BMC provides the structure of a business plan without the need to write a traditional hundred-page business plan that details every aspect of a company that has not yet been created (Hustle to Startup, 2017). Thus, the structure designed for Kara Solar for the business model is also considered as the business plan. Regarding the blocks of the Canvas, the market segment is the Achuar community of Pastaza Province. The main value proposition is that Kara Solar offers a sustainable transport service by means of a solar boat that does not pollute, but above all, helps as an alternative to preserve nature and their identity. The proposed price is US \$1 per person and per trip, which is affordable for the communities' inhabitants. It is not proposed a higher price because the business model focuses on improving the well-being of people, and income is seen as a means to development, rather than as an end. Furthermore, the local assemblies are the preferred channel for clients to obtain more information. Regarding the customer relationships, these will be delivered through personal assistance, community management, and co-creation.

With respect to the key activities, the entrepreneurship will focus on the service provisioning, trainings, boat maintenance, and networking. Therefore, the leaders and other representatives of each community are trained in the construction and maintenance of the boat. The platform for service provisioning will be the solar boat. Also, the networks are built through the Achuar assemblies.

Until now, the whole project has been financed by NGOs, crowdfunding, and the sponsorship of private companies, which are Kara Solar main allies. Thus, it was proposed to calculate a loan so that the villagers can also take ownership of the project on the monetary side, paying part of it. In terms of cost-effectiveness, indexes show that Kara Solar is profitable. The investment is recovered in 4 years, 8 months, and 12 days. This means that if the project wants to recover it in a shorter period of time, they should establish strategies to reduce costs or to increase revenues.

In this way, the implementation of the community enterprise will have not only a positive social impact among communities that have joined forces

with its management to confront the oil companies, the government that threatens their identity, and climate change, but also an environmental impact given that the 4,200 gallons of fossil fuel and 38 tons of CO₂ produced annually by peque peques would be annulled. These communities, acting on the principles of subsidiarity and solidarity, are being responsible for the common good like all other individuals (Auping, 2004).

However, there is no denying the risk that some people could put the economy above well-being, the principles of the Achuar, and nature. That is why the principles of the Good Living are also part of the business model. The key partners like the Achuar Nationality of Ecuador, ALDEA and Pachamama Foundations, Plan Junto, the MIT, Charity Pot, Torqueedo, Hanergy, and so on, are part of the principle of complementarity because despite being different, they help mutually through solidarity. Also, the profits of the company will be redistributed among the communities. But, above all, this company will allow them to live in harmony with nature and protect their identity and nature for present and future generations.

Alexander Osterwalder and Yves Pigneur point out that it is necessary to replace obsolete business models with innovative ones that create value not only for companies and clients, but also for society. Kara Solar responds to this statement, innovating, merging technology and ancestral knowledge, and providing solutions to social and environmental problems through a profitable business. This, using the principles of sustainable development as a guide, allows the indigenous communities to live in harmony with nature.

VII. CONCLUSIONS

Once the analysis is completed, it can be concluded that the research responds to the hypothesis which raises that the design of a business plan through the Business Model Canvas and Lean Startup methodology would provide the adequate tools for the creation of the fluvial transport company Kara Solar in Pastaza Province with positive social and environmental impact generating competitiveness and profitability. The concluding explanations that support this result are as follows:

- Climate change is a result of the human being's productive activities and the irrational use of resources, without planning the adequate return of waste to nature or the planet's capacity.
- The concept of sustainable development emerged in view of the perceived threat from climate change to humans, nature, and the economy.
- The industrialized countries are the main responsible for accelerating and magnifying climate change.
- Although economic growth with equitable redistribution was recommended for developing countries in order to end poverty, this objective has been applied by the industrialized countries too.
- The concept of sustainable development has been mainly applied through the western perspective: with excessive consumerism and individualism.
- Although sustainable development indicates that communal rights must be respected, countries and companies have not respected this commitment established in the Brundtland Report and the Agenda 21.
- "Economic growth" is part of the objectives of several documents, inter alia, from the Brundtland Report to the 2030 Agenda, but it is not

intrinsically part of the concepts. Thus, for the drafting of future United Nations resolutions or treaties, this objective must be eliminated. Otherwise, alternative theories should be applied if countries want to stop climate change.

- Economic growth has been part of the needs of the past post-war generations. However, those needs do not represent the ones of the current generations who need sustainable development without economic growth.
- What must be sustained is nature and cultures, while the economy, wellbeing, and institutions must be constantly developed.
- For the elaboration and implementation of projects, sustainable development must be used only as a guide, respecting the communal rights.
- The international community pledged to reduce 5% of their emissions in 2012 with respect to 1990, as part of the Kyoto Protocol, and as a result, they managed to reduce 22.6%. However, the global temperature continues to rise because as the use of renewable energies increases, so does the exploitation of fossil resources.
- The countries that produce the most CO₂ emissions should not only set higher targets in the Paris Agreement, but also work between their own culture to transition from an excessive consumerism to a sustainable model.
- Companies that aim to have a positive economic, social, and environmental impact have emerged to deal with climate change and achieve sustainability. They seek not only to generate income, but mainly to create value for employees, customers, competitors, suppliers, and the communities where they operate, differing from traditional companies.

- Ecuador has not only coined the concept of sustainable development, but has also implemented it through the creation of institutions that develop plans and programs, which in turn deal with climate change.
- The Ecuadorian government made a synergy between sustainable development and Good Living, adapting the concepts to the national reality. However, economic growth is also part of the policies, which is not consistent with the concept of Good Living. Therefore, it is necessary to change this objective, in a way that economy be maintained as a means to redistribute wealth and achieve well-being. Otherwise, the governments will allow the destruction of natural resources and communities will be affected.
- Although Ecuador wants to change its energy matrix, there is a strong dependence on the exploitation of fossil resources and also, the same renewable hydroelectric projects are polluting. This behavior is contrary to the principles of sustainable development that defend the preservation of nature. People and communities cannot wait for the good will of the government. It is necessary to implement initiatives like Kara Solar, that arise from people's basic needs and efforts to achieve real results to the problems that afflict us and, at the same time, reach global commitments.
- The projects implemented by public or private entities in the communities without prior teaching of their economic and social situation, of how the monitoring of a project or the maintenance of equipment is carried out, that is, if a community is not empowered, these types of projects are most likely to fail. Local solutions built in conjunction with the community and based on their needs are more likely to be successful and have real results.
- The current situation of Kara Solar project in Pastaza is favorable because it is not only an idea that arose from the community, but also aligned with the National Plan of Good Living and the 2030 Agenda, having national and international backing.

- Although Kara Solar has not yet been established as a company, it has already generated social impact through principles such as solidarity and subsidiarity, and has already potential clients and places of interest from which passengers would use the service.
- Although Kara Solar's main objective is not seeking to obtain economic returns, the project is profitable and the investment is recovered after 6 years. With this recovery, the communities could build another unit to obtain more income, or invest it in other community needs.
- Kara Solar can replace the use of *peque peques*, reducing at least 4,200 gallons of gasoline or diesel and avoiding 38 tons of CO₂ per year.
- Kara Solar is profitable not only for the cost-effectiveness' results, but also because its innovation has captivated most of the inhabitants. So, this new technology can be used not only by the community, but also by tourists.
- Although one solar boat would reduce the generation of 38 tons of CO₂, this amount represents only 0.0082% of the total emission nationally. Therefore, it is necessary that this initiative increase the number of boats, be replicated in other communities, or implement similar projects.
- The worldview of the Achuar communities has been complemented with the principles of sustainable development. Fortunately, this has not been imposed. Rather, they are harnessing new opportunities such as technology and innovation to adapt them to their lifestyle, merging this knowledge with their ancestral wisdom.
- This study opens the way to the idea of expanding the service to the Achuar communities of Peru, communicating to both countries through this service and, above all, uniting same visions.

VIII. RECOMMENDATIONS

After identifying and developing the key points of the research, the recommendations are:

- Invest in non-conventional renewable energies and environmentally friendly alternatives to reduce environmental pollution and therefore the problems caused by climate change.
- Allow tourists to use the solar river transport in order to get more income and build other boats that can complement the long route traveled by the first solar boat.
- Train the leaders and representatives of the communities continuously so that the sense of ownership that exists today is not lost.
- The creation of the enterprise can wait so that ALDEA can have more time to build more boats and a better fluvial transport system. They could also continue in the circle of Lean Startup recollecting more information through the solar boat prototype.
- Suggest to the government and companies to immerse themselves in the communities or places where they want to carry out any initiative because the projects that are implemented without community empowerment are not effective in the long term, generating not only economic losses, but also the distrust of the population towards them.
- Use the Business Model Canvas for projects that are being implemented and Lean Startup to complement, in case that it is a company that recently wants to position itself in the market.
- Suggest to possible entrepreneurs that data collection and initiatives that emerge from the heart of the very same communities are more likely to generate long-term positive results than those that have been imposed.

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X. APPENDIXES

APPENDIX No. 1 INTERVIEW WITH OLIVER UTNE

Priscila: Oliver. Tell me, how did Kara Solar come about?

Oliver: This is a project that benefits so many indigenous communities. The name of the project comes from a word Kara that means a dream that is going to come true. This project was born as a shared dream between Achuar communities and experts and national and international collaborators. Several people who worked on the project had the opportunity to spend time in the territory and being there we saw the reality they live. On the one hand, there is a lack of access to health and education services. The Achuar people are also afraid that the government will build roads in their territory. Another problem identified is that the cost of gasoline or diesel for river transport use is five times greater than in Quito.

Also, the price of the plane ticket or for transportation on a conventional canoe is a minimum of \$ 5 from one community to another.

But the ultimate goal of Kara Solar, in addition to keeping its territory intact, is to fight against climate change and achieve true sustainable development. Obviously, this development is implemented here in a different way since the Achuar communities have their own traditions and vision of the world. But it does not differ so much from the Western one.

Priscila: Is Kara Solar a project or an entrepreneurship?

Oliver: This is a project. We are in the project phase. But we want it to become a community enterprise.

Priscila: Oliver, how many people use Tapiatpia approximately every day? What is the cost of the ticket?

Oliver: The communities decided to put a price of \$ 1. A really affordable price compared to other means of transport. The approximate number of people who used Tapiatpia was 30. Normally, there are more people. But, the approximation of stops was

4 between round trips because people go more to the hospital or the kids to classes. Although, most times it is to transport cargo.

Priscila: And how many hours does it take for the boat to arrive from its starting point to the arrival point?

Oliver: Well, the boat takes about 6 hours and it recharges on the way.

Priscila: And do you plan to expand into other communities or market segments?

Oliver: Yes. In fact, we are thinking about the construction of a ship whose power takes the Achuar communities of Ecuador to those of Peru. As you may know, these communities have not been around for some time. But given that they have common visions and customs, it would be interesting if the project were extended there to communicate to the communities and they could carry out commercial exchanges or simply transport themselves.

APPENDIX No. 2 SURVEY

SURVEY

1. How old are you?

- a. 5 – 17
- b. 18 – 25
- c. 26 – 35
- d. 36 – 45
- e. 45+

2. Do you use transportation to move from one place to another? Why?

- a. Yes
- b. No

3. What is the means of transport you use the most? Why?

- a. Small plane
- b. Canoe
- c. Truck
- d. By foot

4. Have you heard about the Kara Solar project? If the answer is yes, explain what it is about

- a. Yes
- b. No

5. Which of the following options would you consider when using the Tapiatpia? Please put your preferences in order 1-7 (1=first to consider, 7=last to consider)

- a. To avoid oil exploitation
- b. To avoid road construction and deforestation
- c. To maintain the Achuar identity
- d. To avoid pollution of rivers
- e. To avoid buying gasoline
- f. To face climate change
- g. To reach sustainable development

6. How much do you spend on average on transportation per week?

- a. \$0
- b. \$1 – 5
- c. \$5 – 10
- d. 10 – 20
- e. More than \$20

7. What is the price you would be willing to pay for the solar river transport service from one community to another?

- a. Less than \$1

- b. \$1 – 5
- c. \$5 – 10
- d. \$10 – 20

8. How would you like to know more about this service?

- a. Through the GAD
- b. Through the local assemblies
- c. Through informative pamphlets