Fachhochschule Köln
Cologne University of Applied Sciences

UNIVERSIDAD AUTÓNOMA DE SAN LUIS POTOSÍ
FACULTADES DE CIENCIAS QUÍMICAS, INGENIERÍA Y MEDICINA
PROGRAMAS MULTIDISCIPLINARIOS DE POSGRADO EN CIENCIAS AMBIENTALES
AND
COLOGNE UNIVERSITY OF APPLIED SCIENCES
INSTITUTE FOR TECHNOLOGY AND RESOURCES MANAGEMENT IN THE TROPICS AND SUBTROPICS

POTENTIAL OF RENEWABLE ENERGIES IN THE GALÁPAGOS ARCHIPELAGO - ACCEPTANCE OF TECHNOLOGICAL SYSTEMS IN A PROTECTED ENVIRONMENT

THESIS TO OBTAIN THE DEGREE OF
MAESTRÍA EN CIENCIAS AMBIENTALES
DEGREE AWARDED BY
UNIVERSIDAD AUTÓNOMA DE SAN LUIS POTOSÍ
AND
MASTER OF SCIENCE
TECHNOLOGY AND RESOURCES MANAGEMENT IN THE TROPICS AND SUBTROPICS
IN THE SPECIALIZATION: RESOURCES MANAGEMENT
DEGREE AWARDED BY COLOGNE UNIVERSITY OF APPLIED SCIENCES

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COLOGNE 19 July 2013

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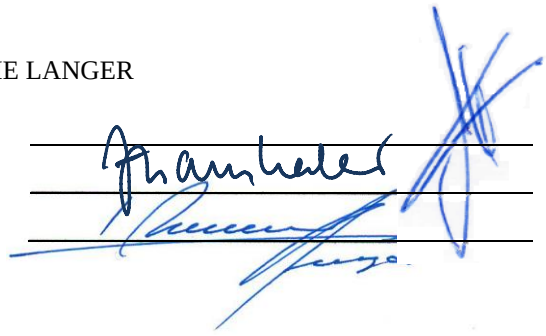

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PROYECTO REALIZADO EN:

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CON EL APOYO DE:

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LA MAESTRÍA EN CIENCIAS AMBIENTALES RECIBE APOYO A TRAVÉS DEL PROGRAMA NACIONAL DE POSGRADOS (PNPC - CONACYT)

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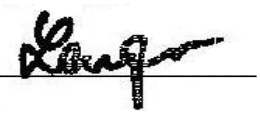
Unterschrift / *Firma*: 

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Abstract

In 2001, an oil spill occurred in the Galápagos archipelago caused by the tanker Jessica. The leaking oil contaminated the underwater world and several coastal sections and caused a huge to the flora and fauna of Galápagos. One year later, in response to potential risks of oil spills and also due to the increasing population and the resulting intensified pressure on natural resources, the government of Ecuador decided to strengthen the renewable energy systems on the archipelago. This agreement was supported in 2007 by the initiative "Cero Combustibles Fósiles para Galápagos". This initiative aims to replace the energy through energy obtained via renewable resources (biofuels) and inexhaustible resources (wind and solar). The technologies of renewable energies are a key component to facilitate sustainable development and are a major step toward energy independence in the future. However, a company, an industry or the government, which aims to establish renewable energy projects, may encounter resistance within the local population. This study research explores the acceptance levels of residents and visitors on renewable energy systems in the archipelago and detects concerns about possible economic, environmental and public safety issues. As research methods, semi-structured expert interviews and questionnaires with visitors and residents were developed and conducted, in order to understand the perception of the actors involved. The results indicate that the majority of participants approve to renewable energy systems, while they are not aware of the project initiative. In addition, local population demands to be engage more actively by the government in the project implementation.

Key words: Renewable Energies, Local sustainability, Zero emission, Public participation

Resumen

En 2001, en el archipiélago de Galápagos occurió un derrame de petróleo causado por el buque Jéssica; el derrame generó un inmenso riesgo y consecuencias desastrosas para la flora y la fauna de Galápagos. Un año después como reacción a los riesgos de derrames de petróleo y, además, por el incremento de la población y el consecuente aumento de la presión sobre los recursos naturales, el gobierno de Ecuador acordó espezializarse en los sistemas de energía renovables en el archipiélago. Este acuerdo fue reforzado en el año 2007 por la iniciativa "Cero Combustibles Fósiles para Galápagos". Esta iniciativa tiene como objetivo reemplazar la energía derivada de combustibles fósiles por las energías obtenidas vía recursos renovables (biocombustibles) y recursos inagotables (energía eólica y fotovoltaica). Las tecnologías de las energías de recursos renovables son un componente clave para facilitar el desarrollo sostenible y un paso importante hacia la independencia energética de nuestro futuro. Sin embargo, una empresa, industria o el gobierno, que pretende establecer proyectos de energía renovable puede encontrar resistencia dentro de la población local. En este proyecto se analizarán los niveles de la aceptación sobre los sistemas de energías renovables de los habitantes y visitantes en el archipiélago y las preocupaciones acerca de los posibles impactos económicos, ambientales y de seguridad pública. Mediante los métodos de investigación, que consistieron en la aplicación de entrevistas semi-estructuradas y cuestionnarios con los visitantes y los residentes, con el fin de comprender la percepción de los actores involucrados. Los resultados indican que la mayoría de los participantes aprueban los sistemas de energía renovable, mientras que mucho de ellos no tienen conocimiento acerca de la iniciativa del proyecto. Además, la población local, exige participar más activamente con el gobierno en la implementación del proyecto.

Palabras claves: Energías Renovables, Sustentabilidad Local, Cero Emisiones Fósiles, Participación Pública

Zusammenfassung

2001 havarierte der Öltanker Jessica in der Nähe der Galapagos-Inseln. Das auslaufende Öl verseuchte die Unterwasserwelt und mehrere Küstenabschnitte und stellte insgesamt eine Bedrohung für die einzigartige Flora und Fauna des Archipels dar. Aufgeschreckt durch diesen Vorfall beschloss die ecuadorianische Regierung ein Jahr später sich für eine stärkere Nutzung Erneuerbarer Energien auf der Inselgruppe einzusetzen. Begleitet wurde diese Entwicklung von einer stetigen Bevölkerungszunahme und damit einhergehenden stärkeren Nutzung endlicher, natürlicher Ressourcen. Die Bemühungen gipfelten schließlich in der Regierungsinitiative "Cero Combustibles Fósiles para Galápagos". Ziel dieser Initiative ist es, die benötigte Energie für die Inselgruppe durch Energie aus erneuerbaren Ressourcen (Biokraftstoffe) und unerschöpflichen Ressourcen (Wind und Sonne) zu gewinnen. Dadurch soll eine nachhaltige Entwicklung ermöglicht werden, die gleichzeitig eine größere Energieunabhängigkeit mit sich bringt. Allerdings können Regierungen, Unternehmen oder Industriezweige, die Projekte mit Erneuerbaren Energien durchführen möchten, auf Widerstände innerhalb der lokalen Bevölkerung stoßen. Die vorliegende Forschungsarbeit untersucht die Akzeptanz von Erneuerbaren Energien bei Bewohnern und Besuchern des Galapagos-Archipels. Dabei werden Bedenken über mögliche wirtschaftliche Entwicklungen, öffentliche Sicherheit und ökologische Folgen erfasst und ausgewertet. Um die Wahrnehmung der betroffenen Akteure nachzuvollziehen, kombiniert das Untersuchungsdesign semi-strukturierte Experteninterviews mit Fragebögen, die von den Inselbewohnern und Besuchern ausgefüllt worden sind. Die Ergebnisse zeigen, dass die Mehrheit der Teilnehmer Erneuerbare Energien befürwortet. Gleichzeitig wird deutlich, dass sie nur wenige Kenntnisse über die Projektinitiative haben. Vor allem die lokale Bevölkerung wünscht sich, dass die Regierung sie stärker in die Durchführung des Projekts einbezieht.

Schlüsselwörter: Erneuerbare Energien, Lokale Nachhaltigkeit, Null-Emissionen, Partizipation

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AECID – Agencia Española de Cooperación Internacional para el Desarrollo

ASOGAL– Asociación Nacional de Empresas Turísticas en Galápagos

BID – Banco Interamericano de Desarrollo

BOE – Barrel of oil equivalent

CAPTURGAL – Cámara Provincial de Turismo

CI – Conservation International

CELEC – Corporación Eléctrica del Ecuador

CENACE – Centro Nacional de Control de Energía,

CNEL – Corporación Nacional de Electricidad

CO_2 – Carbon dioxide

CONELEC – Consejo Nacional de Electricidad

DED – Deutscher Entwicklungsdienst

EEG – Erneuerbare Energien Gesetz

EEPG – Empresa Eléctrica Provincial Galápagos

EOLICSA – Eólica San Cristóbal S.A.

ERGAL – Energías Renovables para Galápagos

FERUM – Fondo para la Electrificación Rural y Urbano Marginal

FCD – Fundación Charles Darwin

GEF – Global Environment Facility

GIZ – Deutsche Gesellschaft für Internationale Zusammenarbeit

INEFAN – Instituto Ecuatoriano Forestal de Áreas Naturales y Vida Silvestre

INGALA – Instituto Nacional Galápagos

INEC –Instituto Nacional de Estadística y Censos

INER – Instituto Nacional de Eficiencia Energética y Energías Renovables

JICA – Agencia de Cooperación Japonesa

KfW – Kreditanstalt für Wiederaufbau

km – Kilometer

kWp – Kilowatt Peak

kWh – Kilowatt per hour

n/a – not applicable

NGO – Non-governmental organization

NIMBY– Not in my backyard

MEER – Ministerio de Electricidad y Energía Renovable

UNCED – United Nations Conference on Environment and Development

UNESCO – United Nations Educational, Scientific and Cultural Organization

UNDP – United Nations Development Program

UNDP-GEF – Naciones Unidas a través del Fondo para el Medio Ambiente Mundial

UN Foundation – United Nations Foundation

US – United States

USAID – Agencia Internacional de los Estados Unidos para el Desarrollo

SESA – Servicio Ecuatoriano de Sanidad Agropecuaria

SICGAL – Servicio de Inspección y Cuarentena de Galápagos

SPSS – Statistical Product and Service Solutions

WWF – World Wide Fund for Nature

1 Introduction

During the industrialization the use of fossil fuels for electricity generation was widely accepted as they provided a cheap and secure source of energy. However, fossil fuels are a finite resource and a source of pollution through their use. The consumption of fossil fuels has been identified as a cause of environmental problems such as acid rain and contributes substantially to the greenhouse effect. On the international level it is a common challenge to reduce significantly carbon dioxide (CO_2) emissions in order to avoid the effects of climate change. A decrease in CO_2 emissions requires a transition of the current energy systems towards a more sustainable energy generation techniques. The growing problem of an energy supply based on fossil fuels has led to advances in the fields of renewable energies. These systems generate electricity through the use of solar power, wind energy and biofuels and provide an environmentally friendly source of power. They offer a sustainable supply of energy, as they are constantly replenished by natural energy flows in the environment. Additionally, they have a lower environmental impact than conventional energy sources and therefore represent a key means of tackling local environmental challenges. In the Galápagos archipelago, a highly sensitive area, the challenge of implementing a sustainable energy transition, are already underway. The government of Ecuador has set ambitious targets and has started to implement support schemes aimed at implementing renewable energies. As renewable energies are spreading, however, it has been increasingly recognized that there is one potential factor that can be responsible for the refusal of the implementation of renewable energy systems: social acceptance. Public concern can act as a barrier to the success of planning permission.

1.1 Background

"The Galápagos Islands have managed to escape much destruction because of their isolation and recent discovery, but these islands are in danger of losing the very qualities that make them so special. The islands are at risk both because of past ravages and also because of modern economic and social pressures" (Jackson, 1993)

Already in 1993, the natural scientist Michael H. Jackson has foreseen an endangered and vulnerable future for the archipelago of Galápagos. These modern economic and social pressures are related to the increasing numbers of residents and visitors. As a consequence also the electrical energy consumption is rising. In the last decades the majority of electricity produced in the archipelago was obtained with diesel generating facilities. The import and

transport of diesel to the Islands not only creates an extremely large economic cost, but also displays an extreme environmental threat.

As an answer to the risk of oil spills, to the enormously increasing annual population and tourism growth rate and its correlated higher pressure on water, food and electricity, the Government of Ecuador signed an agreement in 2002 with at that time the Ministry of Energy and Mines for the project "Energía Renovable para la Generación de Energía Eléctrica - Electrificación de Galápagos con Energías Renovables". Then, in 2007 started the initiative "Cero Combustibles Fósiles para Galápagos" (Zero Fossil Fuels for Galápagos) with the aim to diminish fossil fuels needed in the Islands by the substitution of renewable energies such as biofuels, wind and solar energy and thereby reduce the risks associated with the transportation of fossil fuels. The project "Cero Combustibles Fósiles para Galápagos" has developed and demonstrated sustainable and commercial approaches to deliver community-based renewable energies. It encourages the wider use of renewable energy technologies. It approaches the issue of protection of biodiversity through a substantial reduction in the quantity of diesel annually shipped to the islands.

The project "Energía Renovable para Galápagos" (ERGAL) is coordinating the implementation of renewable energy projects in the archipelago of Galápagos. The activities of the Project ERGAL started in the year 2004 to review identified barriers to the use of renewable energy technologies in the Islands. The ERGAL Project was conceived as an umbrella project that seeks to establish collaborative arrangements and to develop synergies between different subprojects of the four inhabited islands, in order to interact and coordinate between the diverse activities of the different subprojects. A coordination between the projects helps to relate common issues of renewable energy projects, such as the design of systems, contractual procedures, institutional issues, environmental impact studies, and the maintenance of the systems.

The project has been financed by several international institutions: KfW (Kredianstalt für Wiederaufbau), e8[1], GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit), UN (United Nations) Foundation, and the Agencia Española de Cooperación Internacional para el Desarrollo (AECID, Spanish Agency for International Development Cooperation). In general,

[1] "The e8, comprised of nine leading electricity companies from G8 countries, was formed in 1992 to examine and co-operate on major global electricity-related issues, with an emphasis on the global environment and sustainable energy development. The current members of the e7 are: American Electric Power- USA, EDF- France, Enel- Italy, Hydro-Québec- Canada, Kansai Electric Power Company- Japan, Ontario Power Generation- Canada, RAO UESR- Russian Federation, RWE- Germany and Tokyo Electric Power Company- Japan" (Eolicsa, 2013)

the project aims to introduce biofuels, wind and solar energy as an alternative energy source in the islands. The respective energy systems will be presented in chapter 5.

1.2 Significance

From a geographical point of view, Ecuador's territory only occupies 0.17% of the Earth's surface, but maintains 1.6% of the Earth's species, for example 16,087 vascular plant species, and more than 11% of all land vertebrate species, around 600 species of marine fish and 2200 bird species (e8, 2008, p.10). This disparity between the size and the amount of species makes Ecuador a unique place in the world. Especially, the Galápagos archipelago is known for its unique endemic biodiversity and scientific importance. Due to its remote location (more or less 1000 km from the continent) and genetic isolation (for more than 5 millions of years) the species in the archipelago evolved and adapt to the diverse habitats. Thus, the Islands are the origin for a number of endemic species, which evolved in a specific and unique way. For instance, it is home for the only lava iguana (*Amblyrhynchus cristatus*) worldwide that feeds under water, because it adapted to dive for food. The beaks of the birds, such as the Darwin finches (*Geospiza* genus) evolved and adapted in order to be able to reach their preferred diet. Due to its significant ecological value, Galápagos has the responsibility and the pioneer task to develop a sustainable energy development in an archipelago, to ensure the protection of its unique ecosystem (e8, 2008, p.11).

Furthermore, it is important to protect and conserve the land ecosystem of this world heritage site (it was declared as such from UNSECO since 1979) by reducing the use of highly polluting energy production systems as well as by the consumption of polluting agents from diesel, transportation and containment facilities (Fundación Natura, 2001). This is essential to conserve the biodiversity of the Galápagos Islands under comprehensive and long-term conditions to ensure a sustainable management of the terrestrial and marine ecosystem.

Another challenge is the increase in global warming, due to the emission of greenhouse gases into the atmosphere. The vast majority of CO_2 emissions of the Islands are released through maritime transportation and diesel power generators. Due to the characteristics of small islands they are especially vulnerable to the consequences of climate change. They consist of small land masses, are enclosed by ocean, and are often situated in regions disposed to natural disasters. In tropical areas they are highly populated, with high growth rates. In general small islands have a weak infrastructure, limited resources (natural, human and economic), and rely on marine resources (IPCC, 2013). Therefore, climate change can result in an alteration of the

physical and human geographical characteristics of the islands. Transformations of abiotic factors such as temperature levels, air currents, sea level and rainfall have severe results for the local biodiversity and the entire natural ecosystem. The reduction of water resources induced by climate change is expected to affect local resources and to lead to a significant risk of water shortages during low rainfall periods. In order to reduce CO_2 emissions and prevent the risk of these impacts of climate change the archipelago needs to transform their current energy production through technology transfer in order to promote a sustainable energy supply (e8, 2008, p.15).

Moreover, the archipelago of Galápagos has the highest population growth in Latin America. Through the increased demand of natural resources, the Islands face increasing consumption pressures and environmental impacts. To provide sufficient power supply the inhabited Islands use mainly electricity generated by diesel fuel that is shipped by tankers from the mainland. On account of its remote location, the transportation of fossil fuel to the Islands is challenging and has the inherent danger of spilling and contaminating the archipelago. The total dependency on imported energy signifies a fragile energy system with constant security problems due to the vulnerability of the supply chain. Furthermore, the lack of diversity in the energy supply forms and the increasing demand of electricity technology determine an extremely vulnerable energy system, as it is a very limited system, unable to react to changes. In fact, in 1988 the Motor Yacht Iguana went aground off the island of Santa Cruz, spilling 189,271 liters of diesel into the bay. More recently, in 2001, the Islands experienced another oil spill caused by the tanker Jessica which spilled 283,906 liters of diesel on to the outskirts of Puerto Baquerizo Moreno, San Cristóbal. These accidents portray the immense risks associated with the efforts to supply the Islands with fuel, which may lead to substantial impacts to the high variety of endemism of the Galápagos marine fauna and flora (Fundación Natura, 2001).

Even between the loading of diesel fuel tankers and the ultimate consumption in tourist boats, power plants or vehicles, the diesel and gasoline fuel is handled and stored several times, at each stage of which leaks may occur. The main storage facility on island Baltra (in front of island Santa Cruz) lacks sufficient technology, for secure handling, increasing the risks of oil spills (Kreider and William, 2001). Unfortunately, no data was available about the current situation of the storage facilities in the archipelago during literature research.

1.3 Identification of the Problem

In light of the aforementioned challenges of climate change and increased CO_2 emissions, the last decade has experienced an increase in renewable energy technologies, as new potentials for the generation of clean energy have been developed. The renewable energy technologies are a key component in addressing the current energy crisis and are an important step toward an independent and transformed energy future. Besides, renewable energy sources are known to enhance sustainable development through a number of socioeconomic benefits, "including the diversification of energy supply, enhanced regional and rural development opportunities, creation of a domestic industry and employment opportunities" (Del Rió and Burguillo, 2008, p.1). This statement is affirmed by the European Directive 2001/77/EC[2] of the European Parliament and of the Council on renewable electricity which "recognizes the need to promote renewable energy sources as a priority measure given that their exploitation contributes to sustainable development, create local employment and have a positive impact on social cohesion".

Despite the obvious environmental benefits of renewable energies, the implementation of renewable technologies faces several political, environmental, economic and social challenges in different spatial and temporal scales. For instance, impacts associated with wind energy include the noise level of wind farms, the uncertainty and discontinuity of wind as well as adverse effects on the landscape view. The degree to which an alteration in land cover will be noticeable and visible to an observer is also important. Furthermore, property owners fear the reduction of the monetary value of their real estates' due to the installation of wind parks near their properties (Schwarz, 2010). From an environmental point of view, wind power plants are a risk in ecologically sensitive areas, such as the National Park of Galápagos. Such installations may conflict with the habitat, fauna and flora of such an environment, consequently these factors need to be taken into consideration, along with the soil movement issues due to the installation of wind parks. Here, the main issue of wind energy would be the potential effect on bird mortality or more subtle changes to condition and breeding success, due to "collision, displacement due to disturbance, barrier effects and habitat loss" (Drewitt and Langston, 2006, p.29).

Photovoltaic systems may generate safety and environmental health issues during construction, manufacturing processes and waste disposal, as the operation of solar facilities

[2] Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market.

generate particulate matter which is a source of pollution. Additionally, photovoltaic panels may contain hazardous components and even though they are coated, there is a potential risk for environmental contamination if they are damaged or incorrectly disposed of. During the production and construction, the regular application and treatment of hazardous materials such as arsenic and cadmium may display health and safety problems for workers (Brower, 1992). A further concern is how much energy is required "to manufacture and install solar components, and how much fossil energy input is required for solar systems compared to the fossil energy consumed by comparable conventional energy systems" (Brower, 1992). Another potential impact, especially relevant in the archipelago, may be the displacement of breeding birds from the area of the solar parks and collision mortality, as birds could be attracted to the reflective surfaces of the solar cells as it could imitate areas of water (Hötker and Thomson, 2006).

In the case of biofuels, the use and application may be restricted due to several possible impacts generated by the production of biofuels, such as the risk to food security due to the substitution of food crops to those used for energy use. Furthermore, cultivation of biofuels may lead to higher deforestation rate due to the expansion of agricultural land, encouragement of monoculture, as well as the intensive use of agrochemicals and fertilizer, and an increased water demand. In addition, biofuel production may result in an increase of pollution as fossil fuels are used along the whole production phase of biofuels (preparation of land by machines, application of fertilizers, and transportation of harvested crop to final destination). According to Grunwald (2008), the basic problem of biofuels is that "using land to grow fuel leads to the destruction of forests, wetlands and grasslands that store enormous amounts of carbon".

Thus, a company, industry or government that seeks to introduce renewable energy projects may encounter resistance within the community. Further, such opposition can also derive from other factors such as the lack of knowledge about energy sources and production; lack of trust in government and industry; beliefs about the disadvantages of proposed renewable energy technologies and the objection to have renewable energy facilities in the own community.

On account of these limitations a resistance and disparity among different stakeholders may occur. For instance, in the construction of onshore wind farms of Isthmus of Tehuantepec in Mexico a social conflict of the wind parks has emerged due to several negative social and environmental limitations (Hamister, 2010). Thus, it is essential to obtain information about the different impacts which implementation of renewable energy projects may entail. This

should be taken into account in advance and integrated into the planning process as a criterion to determine the feasibility of these projects in terms of social and environmental acceptance.

There is a need for more in-depth research and analysis to investigate the knowledge of the social construct of individual attitudes and to explore the dynamic disparities between social or environmental attitudes in principle and actual social or environmental behavior in practice. Thus, in order to better understand the perceptions of the general public this thesis investigates the attitudes and knowledge levels of renewable energy systems within the general public of the Galápagos Islands. Moreover, this thesis is designed to research, understand, analyze, and evaluate the state of mind of visitors and residents towards the introduction of renewable energies in the archipelago. It shall further examine how people's viewpoints, concerns or support in relation to economic, environmental, and public safety issues of renewable energy systems in the islands are.

1.4 Objectives

In recent years, there has not been any empirical research on the perception of residents and visitors related to the implementation of renewable energies in the archipelago. As an overall aim this thesis investigates and provides a valuable insight of people's belief towards the green energy transition in the archipelago in the context of a pioneer study. Another goal of this study is to present the empirical work with great precision and transparency in order to facilitate the access of interested people and institutions. Therefore, this pilot study should allow to provide environmental or governmental institutions an insight about how the interviewees (i.e. representative of the general public) perceive the introduction and implementation of renewable energies in the archipelago.

Based on the above, this thesis postulates the following main objectives:

- To analyze the perception of stakeholders regarding renewable energy projects.
- To analyze the possible presence of conflicts between renewable energy projects and the actors involved.
- To investigate how the impacts have influence on the perception of people about renewable energy projects.

The results of the field research, which was carried out from March to May 2013 in the archipelago and the presented empirical analysis generates a baseline study with data, which qualifies the creation of an in-depth analysis of the current status-quo of residents and visitors

according to their environmental attitude and acceptance of renewable energy systems. Within this approach, this thesis describes the current energy situation of the archipelago, in order to analyze the motivations and constraints of visitors and residents towards a green energy transition and thus finally to understand the perception towards a sustainable energy development.

1.5 Limitations of the Research

This thesis aims to investigate the behavior of residents and visitors; however public attitudes are not stable but rather adapt and change in relation to events or changing situations. In addition, public opinion should not be presented as something static which can be measured once, but rather as highly flexible, transitory and adaptable. However, this thesis has to neglect the temporal variability of the attitudes of visitors and residents, due to the limited time for field research. While it focuses on the current status-quo of visitors and locals perception towards renewable energies in Galápagos it is important to put these in the context of ongoing developments.

The thesis also excludes considerations about the gender of the interviewed person or the participants of the questionnaire.

The researcher tried to minimize the risk of bias during the field work. However, the realization of some social science research, such as the performance of survey and interviews, "involve the researcher as the data collecting instrument" (Balnaves and Caputi, 2001, p.65). During an interview the interviewer has a higher ability to handle the questionnaire, as the respondent may ask directly questions to the interviewer. However, this also implies interaction and distortion between the interviewer and the respondent. Therefore, the quality of answer of a face to face interview is only satisfactory, as researchers might objectify their research group (Cloke *et al.*, 2004). Among the most known effects of respondents are their tendency of approval and social acceptability. These attitudes refer to the behavior to answer significantly more often positive and to adapt their true attitude to the prevailing opinion (Skulschus and Wiederstein, 2008, p. 219f).

Although the study includes questionnaires of the islands Santa Cruz, San Cristóbal and Isabella, the number of questionnaires of each Island is not sufficient to be representative. The main reason was that the time and resources available did not permit the undertaking of an adequately representative questionnaire survey on all islands. To balance this out, a number of interviews have been undertaken, in order to get an overall view about the situation.

2 Theoretical Framework

The following chapter identifies the theoretical framework of the research study. It presents not only the definition of the main subject (acceptance), but also poses important theories and combines theories and thoughts which frame the subject.

2.1 General Definition

The concept of "acceptance" (derived from Latin *acceptatĭo, -ōnis*) is used both in everyday language as well as in the scientific literature, however it lacks a clear and generally accepted definition. According to the Oxford dictionary (2000), the term defines "the act or agreeing with something and approving of it" as well as "the willingness to accept an unpleasant or difficult situation". As the official language in Galápagos is Spanish, it seems crucial to include the meaning of this word from a Spanish perspective. Conforming to the Spanish dictionary Real Academia de la Lengua (2013), acceptance has several meanings: "voluntarily or uncontested receive what you get, offer or charge; approve or agree to something; receive or provide the input of something; approve resigned to a sacrifice, bother or degradation".

In the psychological sense user acceptance is defined as the "positive acceptance or acquisition of an idea, a product or a situation, in the sense of active willingness, not just in the sense of reactive toleration" (Dethloff, 2004, p 181). Such a definition implies in general terms that users accept or adopt an innovation, as it is attractive to them, which means that it is more attractive than existing possibilities on the market.

According to Fauser (1990), the term acceptance can be described as a positively individual attitude "implying a person authorizing, endorsing or approving to a situation" (Kistler 1990, p.167). This indicates that the term acceptance describes a certain statement, opinion and behavior at a specific time. Endruweit (1986, p.81ff) extended the concept of acceptance by including a temporal dimension. Research of acceptance tries to determine the probability of a positive response to a particular stimulus in the future. On the basis of present fundamentals, future behavior could be determined.

Thus, acceptance or rejection towards a subject results from a person's attitude. This hypothetical construct refers to an individual's evaluation of, or orientation towards, an object such as an idea, person, group or action. In general development of an attitude depends on the cognition (knowledge), affects (emotions) and behavior of the environment and varies in intensity and direction. A main criterion is that the state of attitude is not static; rather it is dynamic and influenced by a range of factors. It may change temporarily through communication processes, preexisting beliefs and experience, but also as a result of

behavioral change. Thus, the level of acceptance depends on a number of contextual factors that shape values, attitudes and behavior (Upham *et al.*, 2009, p.2).

2.2 Acceptance in the Context of Protected Areas

A lot of protected areas have to deal with pressures derived from increasing populations and the subsequent intensification of the use of natural space. However, protected areas are not capable to harmonize in the long run with communities that are pollutant to them. In the Convention on Biological Diversity at the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in June 1992, it was determined "that countries are sovereign, and thus have control over the use of their own genetic resources, and that they need to act to protect their interests in the growing market for biological resources" (McNeely, 2007). One main consequence of this statement is to guarantee a well-established management for protected areas.

In general, the local communities in and around protected zones often have special and long-lasting associations to these areas. These relationships include cultural identity and spirituality which may assist to the maintenance of biological diversity. Thus, protected areas should be considered as a tool to sustain both cultural and biological diversity. Consequently, these areas can be seen as a component which contributes to the conservation of biodiversity (McNeely, 2007).

The main objective of a national park may be directly derived from the American National Park Service Act from 1916, which defines the main task to:

"Conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." (National Park Service Act, 1916)

The report "Our Common Future" of the Brundtland Commission in 1987 defined the term sustainable development as the "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". In their basic meaning and significance both definitions state the same, namely to protect and conserve our cultural and natural resources in order to allow future generations to use them as well. Thus, from the national park service act definition derives the importance of the sustainable implementation in a national park. Sustainability defines the three dimensions to be society, economic and environment. A main component and objective of a sustainable design is a

sustainable energy management. Therefore, the use of renewable energy systems should be a key strategy for the energy management in national parks.

Further, sustainability designates a permanent and existing human - nature interaction in a protected environment. Thus, it is essential for the national park management to know the demands of the local population as well as the adequate supply of natural resources. This requires sufficient knowledge of the decision makers, in order to develop solutions and decisions regarding potential conflicts. The main challenge of the management of a protected area is to balance the needs of conservation with the complex entity of stakeholders. Thus, the institutional body may secure a permanent local acceptance. In particular at local level however, individual management decisions can have direct or indirect perceived consequences to individuals. Consequently both, the identification of the causes of problems and their solutions can be regarded as an important task of the management of protected areas (Von Ruschkowski, 2009, p.4).

In order to guarantee on the one hand an efficient energy supply system, and on the other hand a supportive population towards renewable energy techniques, it is important to primarily determine the knowledge level of the local population towards renewables. This step allows to ensure that the supply structure of a protected area will meet the expectations and needs of the different target groups. In particular, essential for the long-term success of the conservation of protected areas is the satisfaction of local inhabitants as well as foreign visitors.

As a result the experience of local inhabitants and visitors has to be determined. Do they know about the current project for the implementation of renewable energy or even participated in? Are they satisfied with the realization of the project? How do they like the future procedure of the project? The central aim of this investigation is to be able to answer these crucial questions with regard to the acceptance of the locals and visitors.

2.3 Dimensions of Acceptance

2.3.1 Level of Action

A key distinguishing aspect of the term acceptance refers to the inclusion of the level of action (Figure 1). The level of action is a main characteristic to classify the different statuses of acceptance. According to Schweizer-Riess *et al.* (2011), the concept of acceptance can be

distinguished into four levels: rejection, resistance, approval or support/ engagement. Between the possible statuses of acceptance are no clear boundaries. As human attitudes are basically variables, conversions between the groups are possible. Equally variable is the activity, it can break off or be added on (Nationalparkverwaltung Bayerischer Wald, 2011, p.5). Depending on the circumstances these levels depend on two features, appraisal and action. Both characteristics can develop in a positive to negative appraisal, as well as a passive to active action towards the implementation of a sustainable energy management. For instance, if both the evaluation of the use of renewable energies as well as a positive active participation is present, then the concept speaks of active acceptance. These could include for instance the participating in signature campaigns, a shift to green electricity or the participation in planning processes (Schweizer-Riess *et al.*, 2011).

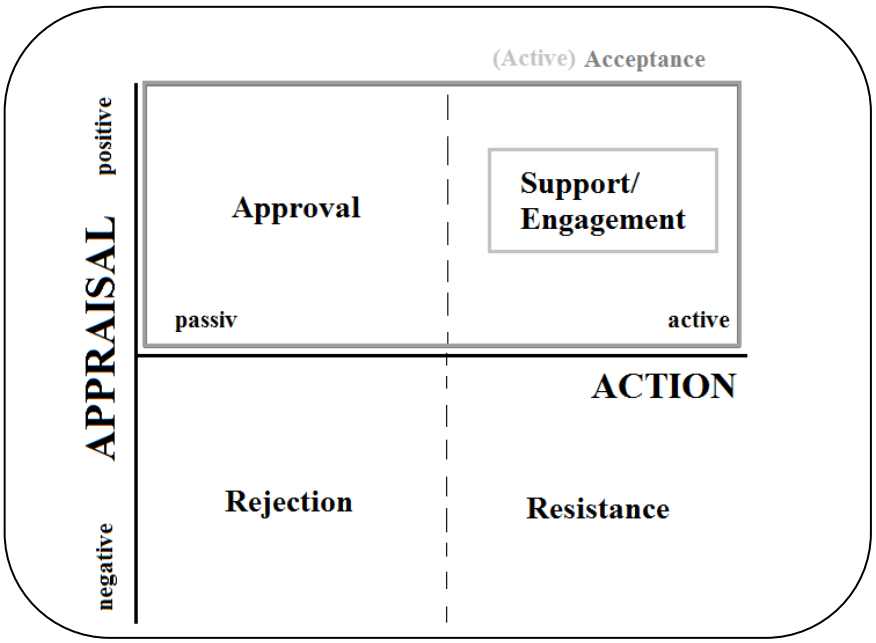

Figure 1: Dimensions of passive to active acceptance

Source: Schweizer-Riess *et al.*, 2011

The varying definitions of several authors show that the concept of acceptance ranges from recognition over approval to encouragement. Besides, it shows that the term is associated with a high degree of uncertainty. On the one hand it can imply specific approval or recognition for something and on the other hand the term can also be used simply for pure authorization or consent without a positive assessment to the situation (Schweizer-Riess *et al.*, 2011).

2.3.2 Triangle of Social Acceptance

In general the term acceptance has to be distinguished between social and individual acceptance. Social acceptance could discern that of a general public and local acceptance,

based on the assumption of different distributions of costs and benefits of the innovation and whether or not the impacted population is affected more or less immediately.

With the help of three dimensions Wüstenhagen *et al.* (2007) amplify this model by determining key factors which constitute social acceptance, specifically analyzing renewable energy innovations. These dimensions are socio-political acceptance, the community acceptance and the market acceptance (Figure 2).

Figure 2: The triangle of social acceptance of renewable energy innovation
Source: Wüstenhagen *et al.*, 2007, p.2684

The first dimension, the **social-political acceptance** is the most common form of social acceptance (public, media, politics), which can involve both policies, as well as technology itself. While public opinion towards renewable energy technologies in many countries tend to be very positive, their attitude changes if the level changes from a global to a local perspective and an implementation of a concrete project planning and site selection.

Although Wüstenhagen *et al.* (2007, p.2684) confirm that the number of renewable energy installations especially wind turbines is growing constantly, they clarify that the number of successful projects vary from country to country and cannot be explained solely by the respective wind potential of a country. Rather, many projects were not implemented due to a lack of social acceptance. This lack also concerns the acceptance by key stakeholders and policy makers, and thus hinders effective decision making at all levels.

The second dimension, the **community acceptance** includes the specific acceptance of siting decisions by local actors, especially local residents and local authorities. In this context arises the NIMBY debate addressing the tension between a general agreement of renewable energy systems and the rejection of specific plants in their own neighborhood. Conversely, other studies state the opposite behavior patterns and argue that a higher degree of being directly affected decreases the opposition of locals. According to Wolsink (2000, p.57), who analyzed this relation specifically for wind power developments, the NIMBY paradigm "misses the multitude of underlying motivations" for public opposition and is a too basic concept of explaining people's attitudes. A number of other independent variables are influencing the perception of renewable energies.

The last dimension, the **market acceptance** may be defined as the process of market adaptation of innovations in the electricity market. Market acceptance involves all market players and deals with how the market absorbs innovations. Key players include consumers, investors, electric power companies, grid operators, supply companies and financial institutions. Besides, market acceptance includes intra-firm acceptance of renewable energy innovation. Regional monopolies may present an entry barrier for potential investors (Wolsink, 2005).

Although the model of social acceptance of Wüstenhagen *et al.* (2007) is accepted in the specific scientific research fields, the model refers primarily to the constitution of public opinion and how this is developed or influenced. While the concept includes the community acceptance (procedural justice, distributional justice and trust), the model does not depict specific factors which might affect the local acceptance. Thus, the concept is limited in terms of a comprehensive analysis of relevant factors influencing the local acceptance.

2.3.3 Influencing Variables

While conservation issues are broadly supported at the general level, specific conservation measures at the local level often have to fight with acceptance deficits within the local population (Sieberath, 2007, p.8). Several authors (Devine-Wright, 2007; Wolsink, 2005; Van der Horst, 2007) have identified a number of recurrent factors regarding influencing variables of the accepting the implementation of renewable energy systems on the local scale. For this reason, the following section provides an overview of these potential and relevant factors at the individual and community level, in order to develop an own model, which depicts the relevant variables and relationships that influence the acceptance of renewable energy systems at the local level.

On the individual level, socio-demographic characteristics such as gender, age and social status can have an influence on the perception towards renewable energies. The literature review displayed that older people are more aware of renewable technologies than the young people are. However, older people are more unlikely to install these new systems. In terms of gender, the literature review identified opposed conclusions, according to different opinions among women and men towards renewable energies. Further it also showed that the political beliefs, the development of environmental awareness, the personal landscape evaluation and the local identity, may affect the acceptance (Devine-Wright, 2007, p.5f).

Furthermore, some studies demonstrated a positive correlation between the knowledge of renewable energy technology and acceptance. Potential users, who understand the principles of the technology and do not presume a high complexity of the issue, are assumed to be more open for new technology systems. Thus, the higher the information level of the person about renewable energy, the more likely the person has a positive attitude towards them. For this reason, the acceptance of a person is especially high if previous experiences with renewable energy projects have been made (Devine-Wright, 2007, p.5f; Mallet, 2007, p.2791, Aitken, 2009, p.1837). However, other studies assume that there is no clear connection between knowledge and acceptance. In the case of wind energy opposition can arise precisely due to informed individuals (Aitken, 2010, p.1838).

The personal evaluation of the technology is also a factor how individuals may perceive renewable energies. These include both the economic assessment, reliability, and risk assessment. Further, the design of the system plays a role. In the case of wind turbines, visual impairments are often the reason for low acceptance. Additionally, the potential environmental impacts and concerns may result in rejection. Studies indicated high levels of public support for energy policy-making which strengthened the goal of environmental protection. Even the shadows and the noise from the air resistance of the wind turbines, or the possibility that a wind turbine is out of control and can explode scattering their blades, can affect the personal attitude of renewable energy technology evaluation (Devine-Wright, 2007, p.6f; Wolsink, 2005, p.1192, Geissmann and Hubert, 2011, p.9).

According to Wolsink (2005, p.1198), the community acceptance depends on a time dimension, as attitudes of people may be very dynamic. Public attitude is unsteady and may adapt and change in relation to occurrences or altering situations (Aitken, 2009, p.1835). Figure 3 shows the typical model of acceptance before, during and after a project. The development of attitude is similar to a U-curve “going from high general acceptance to

(relatively) low acceptance during the siting phase (usually still positive on average) and back up to a higher level of acceptance once a project is up and running" (Wolsink, 2005). The graph demonstrates that the attitude of people changes according to time, implying that different relevant variables shape the mind of people. For instance, personal judgments may change as soon as people are confronted with an energy application, and are assured that environmental impacts are adequately dealt with. Thus, he argues that the return of the public towards a positive opinion only occur when environmental impacts are adequately dealt with in the mind of the local population. Therefore, a good management is essential, in order to create and trigger a positive community feedback (Aitken, 2009, p.1837).

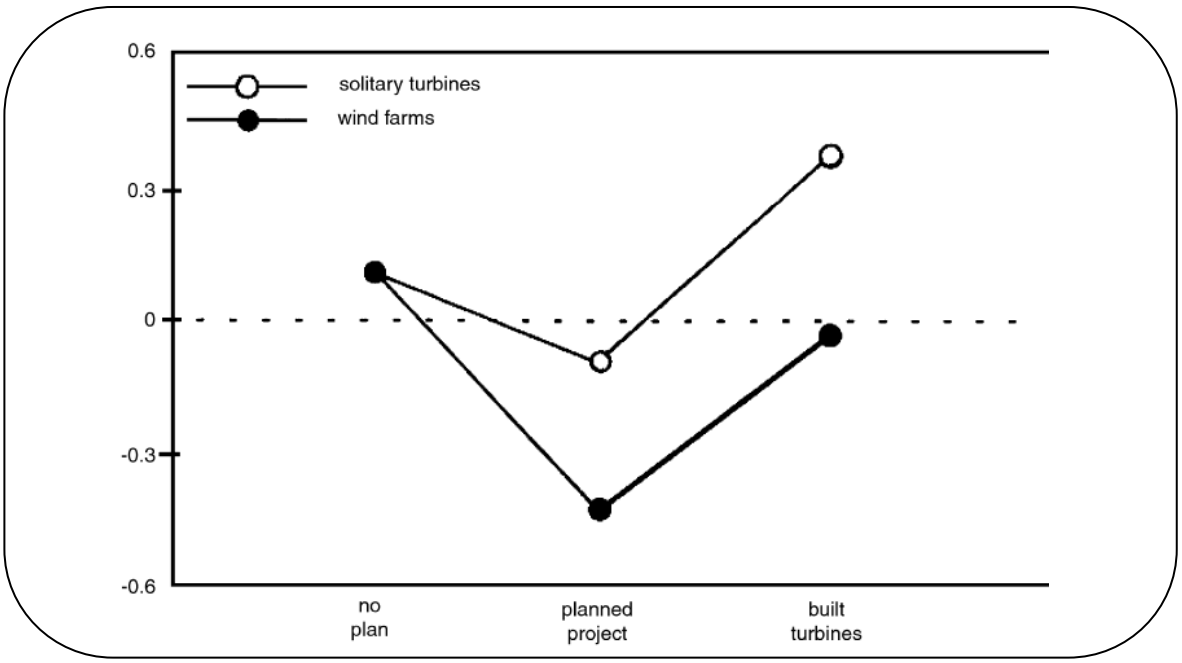

Figure 3: Development of public attitudes towards wind power dependent on near-by project
Source: Wolsink, 2005

The perceived fairness of the development process and the levels of trust in key actors were also important in shaping beliefs towards sustainable energy development. Procedural justice is defined as the "full participation in the process, the ability to express opinions freely and to be heard (voice), being treated with respect, being given adequate information, the impartiality of the decision maker" (Gross, 2007, p.2730; Wolsink, 2005, p.1192ff). This behavior includes a transparent and fair decision making process, which encourage the acceptance of local residents. A sustainable energy development allowing the residents to participate and to be directly and substantially involved contributes to a greater project acceptance and support. Studies showed that the involvement of the public society into the

decision-making process is a key component in shaping the decision whether or not to accept a technology. Moreover, the integration of financial incentives, such as participation in profits or rental income, may increase the support of renewable energy system implementation (Walker and Devine-Wright, 2008, p.499; Schweizer-Riess *et al.*, 2011, p.142; Mallet, 2007, p. 2791).

The number, size scale and type of the implemented energy system also affect the acceptance of people. As technologies of renewable energies capture different natural resources in different ways, the environmental, economic and social impacts of each technology vary. These changes can result in visual impacts, emitted smells, and noise levels, among others. Consistently, studies showed that small scale renewable energy development is more positively accepted (Devine-Wright, 2007, p.7; Wolsink, 2005, p.1194, Van der Horst, 2007, p.2708).

Another factor that can contribute to the acceptance or rejection of renewable energy systems is the choice of location of a renewable energy system. According to Jones and Eiser (2010, p.9) and Devine-Wright (2007, p.8), the acceptance increases if renewable energy system are not visible and not affecting directly the landscape. However, the results of other studies provided contradictory conclusions, namely, that the acceptance rises through the installation of renewable energies close to the residents. This statement will be justified through the assumption that residents directly affected will be much more informed about the issue and demonstrate more interest. This interest can cause a greater acceptance, which after successful implementation often turns into pride. But not only the distance between the location of renewable energies and the population is relevant for acceptance. Also the importance of the location and its previous use can influence the acceptance of the population. Sites that residents may feel emotionally attached to or sites of local importance for political, historical, cultural reasons, the acceptance is assumed to be low. On the other hand, if the site does not represent a value to the local residents (such as a former industrial site) acceptance can be expected to be much higher (Van der Horst, 2007, p.2707).

The above mentioned factors of the social acceptance of renewable energy installations illustrate the relevant influences; however it has no claim for completeness. The origin of acceptance can also develop by other factors.

2.4 Conceptual Approach

The development of local acceptance of renewable energy systems is a complex process. To illustrate factors that influence social acceptance on local level and their dynamics, table 1

below shows a proposed model, which is based on the analysis of the literature and on factors mentioned in the previous chapter.

Table 1: Awareness and perception model of renewable energies

Awareness and Perception	
Negative appraisal	**Positive appraisal**
Technology	
• High financial costs and risk evaluation • High number of energy systems	• Trust in reliability • Low number of energy systems
Communication	
• Top-down process • No involvement of community	• Information, involvement & integration • Partnerships & participation
Location	
• Noise, smell and visual impacts • High local identity	• Solidarity for the collectivity • Low local identity
Political	
• Negative perception • High economic estimation	• Trust, transparency and fairness • Perception of justice • Financial participation
Personality	
• Environmental impacts • High frequency of negative consequences	• Positive evaluation of renewables • Open for new technologies

Source: Own elaboration, 2013

In reference to Devine-Wright (2007, p.3), who introduced three dimensions of influencing factors (personal, social-psychological and contextual factors), this model is complemented by the features of technology, political and institutional, location as well as communication features. The model depicts that various components may affect the acceptance and shows the most important factors which might influence the perception of the public. These components include the areas technology, communication, location, policy level and personality. These five areas can develop in a negative or positive appraisal, depending on the realization of each project. For instance, communication and exchange of information between the authorities and the interested stakeholders may identify the approval or rejection of a project. Furthermore, aspects such as transparent decision-making process with participation, investment opportunities for local residents and impartiality of decision-makers can result in positive impacts on local peoples' understanding of renewable energy. Moreover, personal evaluation of environmental impacts, technology knowledge, consequences to the landscape

and the degree of local identity constitute the awareness and perception of people towards renewable energy projects.

Especially the two factors politics and communication play an important role in the complexity of the process. These two factors can shape and influence each other, either by the political orientation of individuals, through the promotion of specific technologies, special rules regarding location decisions or laws for the financial distribution (e.g. subsidies). The media can influence the whole process and the assessment of individual factors by reporting. In particular, the role of the media is very strong, as opinions can be spread quickly and easily through digital media.

The attitude towards these factors can modify and change during the implementation of renewable energy systems. Preexisting beliefs and experiences may alter, as they are no static elements. The model shows that the factors are depending on the evaluation and assessment of the parties involved, which can lead to a higher or lower level of acceptance. The factors work individually and in combination and can interact with each other positively or negatively, since they cannot be separated clearly from the aggrieved party.

The graphical presentation shows that shaping the public perception is a complex, multidimensional nature of forces. The composition of acceptance may develop own dynamics which are difficult to predict. Dependent on how the process implementation is conducted, people’s attitude might change towards an approval or rejection of the project.

3 Research and Data Collection Methodology

In order to deal with the complexity of the topic the study has been conducted in a multi-modal research design and uses a range of data collection techniques. Through combining different methods to study the same phenomenon, also called the concept of triangulation, a more detailed picture about the situation shall be achieved. Studying the research questions from more than one perspective enables diverse and detailed explanations and is a powerful possibility of ensuring concurrent validity. Throughout the study, the collection of data via more than one method was a key principle in the collection of data for the study (Flick *et al.*, 2012, p.302ff; Balnaves and Caputi, 2001, p.87).

The main aim of the survey was the evaluation of the general attitude towards renewable energies, economical estimation, risk evaluation, perceived procedural justice during the implementation process as well as perceived changes of the landscape.

The following subchapters shall describe how this research study estimates the effect of renewable energy systems on the inhabitants and tourists in the Galápagos archipelago by explaining the modalities of the literature review as well as the field work. It further shows the underlying theories and principles for this research.

3.1 Methodology of Literature Review

In order to accomplish all objectives, this research thesis started to conduct a literature review, followed by a chain of actions to achieve the objectives of the thesis. Literature review, including both printed sources and electronic databases "is a critical and evaluative account of what has been published" (Loughborough University, 2013, p.1) on the chosen research topic. Its purpose is to summarize, synthesize and analyze the arguments of different sources. It is a main method for collecting the basic information of the case study and helps to develop the research objectives and the conceptual framework of the thesis. Moreover, it identifies gaps within the literature that the research will attempt to address (Loughborough University, 2013).

During the research work, university libraries in Cologne, Galápagos and Karlsruhe were used to search for available scientific sources. Institutional reports of the Ministry of Electricity and Renewable Energies of Ecuador, the initiative ERGAL, and online databases such as "Sciencedirect" and "Scopus", among others were used to access relevant information of these electronic papers and publications.

3.2 Methodology and Scope of the Field Research

The field research for this thesis has been carried out within three months, from March until May 2011. The aim was to conduct expert interviews and to carry out a questionnaire about the perception and awareness towards the emergent renewable energy technologies within three of four inhabited islands.

3.2.1 Semi- Structured Interviews with Officials and Institutions

As a supplement to the questionnaires of the population and the tourists, qualitative semi-structured expert interviews were conducted. A person may be referred to as an expert if the person acts as a representative of an organization or institution and thus has a privileged access to knowledge (Meuser and Nail, 1991, p.444). The general goals of interviewing are to "create a positive atmosphere, ask the questions properly, obtain an adequate response, record the response and avoid biases such as interviewer attitudes or perceptions of the situation" (Balnaves and Caputi, 2001, p.87).

3.2.1.1 Methodology of Semi-structured Interview

In the framework of this thesis, semi-structured interviews were chosen. Semi-structured interviews use an interview guide with some questions developed in advance, but also give the interviewer the opportunity to ask apart from the interview guide. After a short presentation of the researcher and a very brief explanation of the scientific interest in the project, a couple of prepared questions were asked.

The interview method implies an unavoidable inter-subjectivity, which "means that the respondent is acknowledged as an active subject" (Cloke *et al.*, 2004, p.150). The respondent chooses himself what is told to the interviewer. Further disadvantages such as a time consuming procedure, less control for the interviewer to lead the interview, and a satisfactory procedure to generalize data had been balanced out by a number of advantages of this method. These benefits include that the interviews allowed to obtain good in-depth data, exploration of new data and allowed space for discussions and open conversation (Harrel *et al.*, 2009). Through this openness, in depth questions can be addressed. Further, the respondent can answer in a freeway due to the formulation of open questions. Through the consistent use of the guideline, the comparability of the data is increased and furthermore the data obtained is more structured. Besides, the guideline ensures that all essential aspects of the research questions are taken into account. However, the interviews do not strictly depend on the predetermined order of the questions of the guide. The interviewer has to decide whether and when demanded detailed are necessary (Mayer, 2008, p.37). Thus, this form of interviews allowed to get a more complete picture and provided detailed information of the current

situation of the project “Cero Combustible Fósiles para Galápagos”. The guideline for the expert interviews is displayed in annex A.1.

Subsequently, the interviews were audiotaped and later transcribed in order to provide the word-for-word text in order to allow further interpretations and analysis. Such comprehensive transcripts are important both for precise explanations of the answers of the respondent and for providing a source of the quotations that were used within the research thesis as part of the interpretation validation process (McMillan, 2008).

3.2.1.2 Target Group

During the field work, 16 informal interviews were conducted with governmental officials of the MEER (Ministerio de Electricidad y Energía Renovable), project managers of INER (Instituto Nacional de Eficiencia Energética y Energías Renovables), international and local NGOs, the National Park of Galápagos and the wind park in San Cristóbal, the chairman of the board of the travel company Metropolitan Touring, an external consultant of the Conservation and Development Foundation, and the technical director of the Charles Darwin Foundation. A list with the interview partners and specifications is presented in annex A.2.

3.2.1.3 Coding

The analysis of qualitative data is done by interpretive methods. The transcribed records of the interviews provide the basis for the interpretive techniques. Throughout the interpretation the following aspects will be taken to consideration: comprehensive analysis of the respondent, consideration of the social context, careful and detailed interpretation of each statement, analysis of language use, search for regularities and new phenomena (Mayer, 2008, p.26).

After carrying out the interviews, the data was generalized through interpretative techniques and coding. The process of interpretation gives primarily more structure to the mere observations. Through a second step, the coding of the data will not only be organized but already provides a tool to introduce the interpretations of the gained qualitative method.

Coding is an essential part for the interpretation of qualitative data. After conducting the interviews, they had to be transformed in an interpretative form. Therefore, the extensive data sets had to be condensed “into smaller analyzable units through the creation of categories and concepts derived from the data” (Lockyer, 2004). A key concept of coding is to link different parts of the obtained data, in order “to facilitate the organization, retrieval, and interpretation of data” (Lockyer, 2004). Each topic within the interviews was indicated by a code. Afterwards, theses codes served to summarize, synthesize and sort the observations and

statements. Moreover, a constant comparison among the interviews was carried out, in order to validate whether common themes were emerging across the data (McMillan, 2009). The use of coding approves certain validity, makes the process transparent and allows comparison with other studies.

After distinguishing the interviews into segments, they have to be summarized by the prevalence of codes, similarities and differences have to be discussed, as well as the comparison of the relationship between one or more codes (McMillan, 2009).

3.2.2 Questionnaire with Residents and Visitors

The survey was conducted in spring of 2013. During a period of 2,5 months, of the entity of questionnaires, 100 surveys were realized by inhabitants of the islands and 56 were accomplished by visitors.

3.2.2.1 Underlying Principle

The aim of samplings in social science research is to select subunits from a population in order to be able to conduct analysis. Afterwards, through the help of statistical programs judgments and interferences of the studied phenomenon can be made (Balnaves and Caputi, 2001, p.90).

The data for this study were gathered through the distribution and collection of questionnaires. The survey tool utilized within this study gauged respondents' overall attitudes towards various aspects of the use of renewable energies in the Galápagos archipelago, including people's belief about sustainable energy development in Galápagos, as well as assessments of the likely benefits and risks that might result from such a development.

Surveys are an essential tool for collecting data from people about their beliefs. The overall idea of questionnaires is to collect representative samples of people in order to produce numeric measures of behavior, attitude and attribute, with the aim to provide useful data suitable for the interpretative strategy (Cloke *et al.*, 2004, p. 129; Balnaves and Caputi, 2001, p.76). The major reason for conducting the survey in the Galápagos archipelago was to evaluate people's knowledge and attitude towards the implementation of renewable energy systems in the archipelago.

In total during the time, 100 questionnaires have been carried out with the residents and 56 visitors within the archipelago by the author. The questionnaires were developed by the author in a bilingual form (i.e. in Spanish and English). In order to ensure a scientifically realization of the questionnaires standard literature on quantitative and qualitative research (Balnaves and Caputi, 2001, Cloke *et al.*, 2004, Flick *et al.*, 2000) have been reviewed and

studied prior to the field work. Research questions were transformed into measurable variables in order measure the underlying phenomena of interest of this research namely to assess awareness and acceptance of the respondents (Balnaves and Caputi, 2001, p.61). The survey is presented in annex A.3.

3.2.2.2 Methodology of Questionnaire

For the investigation of the research object, a stratified sample procedure was chosen. Stratified samples divide the population into different groups or layers. A stratified sample has been chosen and potential interviewees were grouped by age, gender, location, and educational status. From each layer the sample has been selected randomly within these groups (Cloke *et al.*, 2004, p. 144). Stratified samples allow to minimize the total sample size (Jacob and Eiser, 2011, p.80) and are especially recommended if the population is very heterogeneous, but consists of relatively homogeneous subgroups (Mayer, 2008, p.62).

A pilot study, a preliminary test of a questionnaire, helped identify possible problems associated with the design and understanding of the questionnaire as well as the processing time (Balnaves and Caputi, 2001, p.87). After conducting the pilot study, the researcher obtained a better understanding of the frame of reference relevant to the questionnaire and question wording. The time frame was between 15 to 25 minutes. As a result of the pretest the length of the questionnaire had to be shortened to two pages, as respondents were in general annoyed about spending too much time on a questionnaire. Therefore, the questionnaire had to neglect the use of duplicate questions to measure reliability in the questionnaire, in order to avoid an extreme length of the questionnaire.

Respondents were asked to give their opinion on 35 items divided in 4 major areas. The questionnaire mixed a series of 33 closed (fixed answers) and two open answers and was administrated on a face-to-face basis. In the questionnaire mainly closed questions were used, as these can be answered easily and quickly and thus the non-answering of questions can be reduced (Sieberath, 2007, p.53). Socio-demographic characteristics of respondents were analyzed, including age, gender, nationality, financial income and professional background with the basic aim to investigate how variables interact with each other and examine possible correlations and influences within the variables (Balnaves and Caputi, 2001, p.46). Closed answers, provide only fixed choices for the respondent and were chosen due to their simplicity to analyze them statistically, from which it is possible to derive patterns regarding behaviors according to respondents' age, sex and social class, etc.. The social class of a person is an important category and is used in many studies as an important explanatory feature. With the use of these kinds of indicators correlation between social status of people

and people's opinion can be made. For this reason, indicators such as education, income levels and occupational position were included in the questionnaire (Cloke *et al.*, 2004, p. 126; Balnaves and Caputi, 2001, p.79; Jacob *et al.*, 2011, p.32).

To ensure a reliable and valid implementation of the questionnaires the following principle guidelines have been followed. Participants did not receive prior information about the content of the survey in order to prevent interviewee bias (Balnaves and Caputi, 2001, p.87). The design of the survey started to explain the purpose of the survey, other important issues have been assured directly and verbal with the participant such as, what will be done with the results, the safeguards for confidentiality and the anonymity of the respondent. The compliance of these principles affirms a high response rate and improves the honesty and quality of response (Cloke *et al.*, 2004, p. 146). Almost all questions entailed a "Don't know" option, so that participants are not force to choose an answer where there is in fact no knowledge or opinion. Besides, internal validity has been enhanced by formatting an appropriate design of questions. The construction of the question have been decided and developed in a considerable way of wording, length, and structure. The questionnaire contains a number of different structured questions, including list, category, scale and grid questions. General rules for the development of the questions have been followed, such as to avoid double-barreled questions, double negatives, technical terms, leading questions and abbreviations and to use simple language and short questions (Cloke *et al.*, 2004, p. 136; Balnaves and Caputi, 2001, p.83).

Table 2 depicts the questionnaire, which is divided into four major sections. Stimulating questions were placed at the beginning and for the respondent rather uninteresting socio-demographic questions (gender, education, family income, and etcetera) at the end of the questionnaire. Questions that require more effort of the respondents were placed in the middle part of the questionnaire. The central research questions were studied within the four scales and explored the knowledge and acceptance level of residents and visitors towards the implementation of renewable energies in the archipelago mainly in relation to the governmental project "Cero Combustible Fósiles para Galápagos". The surveys further examined the correlation between the income groups and knowledge of renewable energies, the degree of awareness, rejection factors, social cohesion as well as trust towards institutions and key personalities within society.

Table 2: Main sections of the questionnaire

Section	Scale
A General environmental attitude	General attitude towards environmental beliefs and knowledge
B Renewable energies on the Galápagos Islands	Procedural justice, risk evaluation, economical estimation, characteristic landscape
C Project "Cero Combustibles Fósiles para Galápagos"	Perception, knowledge and acceptance of the renewable energy project implementation
D Socio-demographic indicators	Age, gender, nationality, family income

Source: Own elaboration, 2013

In order to integrate the potential factors (technology, communication, location, political and personality) influencing the acceptance into the questionnaire, a specific structure was developed which is illustrated in Table 3. Each potential factor which may influence the acceptance level was initially divided into several indicators (*e.g.* trust in reliability, risk perception, information, partnerships, noise perception, visual perception, cost perception, transparency, environmental perception, knowledge level, evaluation of renewables). Then, corresponding questions were developed in order to analyze the specific indicators. The questions were designed so that a backwards implication of the individual factors could be examined. The questions were incorporated into the four above mentioned categories. The integration of the concept (chapter 2.4) which was developed to display factors that influence the perception of renewable energy systems into the questionnaire provides a consistent evaluation of the results.

Table 3: Indicators for measuring acceptance

Factor	Indicator	Questions
Technology	Trust in reliability	- Do you consider renewable energy systems to be a reliable source of energy? - Do you rather prefer to use biofuels than diesel? - What effect, if any, would you say the implementation of renewable energies has had on the Galapagos?
	Risk perception	- Do you believe that wind turbines are a danger to wildlife? - Do you think wind turbines create a disturbing noise? - Do you think the use of biofuels affect the biodiversity?
Communication	Information, involvement and integration	- Have you ever heard about the project "Cero Combustible Fósiles para Galápagos"? - When and by whom did you first hear about the project "Cero Combustible Fósiles para Galápagos"? - Would you like to know more about the project "Cero Combustible Fósiles para Galápagos"?
	Partnerships and participation	- Do you participate in the project "Cero Combustible Fósiles para Galápagos"? - Are you aware of any public consultation being conducted at that time? - Did you respond to the public consultation?
Location	Noise perception	- Do you think wind turbines create a disturbing noise?
	Visual perception	- Would you like the idea of renewable energy sources close to where you live? - In which of the following circumstances would you like to see wind turbines/ solar cells in the Galapagos Islands? - Do you think wind turbines/ solar cells are an attractive feature of the landscape? - Did you notice solar cells installations in the landscape of Galapagos?
Political	Cost perception	- Do you expect to have higher energy costs with renewable energy systems?
	Trust, transparency and fairness	- The population's opinion should be taken into account for the planning of a renewable energy system? - Do you think that the issues concerning the project "Cero Combustible Fósiles para Galápagos" are discussed sufficiently by the government, industry, media, NGOs, public?
Personality	Environmental perception	- What are the 3 most important issues in the world today? - Considering environmental problems specifically: What are the 3 most important problems?
	Knowledge of renewables	- What are the 3 most important measures which could guarantee a secure and sustainable energy supply in the long run? - How would you classify your knowledge of renewable energies (wind, solar, biofuels)?
	Evaluation of renewables	- Do you think renewable energy could contribute to solving environmental problems?

Source: Own elaboration, 2013

4 Study Location

A general description of the geographical, social, and economic background of the Galápagos archipelago is presented in this chapter, in order to give a general overview about the most important issues of the case study and to give an idea about the environment of the archipelago.

4.1 Location

The Galápagos Islands are a province of the Republic of Ecuador located in the east Pacific Ocean. Isolated about 960 km from Ecuador's west coast, the archipelago has developed to a unique melting pot of endemic species. It consists of 19 major islands and 214 islets and rocks that make up approximately 7,970 km² scattered over an area of approximately 70,000 km². 96.7% (7,610 km^2) of the total land area form part of the National Park and the World Natural Heritage of Humanity, and the remaining 3.3% (260 km^2) belong to colonized territory formed by urban and rural areas in the four inhabited islands Santa Cruz, San Cristóbal, Isabela and Floreana (Senplades, 2010, p.6).

Figure 4: Geographical location of the Galápagos archipelago

Source: Wiki, 2013; Nimax, 2013

4.2 Geography, Topography and Climate

Geologically, the young islands were created and shaped by the underlying plate moving slowly eastward over a hot spot in the Earth's crust, forming a succession of volcanic islands. San Cristóbal is the oldest islands with about 2.4 to 3 million years; the youngest island is Fernandina with about 700,000 years. The majority of the islands are formed due to slopping shield volcanos arising above 3,000m from the ocean floor. The islands still experience seismic activity. The last eruption occurred in 2005 in the western part of the archipelago (UNEP, 2011).

The topographical area is generally composed of uplifted marine lava flows which form an uneven surface. The soils are very poor for crop production and freshwater is limited on the islands. Among the inhabited islands only San Cristóbal presents an adequate perennial water supply for human consumption (UNEP, 2011).

The archipelago climate is strongly influenced by the relatively cold Humboldt Current through the islands during most time of the year and the warm tropical oceanic currents from the Gulf of Panama at a point north of the archipelago. Figure 5 below shows the climograph of the Galápagos Islands. Due to the changing currents there are two seasons: 1) cool temperatures (17 - 22°C) combined with a fairly persistent fog that covers the highlands, and southeasterly winds; 2) warmer temperatures (23 - 27°C) mixed with seasonal rain, easterly wind (UNEP, 2011).

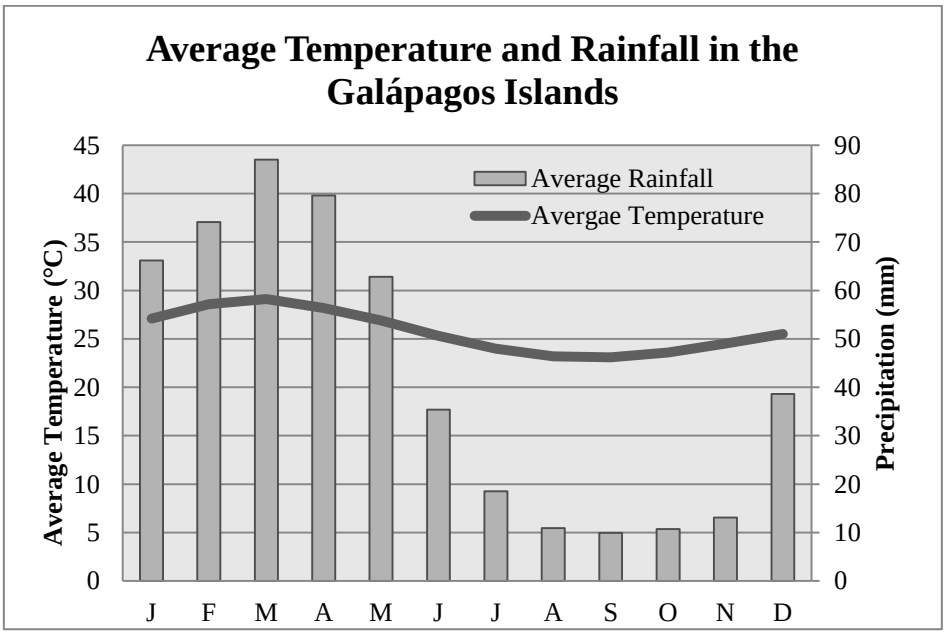

Figure 5: Average Temperature (°C) and Precipitation (mm) in Galápagos

Source: Fundación Natura and WWF, 2001

4.3 History

In the 1970s the Ecuadorian government, under the body of the Forestry Development Department started to manage and conserve protected natural areas in the country. In September 1992, the Ecuadorian government strengthened the forest management policies through the creation of the Ecuadorian Institute of Forest Natural Areas and Wildlife (Instituto Ecuatoriano Forestal de Áreas Naturales y Vida Silvestre, INEFAN). The foundation of this governmental body emphasizes the importance of strengthening the conservation of natural areas in Ecuador. In this regulation, the National park of Galápagos was established as an administrative and financially decentralized entity. Between 1996 and 1997 there were several changes in the administrative structure in Ecuador that directly influenced the management of protected areas. First, in October 1996 the Ministry of the Environment (Ministerio del Medio Ambiente) was created. The ministry is in charge of the executive authority for the design, planning and implementation of environmental policies in Ecuador. In January 1999, the two governmental bodies INEFAN and the Ministry of the Environment merged and functioned from August 1999 under the name of the Ministry of Environment (Parque Nacional Galápagos, 2005, p.27).

The Ecuadorian Constitution ensures in Article 86 the establishment of a national system of protected areas, to ensure the conservation of biodiversity and the maintenance of ecological services in accordance to international conventions and treaties. Besides, the Forest Law and Conservation of Natural Areas and Wildlife of 1981 states in Article 69, that natural areas are constituted by a set of wild areas which are emphasized by their scientific, scenic, education, tourism and recreation value for its flora and fauna, or as they help to maintain ecosystems in balance. Article 71 continues and completes this statement by adding the necessity to keep the state of the natural areas unchanged. The National System of Protected Areas of Ecuador constitutes at the moment of 33 conservation units, which makes up a total protected area of 4.8 million hectares, accounting for 18.1% of the total territory (Parque Nacional Galápagos, 2005, p.25).

The National Park of Galápagos was established by Executive Decree 31 on the 14th of May 1936 and was ratified on the 4th of July 1959. In 1968 the boundaries were extended and the Galápagos Marine Resources Reserve was founded including all waters within 15 nautical miles of a baseline containing the outmost areas of the Galápagos Islands. In 1978 the United Nations Educational, Scientific and Cultural Organization (UNESCO) inscribed the Galápagos archipelago on the World Heritage List under Natural Criteria vii, viii, ix and x. Six years later the archipelago was internationally recognized as a Biosphere Reserve under

the UNESCO Man and the Biosphere Programme (Epler, 2007, p.3ff). From 2007 to 2010 it was listed as a World Heritage Site in Danger due to the threats of invasive species, burgeoning tourism, increasing immigration and poor governance.

As Table 4 demonstrates, the political and administrative division of the archipelago consists of three counties: San Cristóbal, Santa Cruz and Isabela. The provincial capital of Galápagos is Puerto Baquerizo Moreno, which is situated on the island San Cristóbal (Senplades, 2010, p.8).

Table 4: Political and administrative division of Galápagos

Political and administrative division of Galápagos			
Counties	Sectors		
	Urban	Rural	Islands
San Cristóbal	Puerto Baquerizo	El Progreso	San Cristóbal, Floreana
		Santa María	Española, Genovesa, Santa Fe
Isabela	Puerto Villamil	Tomás de Berlanga	Charles Darwin, Teodoro Wolf, Fernandina
Santa Cruz	Puerto Ayora	Bellavista	Marchena, Pinta, Pinzón, Seymour
		Santa Rosa	Baltra

Source: Senplades, 2010, p.8

The governance of the province comprises a number of public institutions and regulatory bodies at national and regional level, whose powers are defined by the Special Law for Galápagos. Therefore, the Galápagos Islands involve various non-governmental organizations (in national and international level) which are related to the conservation and sustainable development of the province (Parque Nacional Galápagos, 2005, p.24). Since the foundation of the Galápagos National Park and the Marine Reserve the conservation sector has been a key factor in the Galápagos Islands, dealing with policies and leading research programs, with influence on fisheries, tourism planning, and the general management of resources. The Charles Darwin Foundation and the Galápagos National Park are the main conservationist institutions. Each of them has their own research institutions that are working in the areas of marine resources, tourism, administration and laws, etc. (Stacey and Fuks, 2007).

4.4 Government and Politics

Table 5 depicts the most important regulations related to the conservation management of the Galápagos National Park. Subsequently, each law will be described more specifically and the most significant issues will be outlined.

Table 5: Main national laws related to the conservation or management of the Galápagos National Park

Set of regulation	Publication	Date
Constitution of Ecuador **(**Constitución de la República del Ecuador)	R.O. No. 1	11/08/1998
Forest Law and Conservation of Natural Areas and Wildlife (Ley Forestal y de Conservación de Áreas Naturales y Vida Silvestre)	R.O. No. 64	24/08/1981
Regulation of the Forest Law and Conservation of Natural Areas and Wildlife (Reglamento General de Aplicación de la Ley Forestal)	R.O No. 436	22/02/1983
Environmental Management Act (Ley de Gestión Ambiental)	R.O. No. 245	30/07/1999
Special Law for the Conservation and Sustainable Development of the Province Galápagos (Ley de Régimen Especial para la Conservación y Desarrollo Sustentable de la Provincia de Galápagos)	R.O. No. 278	18/03/1998
Regulation of the Special Law for the Conservation and Sustainable Development of the Province Galápagos (Reglamento General de Aplicación de la Ley de Régimen Especial para la Conservación y Desarrollo Sustentable de la Provincia de Galápagos)	R.O. No. 358	11/01/2000
Regional Plan for the Conservation and Sustainable Development of Galápagos (Plan Regional para la Conservación y el Desarrollo Sustentable de Galápagos)	R.O. Edición Especial No.2	31/03/2003

Source: Parque Nacional Galápagos, 2005, p.51

The **Constitution of Ecuador** (Official Register No. 1, of the 11th of August 1998, Article 86) affirms that the government of Ecuador shall protect the right of people to live in a healthy and ecologically balanced environment to ensure sustainable development. The Constitution declares in the Article 238 and 239 that the environmental preservation, the conservation of ecosystems, the biodiversity and the establishment of a national system of protected areas as public interest; in order to ensure the conservation of biodiversity and maintenance of ecological services, in accordance with international conventions and treaties (Parque Nacional Galápagos, 2005, p.52)

The **Forest Law and Conservation of Natural Areas and Wildlife** (Law No. 74, Official Register No. 64, of the 24th of August 1981) establishes standards for the forestry sector, the natural areas and wildlife, as well as the conservation of resources. It contributes to the

maintenance of the environmental balance, by determining the opportunities and prohibitions within protected areas (Parque Nacional Galápagos, 2005, p.52)

The general regulations and assignments of the **Forest Act and the Conservation of Natural Areas and Wildlife** (Executive Decree No. 1529, Official Register No. 436, of the 22nd of February 1983) are the system administration of the protected areas. Permissions, possibilities or restrictions related to the use of protected areas are managed from this governmental body. Besides, it sets the administrative sanctions, jurisdictional responsibilities and technical administrative procedure; as well as it provides a parts of the management plan of the protected areas in Ecuador (Parque Nacional Galápagos, 2005, p.53).

The **Environmental Management Act** (Law No. 37, Official Register No. 245, of the 30th of July 1999) depicts the principles and guidelines of the country's environmental policy, by determining the obligations, responsibilities, levels of public and private sector participation in environmental management, as well as the permissible limits, controls and sanctions. The implementation of the Law creates a decentralized environmental management system, such as a coordination, interaction and cooperation mechanism between the different areas and sub-systems. While this Act does not refer exclusively to protected areas, its glossary has a proper definition of the term, which has not been included in previous laws. Natural protected areas are defined as "areas of public or private property, relevant to ecological, social, historical, cultural and scenic value, which are established by the country according to the law, in order to prevent their destruction and ensure the study and conservation of species of plants and animals, natural landscapes and ecosystems" (Parque Nacional Galápagos, 2005, p.53).

The **Special Law for the Conservation and Sustainable Development of the Province Galápagos** (Law No. 67, Official Register No. 278, of the 18th of March 1998) (Annex A.4) establishes legal principles such as: (a) the maintenance of ecological systems and the native and endemic biodiversity of the province, (b) the sustainable and controlled development within the ecosystems, (c) the privileged participation of the local community in development activities and the sustainable economic use of island ecosystems, (d) reducing the risk of introducing diseases, pests, plant and exotic animal species, (e) recognition of the interactions between residential areas, land and marine areas and, thus its need for an integrated management strategy, (f) the precautionary principle in the in activities that might undermine the environment or ecosystems. The Special Law for the Conservation and Sustainable Development of the Province Galápagos determines that the Galápagos National Park is in

charge of the management of the natural resources in the archipelago and coordinates inter-institutionally processes. It also introduced the establishment of new authorities for the marine reserve: the authority management of the marine reserve (Articles 13 and 14), the board participatory management (Article 15, last paragraph), the special counseling through the board advisory (Article 48) and the Charles Darwin Foundation (Article 5) (Parque Nacional Galápagos, 2005, p.54). Table 6 highlights the main aspects of the Special Law. It emphasizes that the main idea of the Special Law is a sustainable development off the flora and fauna of the archipelago.

Table 6: Main aspects of the Special Law of Galápagos

Articles	Main Aspects
2, 11	Sets the national commitment to protect and conserve the ecosystem and biodiversity of the archipelago
2, 73	Highlights the need to reduce the risk of introduced species
2, 53, 54, 55, 56, 62, 73	Underlines the maintenance of the isolation between the islands in order minimize human interference in evolutionary processes
2	Emphasizes the require to manage the archipelago as a comprehensive ecosystem where species do not know boundaries between protected and populated areas
2, 32, 35, 39, 42, 48, 57, 64, 65, 66, 67	Reinforces the idea of sustainable development in the archipelago and states that the quality of life of the residents of the islands should correspond to the unique characteristics of the World Heritage Site
2, 22, 49, 61	Preventive principles of environmental control

Source: Parque Nacional Galápagos, 2005, p.55

The **general regulation of the Special Law for the Conservation and Sustainable Development of the Province Galápagos** (Official Register No. 358, 11th of January 2000) establishes the legal administrative process (such as health, education, conservation, sanitation and basic services) imposed to all organs and bodies which are involved in the processes. Further, it regulates the functions of the National Park of Galápagos. Their tasks include the "formulation, implementation and enforcement of policies and management plans for the Galápagos National Park" (Article 48). It also depicts that every management plan should include an analysis demonstrating the compliance with the regional plan, which will be evaluated by the technical and planning committee of INGALA. Furthermore, the law states in Article 17 the management of the revenue from the taxes gained by tourist income fee (Parque Nacional Galápagos, 2005, p.54).

The **Regional Plan for the Conservation and Sustainable Development of Galápagos** (Executive Decree No. 3516, Official Special Edition Register No. 2, 31th of March 2003) sets the main guidelines, principles and policies to ensure the conservation and sustainable development of the province. Its general goal is "to conserve the biological diversity of the terrestrial and marine ecosystems in the Galápagos Islands in a long-term and comprehensive management, through the social participation of economic benefits". To achieve this goal, various programs in the following five frame areas were identified: Marine eco-region, terrestrial eco-region, sustainable development, population and sustainable human development. Various programs and projects are identified in the regional plan, especially those linked to the conservation of protected areas and sustainable development in the archipelago, have been incorporated into the management plan of the Galápagos National Park (Parque Nacional Galápagos, 2005, p.56).

According to the administrative status of the National Park of Galápagos (2006), the general goal of the national park is the protection, conservation, control, interpretation, environmental education and sustainable use of the island marine and land ecosystems. The management plan of the national park depicts more specific goals, which includes six objectives, each consisting in a number of different programs. As Figure 6 demonstrates the second objective is related to the use and development of energy in the Galápagos Islands. The conceptual framework and guiding principles of the second objective involves the efficient use of energy in order to guarantee a rational use of environmental goods and services. More specifically the actions include the installation of alternative energy systems in the National Park of Galápagos, the education and awareness rising of efficient energy use of the working staff of the national park as well as to the local population.

Objetivo básico 2

Programa 2.2: Mantenimiento de la calidad ambiental

Objetivo específico 2.2.3.
Garantizar el mantenimiento de la calidad ambiental en todos los procesos de desarrollo y productivos que se generan en el interior del PNG, promoviendo la eficiencia en el uso del agua y la energía, y fomentando el empleo de energías alternativas en todas las instalaciones y equipamientos del PNG, así como entre los diferentes usuarios del área protegida.

Acción 2.2.3.1.
Elaboración de procedimientos para el manejo de desechos sólidos y efluentes en las instalaciones, equipamientos, vehículos y embarcaciones del PNG.

Acción 2.2.3.2.
Instalación de equipos de energía alternativa en las instalaciones del PNG donde sea factible.

Acción 2.2.3.3.
Formación y sensibilización del personal del PNG en la aplicación de buenas prácticas para un uso eficiente del agua y la energía.

Acción 2.2.3.4.
Fomento de las energías alternativas y sistemas eficientes de uso del agua y la energía entre los distintos usuarios del área protegida.

Acción 2.2.4.4.
Difusión de buenas prácticas de ahorro y eficiencia en el uso del agua y la energía entre la comunidad local.

Figure 6: Objective 2 of the management plan of the National Park

Source: Parque Nacional Galápagos, 2005, p.186

4.5 Demographics

In 2013 the province accounted for 28,000 inhabitants of which the majority (61%) lives in Santa Cruz, 29% inhabits San Cristóbal, 9% resides in Isabela and 1% settles in Floreana (INEC, 2013). Although Galápagos presents the smallest province of Ecuador, it has a significantly high rate of population growth of 6.3% due to immigration (Senplades, 2010, p.7). As Table 7 below demonstrates the population of the Galápagos archipelago is going to increase steadily during the next years due to birth rates.

Table 7: Galápagos population from 2010 to 2020

Island	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
San Cristóbal	7,707	7,899	8,095	8,293	8,493	8,693	8,890	9,085	9,278	9,473	9,667
Isabela	2,321	2,392	2,464	2,538	2,614	2,690	2,765	2,842	2,918	2,995	3,073
Santa Cruz	15,856	16,285	16,725	17,169	17,619	18,070	18,517	18,963	19,404	19,852	20,302
Total	**25,884**	**26,576**	**27,284**	**28,000**	**28,726**	**29,453**	**30,172**	**30,890**	**31,600**	**32,320**	**33,042**

Source: INEC, 2013

According to a socio-economic study conducted by Taylor *et al.* (2006, p.5), the Galápagos archipelago has experienced in the last years a radical change in its social, cultural, ecological and economical aspects. The main cause of these changes has been due to the rapid growth of tourism which has increased by 14% in the last 15 years. Figure 7 demonstrates the high increase in the number of visitors, as well as in the number of inhabitants.

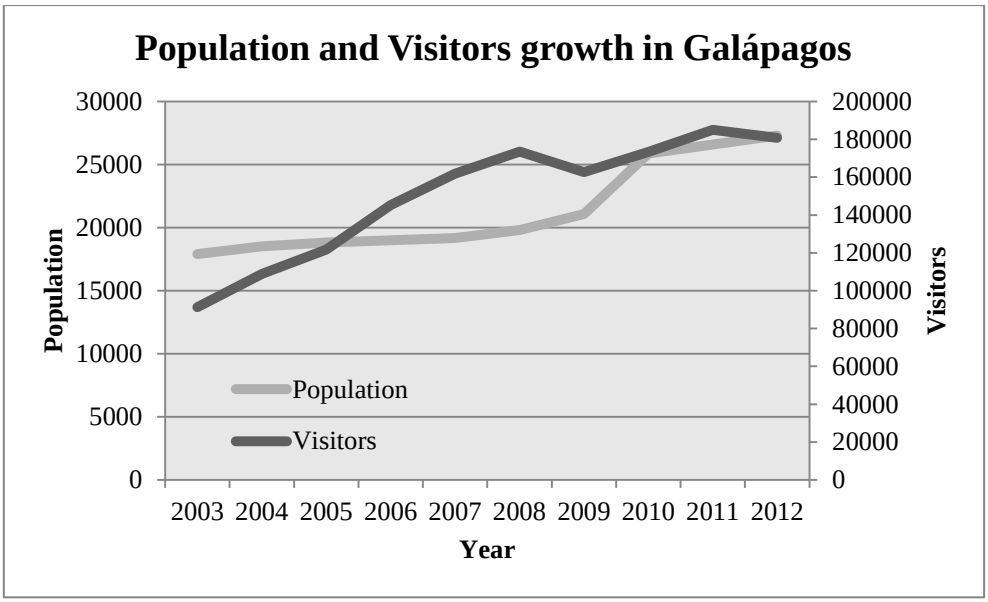

Figure 7: Population and Visitors growth in Galápagos

Source: Tayler *et al.*, 2006; National Park Galápagos, 2013

4.6 Education

As Figure 8 depicts the majority of the Galápagos population has a secondary degree of education which accounts for 42.6%. The residents with a primary degree represent 34.3%. Only 15.4% of the population possesses a higher level of degree and 7.7% did not join any educational institutions (INEC, 2010, p.174).

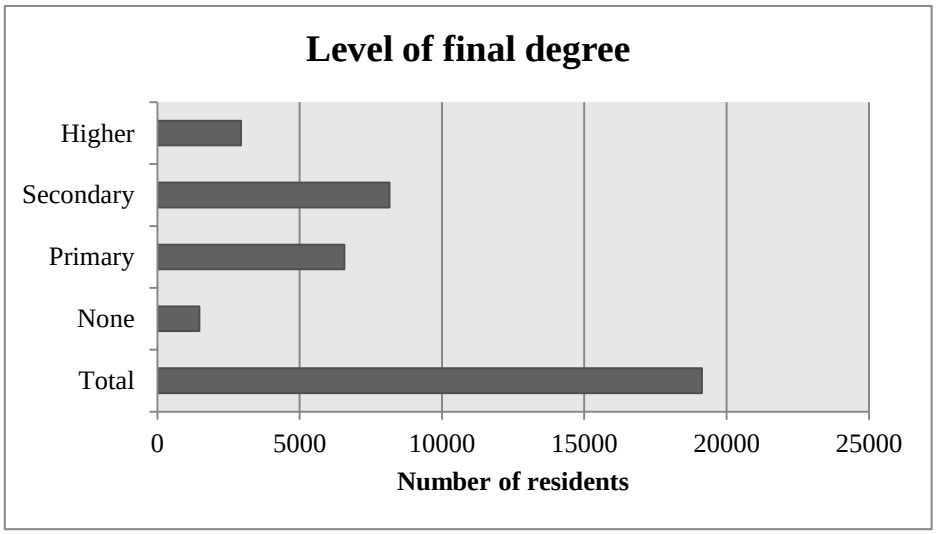

Figure 8: Level of final degree of Galápagos residents

Source: INEC, 2010, p.174

Also an important role plays the location of education. The following Figure 9 demonstrates that a significant high number of students (representing 81%) studied abroad of the archipelago. Only about 19% of the students stayed during their education on the islands (INEC, 2010).

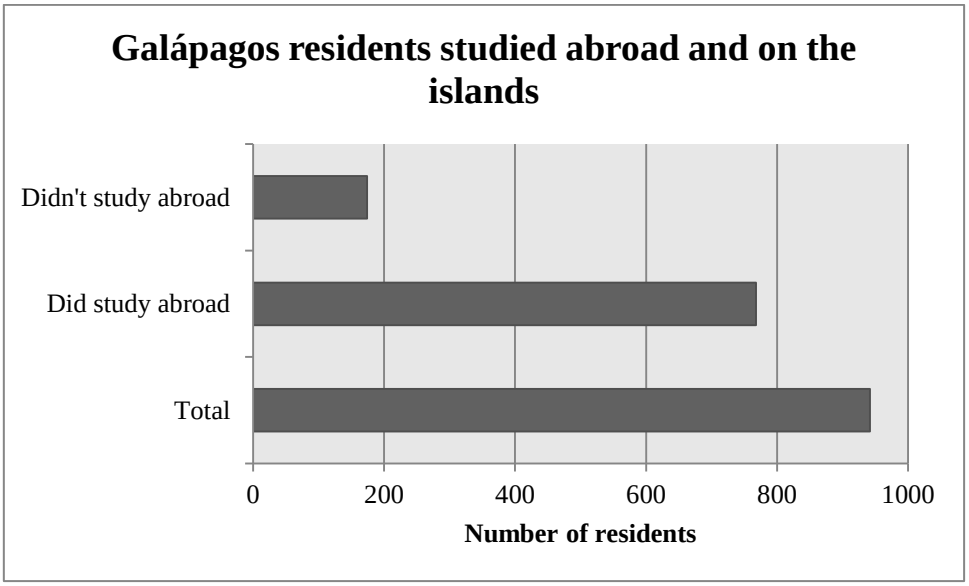

Figure 9: Galápagos residents studied abroad and on the islands in %

Source: INEC, 2010

Table 8 indicates the labor activity in the archipelago according to the level of education. It demonstrates that almost the half of the working force displays a secondary education level. About 30% of the labor activity of population presents a primary level, and only about 18% of the population working verifies a superior level.

Table 8: Labor activity of population in % according to level of education

Level of education	%
None	2.3
Primary	30.3
Secondary	49.5
Superior	17.9

Source: INEC, 2010, p.228

4.7 Economy

The four main drivers of economic growth in the Galápagos archipelago are tourism, conservation and research, fishing as well as government. The importance for each of these intensified during the years (Taylor *et al.*, 2006).

The main economic income to the Islands is generated by the tourism sector, which includes hotels, restaurants, day-tour operations, cruise ships, boutiques, souvenir shops, dive shops, among other (Taylor *et al.*, 2006).

Fishing has been an important activity since the time when the islands were first settled, due to the archipelago's rich marine environment and still remains for some of the locals as their main income (Taylor *et al.*, 2006).

Another pillar is the high interest in scientific research and in conserving the islands' unique ecosystem. The work of scientists and conservation agencies is not only devoted to protect the Galápagos environment, but it also inserts monetary income into the Galápagos economy and is a growing important source of revenue increase. The two most important institutions are the Galápagos National Park Service and the foreign non-governmental organization Charles Darwin Foundation (Taylor *et al.*, 2006).

As a consequence off the growth of population and tourism, the governmental body of the Islands expanded. The Galápagos National Park is responsible to control and maintain the rules for the park. It stimulates the economic growth by the tourist entrance fee and other activities (Taylor *et al.*, 2006, p.4).

According to Figure 10, the main economic driver in the archipelago is tourism. Another important economic support is the contribution of the public sector. Non-governmental institutions and fishing only plays a minor role in the economic income generation (Taylor *et al.*, 2006; Epler, 2007).

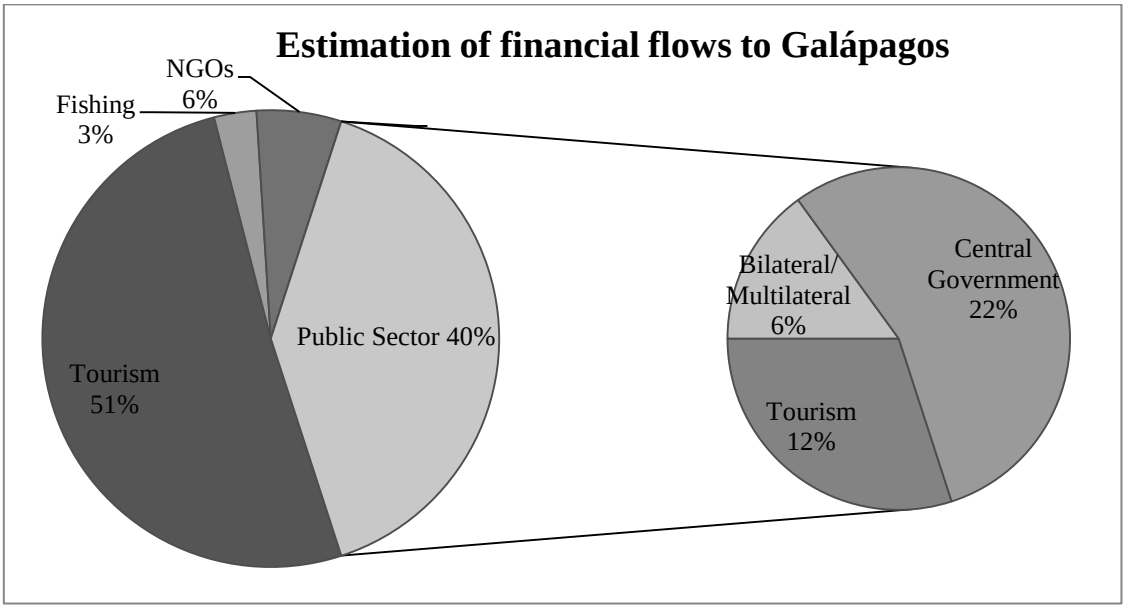

Figure 10: Estimation of financial flows in % to Galápagos

Source: Taylor *et al.*, 2006; Epler, 2007

4.7.1 Labor Activities

As Table 9 depicts during 2010 the main labor activities in the Galápagos Islands are related to transportation (15.2%), followed by trade (14.3%) and tourism sector (14.2%). Residents devoted to public administration amounts for 12.8% and the agricultural, stock farming and hunting sector sums up to 8.4% (INEC, 2010).

Further, Table 9 shows the distribution of labor in the three main inhabited islands Santa Cruz, San Cristóbal and Isabela. It demonstrates that most residents of the island Santa Cruz are dedicated to transportation, trade and tourism (46.6%), in San Cristóbal the main activities are related to public administration and defense (22.8%), while for Isabela the principal activity was identified to be trade and tourism (33.5%) (INEC, 2010).

Table 9: Labor activities in % in Galápagos

Labor activtiy	Galápagos (%)	County		
		San Cristóbal (%)	Isabela (%)	Santa Cruz (%)
Transport	15.2	11.4	10.9	18.0
Trade	14.3	12.2	17.6	14.9
Public administration and defense	12.8	22.8	11.5	7.5
Hotels and restaurants	14.2	8.7	15.9	13.7
Agriculture, stock farming and hunting	8.4	8.6	11.7	7.8

Source: INEC, 2010, p.231

4.7.2 Income Level in Galápagos

A family consisting of four members in the Galápagos Islands received an average net income of about US$ 856 to US$ 4783 per month in 2010 depending on the source of employment and island. This indicates a net income per capita of US$ 214 to US$ 1196 monthly. As the following Table 10 illustrates the highest income groups in the archipelago are found in the governmental sector, followed by self-employees. The lowest average income group presents the private sector. Besides, the Table shows that Isabela receives the highest governmental main income, but also the lowest private median income level. Further, according to a study of INEC (1998), Isabela also depicts high cost of living in the archipelago. Compared to San

Cristóbal the purchasing power is much lower in the island Isabela than in San Cristóbal. In the case of the island Santa Cruz, residents receive a medium average family income, but at the same time the cost of living in Santa Cruz are 8% higher than in San Cristóbal. That is to say, that the income gap between the two islands is greater than the difference in the cost of living, meaning an increased purchasing power appearing in Santa Cruz (Fundación Natura and WWF, 2001; INEC, 2010).

Table 10: Average primary US$ income level per month by employment in Galápagos in 2010

	County		
	San Cristóbal	Isabela	Santa Cruz
Government (in US$)	2091	4783	2082
Private (in US$)	977	856	1216
Self (in US$)	1206	1351	1578
Average (in US$)	1425	2330	1625

Source: INEC, 2010, p.240

4.7.3 Monthly Income and Expenditure Structure

With the aim to get a closer and more defined view of the difference in income levels and to identify the distribution of income in the archipelago the income levels were divided into five groups (each group containing 20% of the population) in the following Table 11. Consequently, the first group appears to be the poorest and the last group the richest in terms of income. The lowest average income amounts for $ 647, while the average households expenditures exceeds to $ 1227. The last income group amounts for $ 3204 and average households' expenditures of $ 2681.

Table 11: US$ income and expenditure structure per month in the archipelago

	Galápagos	Group 1	Group 2	Group 3	Group 4	Group 5
Average household income (in US$)	1732	647	1114	1638	2063	3204
Average household expenditure (in US$)	1861	1227	1407	1875	2114	2681

Source: INEC, 2010, p.278

4.8 Tourism

Galápagos has been undergoing a rapid change that began in 1992. Tourism has grown economically by 14% annually from 1992 until 2007. This extreme growth rate has reached these levels due to the introduction of tourism boats and ships capable of transporting a high number of visitors. Further, today the ships and boats operate more days and the operators are working on average 222 days a year. At the same time, the average number of days that tourists stay in Galápagos has decreased. These changes have allowed tourism to grow at a fast pace (Epler, 2007, p.19).

Also the tourism in hotels increased rapidly. From 1991 until 2006 the accommodation capacity of visitors has grown from 880 to 1668 guests. This indicates an annual growth rate of approximately 4.8%. And also the quantity of restaurants and bars has grown from 31 to 114 (Epler, 2007, p.16).

The immense increase in tourist arrivals and the consolidation between the conservationist and tourist sectors triggered a radical change in the economics of the islands. Traditional activities such as agriculture, livestock and later fishing became less important, while tourism emerged as a main economic sector with a vast potential for continuous growth (Staces and Fuks, 2007).

As the following Figure 11 displays the highest number of tourists who entered the islands during 2012 were Ecuadorians with a representation of 30.8%, followed by citizens of the United States who represent 26.8%. Other frequent nationalities with lower percentages are the United Kingdom, Germany, Canada and Australia. National visitors come mostly from the province of Pichincha with 44.7%, the province of Guayas represents 30.9% and some other provinces (Parque Nacional de Galápagos, 2013).

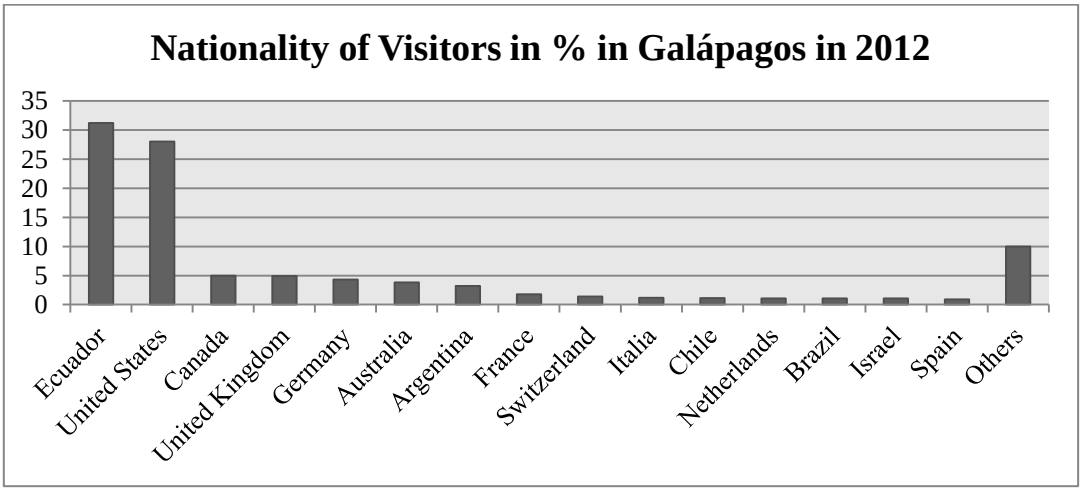

Figure 11: Nationality of Visitors in the National Park of Galápagos

Source: Parque Nacional de Galápagos, 2013

According to the Charles Darwin Foundation (2010, p.94), the main motives for visiting the archipelago is the realization of the observation of wild life, geology and landscape (59%), while 21% of the visitors indicate the main reason to be relaxation and nature, 16% mention sports and adventure and 4% are aiming the contact to the community. Especially, the sport activities and the observation of wild life can result in damaging effects to the biodiversity of the islands, if implementing and performing the tourist activities in a wrong manner.

Furthermore, according to a guide survey in the annual report of Galápagos of the Charles Darwin Foundation (2010, p.135f), the general Ecuadorian tourist does not show much respect for nature conservation or cultural tradition, nor a high interest in the scientific research facilities in Galápagos. On the other hand, the international visitor respects the National Park rules and is interested in conservation and scientific research. Their level of knowledge about Galápagos is greater than national tourists and thus they have a great deal of interest in the nature of Galápagos.

4.9 Transportation

The province makes up a total length of 183 kilometers of roads. Of this total, 72 km belong to the primary network roads, 34 km to secondary roads, 16 km to tertiary roads and 61 km to connection roads of the neighborhood (Senplades, 2010, p.18). After a considerable increase in vehicles, INGALA launched in 2009 a regulation which requires justification for importing a vehicle in the archipelago. A census conducted in 2009 identified a total of 1962 terrestrial vehicles in the five populated islands. The study showed that the largest number of vehicles is on Santa Cruz (1074), followed by San Cristóbal (699), Isabela (154), Baltra (24), and Floreana (11). The majority of vehicles were specified for personal use (1144), followed by commercially owned (610), for personal use in business (181), and for public transport (27) (Oviedo *et al.*, 2010, p.49f).

Galápagos has in total five ports: Puerto Ayora, Baltra, Puerto Baquerizo Moreno, Puerto Villamil and Puerto Velasco Ibarra. For transportation of passengers and local people coming to the island by airway, the archipelago incorporates three airports located on the islands Baltra, Isabela and San Cristóbal. The transport of passengers and cargo between the islands can be through a local airline or by sea with several transportation agencies on speedboats (Senplades, 2010, p.18).

The products derived from petroleum for the demand of the Galápagos Islands are supplied from the refinery La Libertad. Petrocomercial, a state owned enterprise transports fuel to the

region, delivering three types of fuel: diesel, high-octane gasoline, and liquefied petroleum gas (Fundación Natura, 2003). The archipelago has three service stations one in Puerto Ayora (Santa Cruz), another in Puerto Villamil (Isabela) and also one in Puerto Baquerito (San Cristóbal). The electricity company of Galápagos has described the consumption of diesel which is imported for the demand in the province of Galápagos to be 10.8 million liters in the year 2013 (Elecgalápagos, 2013).

5 Galápagos Energy Profile

The following chapter provides information about the general and specific issues (governmental, technical, and environment) regarding the energy constitution on the Galápagos Islands, in order to present a general idea of the energy supply and demand.

5.1 Institutional Framework

The Government of Ecuador organizes its institutional energy framework through two main actors: the Ministry of Non-Renewable Natural Resources (Ministerio de Recursos Naturales No Renovables) and the Ministry of Electricity and Renewable Energy (Ministerio de Electricidad y Energia Renovable, MEER).

The main task of the Ministry of Non-Renewable Natural Resources is to guarantee a sustainable exploitation and efficient use of fossil fuel and mining resources; and to control the policies and institutional framework in the sector. The policies have firstly to be approved by the President of the Republic, and then will be executed by the national petroleum company, namely Petroecuador. Petroecuador is a state company which exploits fossil fuels in order to generate resources for the development of Ecuador.

The second ministry, MEER is specialized in the sector of electricity and renewable energy and is responsible for designing and implementing policies and programs regarding renewable energy development in the country. The main purpose of the MEER is to serve the Ecuadorian society, through the formation of a national policy for the electrical sector and for project management (Rosero *et al.*, 2011). Besides, its responsibilities are to organize, to regulate and to implement energy policies with the approval of the President. Simultaneously to the constitution of the new ministry MEER, the national government approved in the constitution under Article 15 which declares that the State shall support the use of environmentally friendly energy sources, as well as Article 413 in the constitution stating that the State shall promote the development of energy efficiency, support the use of environmentally clean technologies and practices as well as to ensure food sovereignty and balance the ecological ecosystems and water rights (Curbelo, 2010).

Two other important institutions regarding the energy framework are the National Electricity Council (Consejo Nacional de Electricidad, CONELEC) and the National Center of Energy Control (Centro Nacional de Control de Energía, CENACE).

CONELEC is responsible for assigning the activities of electricity generation, transmission, distribution and commercialization to concession enterprises. It also regulates, organizes and

delegates the setting of tariffs and rural electrification. Furthermore, CONELEC serves to regulate the electrical sector and assures compliance with legal dispositions, rules and other technical regulations of electrification in the country, in accordance with the national energy policy (Rosero *et al.*, 2011). Besides, it is in charge of organizing the information system among all stakeholders, monitoring the production, fuel consumption, availability, billing for consumption, losses, failures, energy balance, stopping and reconnection of supplies, and quality control (Faisal, 2012).

CENACE was created in 1996 and is a non-profit organization. Its main responsibilities are the sale of electricity in wholesale markets and retailers in order to meet electricity demand. Companies of transmission, generation, distribution and large consumers chair the Board of CENACE (Rosero *et al.*, 2011).

With reference to biofuels the governing body on this issue is the Coordinating Ministry of Production, Employment and Competiveness (Ministerio Coordinador de Producción, Empleo y Competividad, MCPEC), chaired by the National Biofuels Board, a multi-sectorial body composed of various biofuels related Ministries, state companies and private sector representatives (Rosero *et al.*, 2011).

Another institution is the National Company for Generating and Transmission (Corporación Eléctrica del Ecuador, CELEC) which controls the electricity generation and transmission in the whole Ecuador (Faisal, 2012).

Besides of that, the National Company of Electricity Transmission (Corporación Nacional de Electricidad, CNEL) together with 10 other companies are in command off the electricity distribution in the Ecuadorian territorial (Faisal, 2012). However, distribution companies have to face electricity shortages due to water scarcity during the dry season. At the end of the 90ies the Ecuadorian government has repeatedly tried to privatize the energy distribution sector, yet each attempt has failed due to the opposition from Congress, objections by labor unions and rural activists, and not sufficient interest from private investors (EREA, 2013).

Considering the province of Galápagos, the local electricity company ELECGalápagos started a power production based on diesel generators, modernized power lines and improved operation conditions, to ensure high quality standards of electricity services. Today it is a private company whose shareholder are: Solidarity Funds, the provincial government and local municipalities. During its short operation time, ELECGalápagos has implemented measures to improve the quality of service. For instance, outsourcing processes has been

undertaken as well as the consultation of technical support from the mainland (Lahmeyer International, 2004, p.19).

The main laws which support the renewable energy projects are the "Special Law for the Conservation and Sustainable Development of Galápagos" (Ley de Régimen Especial para la Conservación y el Desarrollo Sustentable de Galápagos) and the "Electrical Sector Regime Law" (Ley de Régimen del Sector Eléctrico).

The first law establishes new legal regulations, in order to define the conditions of human immigration control and a decentralized policy regarding sustainable development of the province. Further, it integrates the communal organizations into the political context, and thereby reinforces the concept of participative management (Lahmeyer International, 2004, p.24).

The second law defines the deregulation and the opening of the Ecuadorian electricity sector. Besides, this act establishes the Rural and Urban Marginal Electrification Fund (Fondo para la Electrificación Rural y Urbana Marginal, FERUM). The fund is developed by the contribution of the energy consumer sector (commercial and industrial), in order to cover investments in rural electrification (Lahmeyer International, 2004, p.24).

5.2 Fossil Fuel Consumption

The main energy consumer in the archipelago derives from the tourism sector, the power sector, fishing, and overland transportation. In the past decades, these demands for energy were met by fossil fuels (diesel, gasoline, and liquefied petroleum gas) which were all imported from the Ecuadorian mainland. Table 12 shows the type of resources being used for the energy consumption of the Islands and their potential environmental risk.

Table 12: Overview of energy source in the Galápagos Islands in 2001

Energy Usage	Energy Source	Environmental Risk Association
Electric power	Diesel fueled generators	Spilled fuel is contaminating the water supplies; ozone emissions, gross particulate emissions
Outboard boat motors for fishing	Gasoline mixed with oil	Unburned, poisonous gasoline and oil are introduced into both water and air
Inboard boat motors for fishing and tourism	Diesel engines	Spilled diesel fuel is toxic to aquatic life; air pollution through high sulfur amount,
Motorcycle motors	Gasoline mixed with oil	Unburned, poisonous gasoline and oil are introduced into the air
Truck and car motors	Gasoline	Due to transportation Galápagos gasoline is mixed with water, thus resulting in an inefficient burning, and subsequently pollution of the air

Truck and bus motors	Diesel fuel	Spilled fuel is contaminating the water supplies; air pollution
Tourist hotels	Primarily diesel generated electricity	Spilled fuel is contaminating the water supplies; air pollution

Source: Kreider and William, 2001

The fuel consumption has been increasing in recent years as Figure 12 demonstrates. The amount of barrel of oil equivalent (BOE) has doubled in the last ten years between 2000 and 2008. In the year 2009, a slight reduction of the BOE can be observed. Notably 77% of the total fuel consumption was consumed by the transport sector and 19% was used for the electricity generation. The fuel consumption per capita for the archipelago and the national average are respectively 15.5 BOE/year/person and 5.0 BOE/year/person (Curbelo, 2010, p.30).

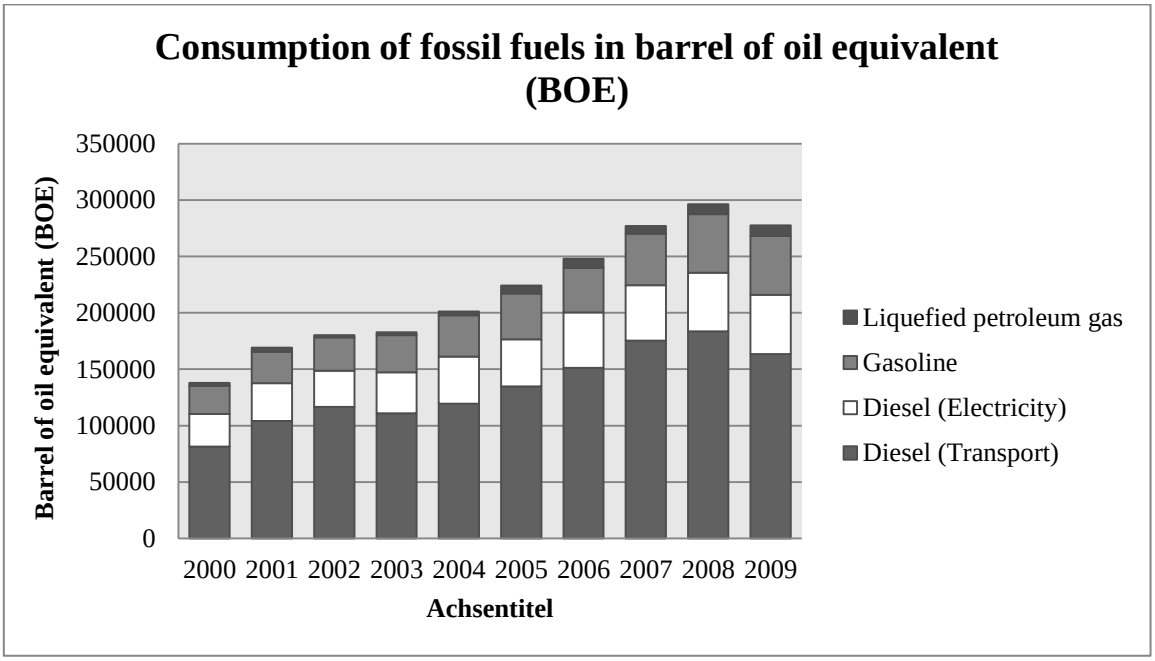

Figure 12: Consumption of fossil fuels in BOE

Source: Curbelo, 2010, p.31

Figure 13 depicts the consumption of diesel and gasoline by sectors for 2001. It demonstrates that the main consumer of diesel is the tourism sector (60%), followed by electricity generation (26%), the institutions (8%), the fishing sector (4%) and the transportation (2%) (Fundación Natura, 2003).

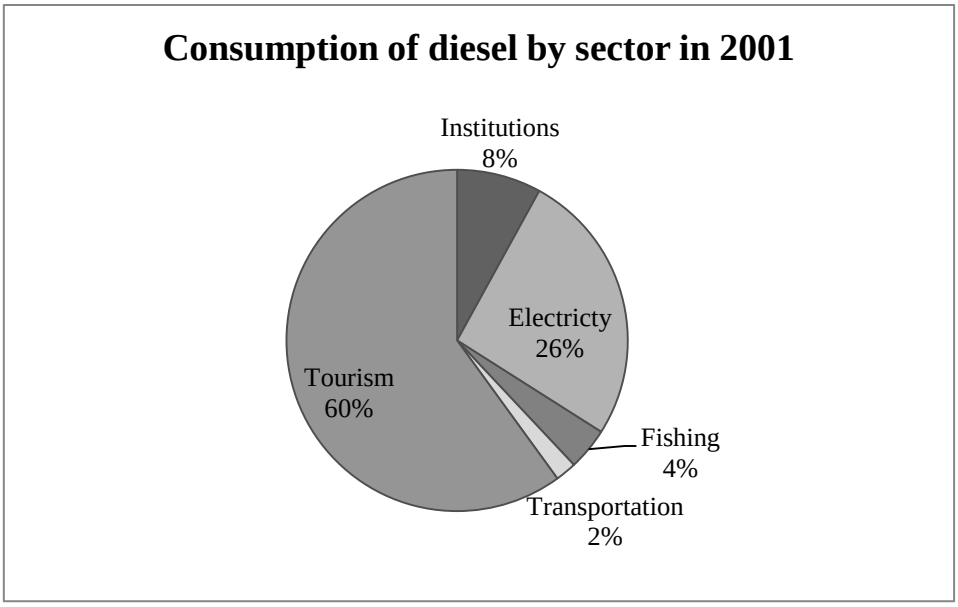

Figure 13: Consumption of diesel by sector in the archipelago in 2001

Source: Fundación Natura, 2003

On the other hand, the proportion of the use of gasoline varies. Figure 14 shows that the main consumers of gasoline are the transportation (41%), fishing (31%), tourism (23%) and institutions (5%) (Fundación Natura, 2003).

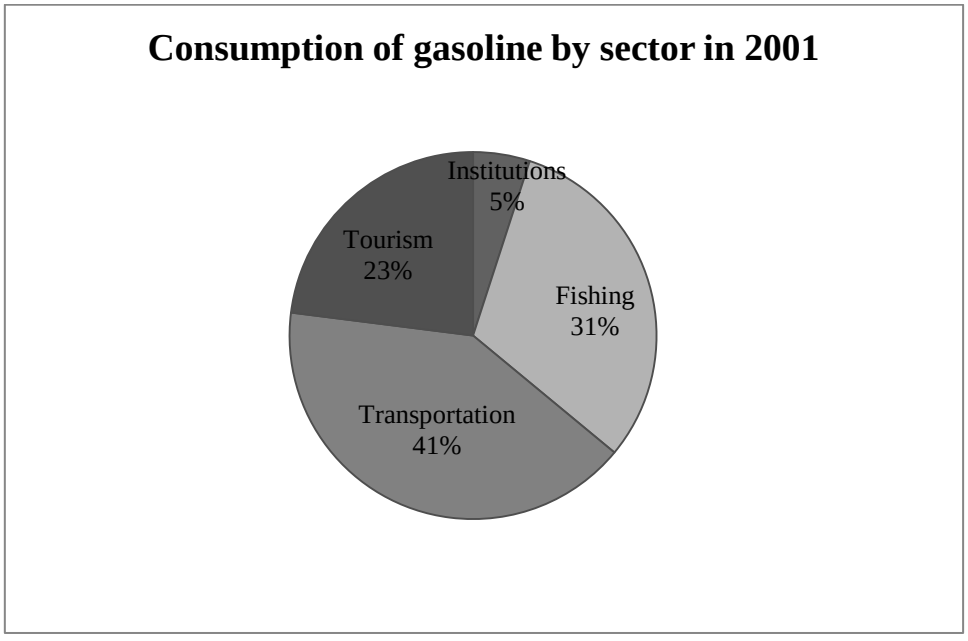

Figure 14: Consumption of gasoline by sector in the archipelago in 2001

Source: Fundación Natura, 2003

Taking into account the demand for diesel and gasoline, the tourism sector (41.5%) has the highest share of the volume of the fuels, followed by transportation (21.5%), fishing (17.5%), electricity (13%) and the use in institutions (6.5%).

5.3 Electricity Demand and Supply

In the archipelago almost 98% of the electricity is produced by diesel generators. Thereby inefficient and old generators (mostly comes from the 80s or 90s) are used. Figure 15 demonstrates pictures of the diesel generators in operation on the island San Cristóbal. Further, in annex A.5 an overview of the currently installed power plants on the Islands are given.

Figure 15: Diesel Generator in San Cristóbal

Source: Own Picture

Table 13 shows the electricity supply in kWh from 2007 to 2012 in the archipelago. It shows that the electricity consumption has steadily increased over the last five years. Further, it reveals the electricity quantities generated by sources, such as wind, solar, biofuels and non-renewables. Still in 2012 a total of 96% of the electricity supply came from non-renewable sources, and only 6% were generated from renewable sources. A quantity of 22.241,33 tons of CO_2 was emitted in 2012 as can be seen in annex A.6 (Elecgalápagos, 2013).

Table 13: Electricity supply in kWh by resources from 2007 to 2012

	2007	2008	2009	2010	2011	2012
Wind (in kWh)	962.135	2.682.461	3.204.893	3.434.854	3.344.626	2.398.373
Solar (in kWh)	18.162	26.687	7.874	16.376	17.851	16.744
Biofuels (in kWh)	-	-	-	-	32.006	87.721
Non-renewable (in kWh)	25.215.843	26.814.975	28.471.120	29.271.035	31.831.799	36.638.946
Energy supply (in kWh)	26.196.140	29.524.123	31.683.886	32.722.265	35.226.282	39.141.784

Loss of energy distribution (in kWh)	9,55	7,09	7,87	9,13	7,69	7,49

Source: Elecgalápgos, 2013

Table 14 depicts the electricity coverage in the archipelago. The urban coverage shows a slightly higher cover percentage than the rural coverage. With a total coverage of 98.8% the Galápagos Islands account to one of the highest electricity coverage in Ecuador (Elecgalápagos, 2013).

Table 14: Electrification in % in the archipelago in 2012

Type of electrification	%
Total	98,8
Urban	99,3
Rural	96,4

Source: Elecgalápgos, 2013

Figure 16 demonstrates the electricity demand of the archipelago by sectors from the years 2000 to 2007. It displays that the total electrical energy demand over the last years has steadily increased to a total growth of 61% in the electricity consumption. Santa Cruz is the island with the highest consumption of about 1.184.366 kWh, followed by San Cristobal with a consumption of 522.653 kWh, and finally Isabella with a consumption of 136.237 kWh. However, the consumption growth over the past eight years in the province of Galápagos showed that the highest growth was recorded on Isabela with 88%, followed by Santa Cruz with a growth of 71% in electricity consumption and finally San Cristóbal with a growth of 39%. The highest electricity demands are found in the residential (45%), commercial (29%) and official unit (12%) sectors. Minor roles in the energy consumption play the industry, public lighting or other (Montenegro, 2010, p.89).

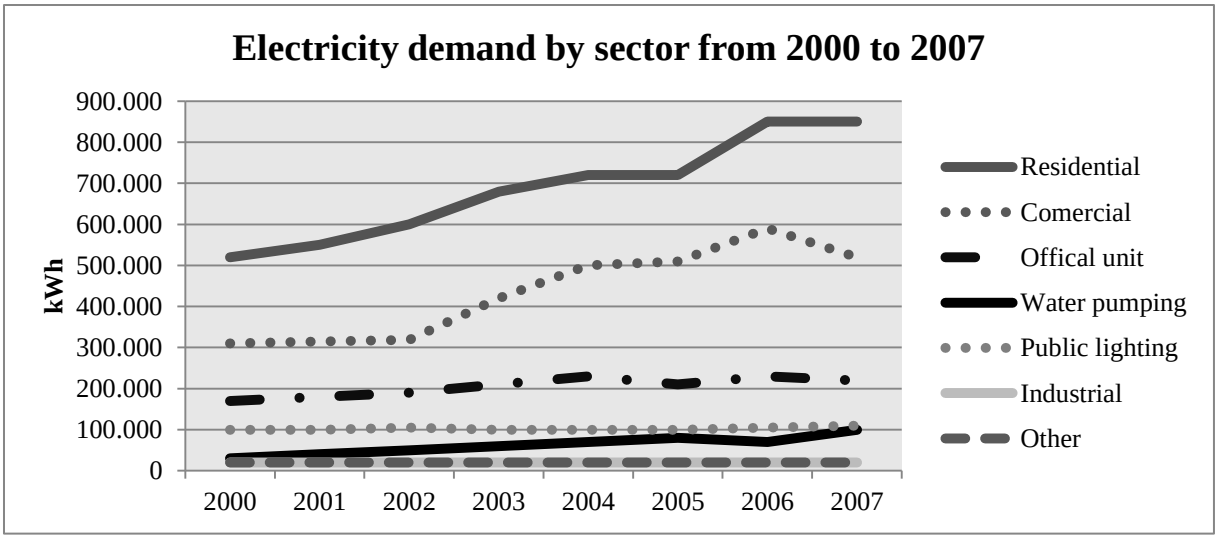

Figure 16: Electricity demand by sector from 2000 to 2007

Source: Montenegro, 2010, p.89

Another central aspect that plays an important role in the energy sector is the subsidy policy in Ecuador for fossil fuels. The government of Ecuador has approved to subsidize the electricity costs, in order to keep the costs of the archipelago to an equivalent electricity price to the mainland. This subsidy has been consistent for the last decades by all political parties that have taken power in Ecuador. Subsidies aim firstly to support initial investment and secondly to continue to pay the operational deficits (Lahmeyer International, 2004, p.15). However, Figure 17 shows that rising international prices or rising production costs associated with additional demand growth increase the governmental subsidies every year dramatically, in order to ensure that the end consumer maintains to pay the same end price (Montenegro, 2010, p.94).

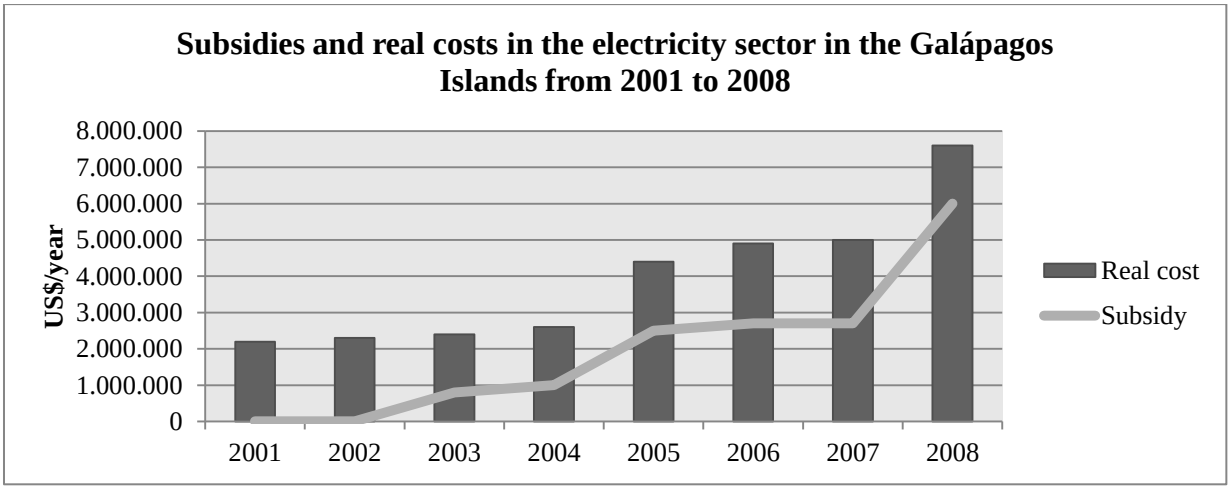

Figure 17: Subsidies and real costs in the electricity sector in the Galápagos Islands from 2001 to 2008

Source: Montenegro, 2010, p.94

5.4 Current State of Energy System Development

The implementation of a sustainable energy development strategy in the archipelago has its roots in the project "Cero Combustible Fósiles para Galápagos". The project is implemented under the agreement signed in April 2003 between the Government of Ecuador and the United Nations Program for Development (UNDP) (ERGAL, 2007).

The project involves the implementation of renewable energy systems in the four inhabited islands of the archipelago: Floreana, Isabela, San Cristóbal and Santa Cruz. The realization of each project is agreed by the government of Ecuador together with other institutions involved. Further, each project is run separately under the coordination of ERGAL which acts as an umbrella project. Table 15 illustrates not only the planned projects for each island, but also the institutions responsible for the financial contribution. It reveals that various international organizations are involved in the financing and funding for the renewable energy projects (ERGAL, 2007).

Table 15: Renewable energy projects in the Galápagos archipelago

ERGAL				
Island	**Floreana**	**San Cristóbal**	**Isabela**	**Santa Cruz**
Projects	Central PV (30 kW) Dual bio-diesel generators (2x 69 kW) Optimization of fuel storage systems	Wind farm (2.4 MW)	Central PV (350 kW-500 kW) Dual bio-diesel generators Optimization of fuel storage systems	Wind farm: Phase I: 2.5 – 3.5 MW Phase II: 6MW – 7MW Phase III: > 15MW New thermal diesel-biofuel power generation Transmission lines from Baltra to Puerto Ayora
Institutions and Organizations	Ecuadorian government, Spanish cooperation and NGOs	Ecuadorian government Group e8 and UN Foundation	German government (KfW)	Ecuadorian government Global Environment Facility (GEF) and UN Foundation

Source: Ergal, 2007

One cornerstone of the project is the use of the pine nut *Jatropha Curcas* as a substitute of fossil fuels. Currently, on the island Floreana a pilot project is implemented, in order to

evaluate its potential for the use in the whole archipelago. According to a feasibility study, the use of the pine nut *Jatropha Curcas* which is cultivated on the mainland in the Province of Manabí, Ecuador as a biofuel is economic, environmental and technical feasible. Especially, in the mainland the province of Manabí which presents problems off desertification, drought and poverty, is a suitable region for the *Jatropha Curcas* cultivation. The intended purpose of the project is to help concurrently two regions of Ecuador one which encounters environmental and socioeconomic problems (Manabí) and the other where fossil fuels depict a potential risk of oil spills (Galápagos). The feasibility study of the "German Society for International Cooperation" displays that the quantity of jatropha plant located in the Manabí province would be adequate to replace the fossil fuel needs in order to meet the energy demand in the archipelago (ERGAL, 2011, p.8).

The pine nut oil is extracted from the plant, has similar characteristics to diesel and requires only a simple technological process (DED, 2008, p.9). Table 16 below shows that the vegetable oils have a higher viscosity and density, which might be a principal problem for their use as combustion fuel. Vegetable oils and biodiesel with an energy density of 9.2 kWh per liter and 8.9 respectively are located between gasoline (8.6 kWh) and fossil diesel (9.8 kWh), resulting in a slightly higher consumption. A major advantage of biofuels is their lower sulfur content, which is more favorable for the environment. Vegetable oil is considered to not pollute water due to a biodegradation of 95% in 21 days, while biodiesel is considered to be slightly more harmful to the water. The comparison highlights that the vegetable oil is the most environmental friendly combustion fuel (DED, 2008, p.67). Thus, the main reasons for the implementation of biofuel-run engines are the better qualities regarding environmental parameters compared to fossil diesel. The release of pollutants in transformed engines is low compared to fossil diesel, they discharge low sulphur content, and they is barely no or not at all polluting to the water and soil (DED, 2008, p.28).

Table 16: Characteristics of vegetable oil, biodiesel and diesel

	Vegetable oil	Biodiesel	Diesel
Physical characteristics			
Density (kg/L; 20°C)	0.90- 0.92	0.88	0.85
Viscosity (mm^2/s, 20°C)	60 - 80	7 - 8	4,7
Boiling point (°C)	>220	135	60

Freezing point (°C)	-8 to -18	-12	-12
Chemical characteristics			
Phosphorus content (mg/kg)	< 15	< 15	
Sulfur content (mg/kg)	< 10	< 100	>100
Chemical behavior	Slow	Rapid	Explosiv
Energy density (kWh/L)	9.2	8.9	9.4

Source: DED, 2008, p.67

In order to provide and guarantee an effective and efficient implementation of each project, the ERGAL initiative exposed as shown in Table 17 five dimensions of sustainability and their corresponding indicators and strategies. These include the efficient use of resources, technological diversification, a secure energy supply, flexibility to meet the energy demand, and a minimal impact on the flora and fauna. Through the mechanism of sustainability ERGAL ensures an adequate realization and operation of renewable energy systems in a highly vulnerable environment such as the Galápagos archipelago (ERGAL, 2007).

Table 17: Dimensions towards a sustainable energy system

Dimension of sustainability	Indicator	Strategy
Effectiveness	Efficient use of resources	Decrease distribution losses and increase efficiency in end uses
Elasticity	Technological diversification	Flexibility of the energy systems (wind, solar and biofuels)
Security	Energy supply	Gradual substitution of imported fossil fuels through renewable energy source
Adaptability	Flexibility to meet demand	Hybrid power generation system capable of adapting to the dynamics of energy demand
Coexistence	Minimal impact on ecological systems	Remove pollution and minimization of impacts during construction and operation of facilities

Source: Ergal, 2007

Besides the contribution of the government of Ecuador of about $ 12 million, the renewable energy projects are supported by several agencies: The GEF contributes $ 3.2 million for the co-financing of the wind project in Baltra-Santa Cruz. Besides, the organization donates once about $ 500,000 for studies and operating expenses of the management. The Government of

Germany through the KfW provided a non-refundable contribution of 7.86 million €, in order to improve the photovoltaic systems and to enhance the fuel storage plants in Isabela. The e8 fund has made a donation of 5.5 million dollars for the construction of the wind farm on San Cristóbal. The UN Foundation has made a donation of $ 1 million for co-financing the wind farm in Santa Cruz and San Cristóbal. The international Spanish Cooperation, made a contribution of about 179,000 €, through its program Araucaria-Galapagos for the photovoltaic project in Floreana (Ergal, 2007).

5.5 Components of ERGAL

In 2007 the government of Ecuador has started the initiative "Cero Combustibles Fósiles en Galápagos" with the purpose to reduce drastically the consumption of fossil fuels at the Galápagos Islands by the year 2015. The main components of the initiative involve primarily biofuels, wind and solar energy. The strong cooperation with international partners has led to the development of many projects in the four inhabited islands, which will be described in the following section.

5.5.1 San Cristóbal

The main action of the restructuring in San Cristóbal included the installation of a wind park which was supported by the GEF (Global Environment Facility) and the e8 and is registered under the Kyoto's Protocol Clean Development Mechanism. It is a non-profit wind project implemented under a new and unique public–private partnership trust and is managed entirely by the corporation Wind San Cristobal EOLICSA (Eólica San Cristóbal S.A). It is a private company, which will transfer its assets after seven years of business to the provincial power company Galápagos ELECGalápagos (Empresa Eléctrica Provincial Galápagos), which will be then in charge to operate and control the performance of the wind park (e8, 2008, p.9).

In October 2007 the wind park of San Cristóbal was launched, and is operating with a capacity of 2.4 MW at the Tropezón Cerro. Three wind turbines from MADE Model AE59 with 59-meter diameter blades and 51.5 meter hub height, and a capacity of 800 kW each were installed. Figure 18 shows pictures of the wind park in San Cristóbal. The generated power is gathered in an electrical collector, and then transported to a transmission line. Leaving the wind park, the first three kilometers of the line run underground to minimize the possibility of collision with the bird endangered Galápagos Petrel (*Pterodroma phaeopygia*) and the electric grid. However, there is still the risk of a collision between the bird and the wind turbine. The transmission line then converts into an aerial conductor for approximately nine kilometers where it finally ends at the current distribution system at the diesel plant.

However, the San Cristóbal wind project does not include energy storage provisions due to maintenance and environmental considerations (e8, 2008, p.27).

Figure 18: San Cristóbal Wind Park

Source: Own Picture

The wind-diesel hybrid system supplies about 50% of the island's electricity needs, though in months of higher wind speed maximum values of about 80% were reached. However, due to the absence of sufficient wind speed during four months, it is still necessary to continue using diesel-generated electricity (e8, 2008, p.36).

A preliminary environmental impact study was prepared in order to determine the project's feasibility. The environmental impact study includes a 15-year Environmental Management Plan for the project with long-term monitoring of the endangered Petrel and provisions for mitigation and enhancement of the bird's population (e8, 2008, p.23).

As Table 18 demonstrates the wind farm is expected to significantly reduce the consumption of fossil fuels in the islands of San Cristóbal. According to the HYBRID2[3] software, during the time period from 2008 till 2028, the wind energy increases, while the diesel displacement decreases to 42% (e8, 2008, p.35).

[3] Hybrid Power System Simulation Model which uses time series data for loads, wind speed, solar insolation, temperature and the power system designed or selected by the user, to predict the performance of the hybrid power system

Table 18: Expected results of power demand (kWh) and diesel displacement (%) at the San Cristóbal wind park

Year	Power Demand (kWh)	Wind energy delivered (kWh)	% Diesel displacement
2008	7,981,164	4,126,164	52
2013	10,186,114	4,887,240	48
2018	11,808,498	5,375,724	46
2023	13,689,286	5,932,941	46
2028	15,869,643	6,626,638	42

Source: (e8, 2008, p.35)

The relatively frequently occurrence of power failures has affected the quality of service. Owing to the incidents of power breakdown, it is assumed that inhabitants of the island have created a negative attitude towards wind power, although it has contributed to the reduction of diesel consumption in electricity generation of the island (Curbelo, 2010, p.11).

5.5.2 Santa Cruz

The main renewable energy project on Santa Cruz is the installation and construction of a wind park on the island Baltra and a transmission line from Baltra to Santa Cruz and apart it would involve the relocation of the current diesel power station from Puerto Ayora to Baltra.

A preliminary environmental impact study indicated that the island Baltra, which is north and in the direct vicinity of Santa Cruz, to be a suitable location for a wind park. Baltra has favorable conditions for the installation of wind turbines such as a flat terrain, very scarce vegetation and ample space. The location of the wind park is close to the national airport in Baltra (Jargstorf, 2008, p.9).

The island Baltra demonstrates strong seasonal variation of wind speeds. Therefore, it only disposes a moderate wind regime with approximately 6 m/s annual hub height wind speeds (Jargstorf, 2008, p.10).

The installation of the project is managed by ERGAL. As Table 19 illustrates, the implementation of the wind park in Baltra is scheduled in three phases. The first phase contains a grid parallel operation (3x750 kW, with a wind energy penetration of up to 20%). The following phase involves the introduction to a wind/diesel system (allowing diesel-off mode, additional ~7x750 kW, battery storage, with a wind energy penetration of ~50%). The

ultimate phase comprises an additional wind power plus additional battery storage to power electric cars and other former fossil fuel consumers (maybe up to 20x750 kW, with a wind energy penetration >100%, plus additional photovoltaic generators (Jargstorf, 2008, p.13).

Table 19: Characteristics of phase I, II and III

Phase	Capacity (MW)	Diesel reduction	Inversion (in million US$)
I	2.5 – 3.5	25% – 35%	$ 6 – $ 7.5
II	6.5 – 7.5	50 – 60%	$ 6 – $ 8
III	>20	90% – 100%	-

Source: ERGAL, 2007

"Advanced communication lines (fibre optics) can be installed between the new thermal power plant and the wind park, in order to facilitate high-penetration operation of the wind park with approximately 50% wind energy penetration" (Jargstorf, 2008, p.11). The transmission line has a total length of 45 km and has been designed under strict criteria to minimize environmental and visual impacts on the islands of Baltra and Santa Cruz (ERGAL, 2007).

5.5.3 Floreana

The main renewable energy projects on Floreana consist of the construction of a photovoltaic plant designed to work with a diesel power plant operating in a complementary manner to meet the energy deficit of peak demand in cases of low sunlight weather conditions. As shown in Table 20, the first phase of the project included the construction of a photovoltaic grid at a building of the Junta Parroquial de Floreana in 2004. During this phase a photovoltaic plant with the capacity of 18 kWp was installed, which is connected to a battery bank and then to a system that transforms the direct current to an alternating current for the consumption of the inhabitants of Puerto Velasco Ibarra. Afterwards, two small, independent and decentralized photovoltaic systems with a total capacity of 4.3 kWp were installed to meet the needs of the owners of the farms located in the highlands of Floreana who do not have access to the network. Subsequently in May 2006, in order to increase the capacity of the photovoltaic plant an additional system with the capacity of 2.6 kWp was installed. Thus, Floreana counts in total a capacity of 24.9 kWp (ERGAL, 2011, p.7). The photovoltaic energy generation was implemented with funding from the MEER, the Spanish Cooperation Agency, the National Park Service, and funds from ERGAL, GEF and the Junta parroquial de Floreana (Curbelo, 2010, p.96).

Table 20: Energy capacity on the island Floreana

Phase	Installation	Capacity
I	Photovoltaic plant	18 kWp
II	Decentralized photovoltaic system	4.3 kWp
III	Additional system	2.6 kWp

Source: Curbelo, 2010, p.96

An essential point of the ERGAL initiative is the implementation of plant-based fuels (in particular *Jatropha Curcas*) as a substitute for diesel and gasoline, which is funded by MEER and a nonrefundable support by the German Federal Ministry of Environment through the GIZ (DED, 2008, p.8). In 2009, there were two electricity generation systems on the island installed with a capacity of 69 kWp each and are in operation since December 2010 (MEER, 2012).

Table 21 shows the biofuel consumption of Floreana from 2008 to 2017. It demonstrates a rapid and immense increase in the biofuel consumption. This development may arise through the increase of tourism activities in the Islands, as well as through the increased use of electricity by the local population.

Table 21: Biofuel consumption of Floreana Island in 2008-2017 in liter

2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
11.863 ,48	33.243 ,49	34.504 ,03	35.806 ,21	37.153 ,82	38.985 ,96	40.424 ,41	41.908 ,29	43.448 ,96	45.485 ,51

Source: DED, 2008, p.94

The project has achieved a 35% reduction of the diesel consumption, despite increased energy demand on the island. The present demand of electric energy of the island Floreana is of 58.014 kWh. By 2017, it is expected that the demand will be 186.658 kWh. According to this projection, the peak demand will grow from 23 to 59 kWh. Due to the excessive increase of energy demand on the island, the generator must cover the increase of the energetic demand (DED, 2008, p.25; ERGAL, 2011, p.7).

Due to technical problems the electricity system went out of service in 2009. The main reason for this power blackout was the increasing electricity demand of the population. As a

consequence, the system failed since the design conditions were not adapted to an increase of energy demand. However, this incidence of shortfall in electricity supply might have adversely affected the perception of people about the electrification with renewable energy sources (Curbelo, 2010, p.10).

5.5.4 Isabela

The project on Isabela will be funded by the government of Ecuador, the MEER and by another contribution of the KfW (Kreditanstalt für Wiederaufbau) group. The received donation should cover the cost of the construction of a hybrid power plant with a capacity of approximately 1.23 MW diesel/ biodiesel generated power, 1.15 MWp photovoltaic power, and a 3.3 MWh power storage system (ERGAL, 2013). The electricity generation of those renewable energy projects should provide an electricity demand cover of 70% on the island. New investment components include new facilities for storage of biodiesel, improved thermoelectric generation groups, improved distribution networks and training workshops for the community about the utility off renewable energy and energy efficiency. As Table 22 illustrates, in total, in Isabela are three energy generators installed with a potential of 310, 315 and 455 kW each (Curbelo, 2010, p.119).

Table 22: Generators in Isabella

Motor label	Motor model	Voltage (kV)	Nominal potential (kW)	Effective potential (kW)	kWh/gl.	Year
Caterpilar	3412	240	450	368,8	9,74	1999
Caterpilar	3408	240	310	248	10,39	1996
Dow Warner	350CA2	127 - 220	315	252	10,98	1993
Total			**1080**	**886,80**		

Source: Curbelo, 2010, p.119

Currently, the international tender and bidding offers are in the process of evaluation, in order to find a suitable company or association which will carry out the project (ERGAL, 2013).

However, up to date, only three of the planned projects have been implemented, so that the goal to have a complete renewable energy source supply by 2015 had to be delayed. Possible reasons for the slow implementation of the planned projects could be among others bureaucratic actions (e.g. licensing procedure). Further, on the Islands is a lack of professional

competencies that support the implementation of the project and inform the population. Moreover, there are not enough initiatives in order to achieve the planned electricity savings by energy efficiency. A final vulnerability of the project which was analyzed was that there are still no strategies developed in order to change the marine petroleum consumption. This fact is an enormous deficit in the project, as this sector consumes 75% of the total petroleum consumption of the archipelago. Felipe Cruz, rector of the technical assistance of the Charles Darwin Foundation, described this situation as:

> *"Hay una situación bastante patética, digo yo, en el tipo de planificación, y es que el consumo de energías, o combustible fósiles en las islas pobladas llega creo al máximo 25% en el consumo total de combustible fósiles en el archipiélago, el resto el 75% del consumo de combustible fósiles está en la reserva marina, la embarcación, flotando en la área protegida como yo lo llamo, lo cual al momento por lo menos no hay ni un solo esfuerzo sobre tratar de cambiar esta situación. Entonces la idea, o los planes del gobierno o la comunidad internacional de llegar a cero combustible fósiles es una utopía."*

Thus, the composition of the renewable energies on the archipelago is also a concern. The plan to cover the current production by 2015 to more than a third by jatropha will continue the dependency of the mainland. In addition, the food security discussion, even if it is asserted that the arable land for jatropha production does not compete on the continent with the food industry, remains an issue.

6 Results and Analysis

The following chapter presents and analyzes the results of the qualitative and quantitative methods. First, the results of the semi-structured expert interviews show and describe the current status-quo of the project. And then the results of the questionnaire identify the attitude of visitors and residents towards renewable energy technologies.

6.1 Semi- Structured Expert Interviews

6.1.1 Renewable Energies on the Galápagos Islands

A principal goal of the expert interviews was to detect the different viewpoints of actors involved in the project. The following section provides the results about the beliefs and opinions of the interview partners regarding renewable energies in the archipelago.

Renewable energy has the potential to play an important role in providing sustainable energy to the population who yet do not have access to clean energy. The use of renewable energy sources will decrease the demand for fossil fuels. Different to fossil fuels, renewable energy sources do not directly emit greenhouse gases. Due to the reasons above mentioned, in general, all the participants of the expert interviews approved and supported the implementation of renewable energy system in the archipelago. Moreover, the executive director Alfredo Mena of the NGO Corporación para la Investigación Energética, stated the following motives for reducing the use of fossil fuels:

> *"Yo diría que el mundo se está encaminando poco a poco al uso mayor de energías renovables. Por dos razones básicamente. La primer razón es porque de pronto se terminarán los combustibles fósiles y en algunos años pueden ser diez, veinte, treinta años en que las energías no renovables van a desparecer. Y la otra razón es que es necesario descontaminar el mundo porque hay mucho contaminación y las energías renovables van ayudar a eso."*

Asked about their vision about the renewable energy situation by 2050 in Galápagos, most experts imagined an independent energy archipelago. The largest parts of the energy demand should then be covered by solar and wind energy, as well as biofuels. María Casafont from the National Park of Galápagos described her vision as followed:

> *"Para mí como debería de ser idealmente sería que las casas y los hoteles poblados, cada uno individualmente tuviera su sistema de energía solar [...] Para que cada uno conozca y sea consciente del consumo, de lo que cuesta generar energía, y eso permite regular su propio consumo."*

Not only the crucial point of energy efficiency was mentioned, but also the importance to involve the rural area into a sustainable energy plan. According to Elicier Cruz, eco-regional director of WWF and further director of the National Park of Galápagos, the rural areas should have their own small solar and wind energy units, in order to avoid the construction of large electric supply network.

> *"Me parece que una cosa muy importante son todas los fincas y casas aisladas de las poblaciones de los centros poblados, que es un buen número, y que esos deberían tener un tratamiento aparte. Deberían tener sus propias estaciones fotovoltaicas y eólicas pequeñas para cada unidad, para cada finca, eso sería muy conveniente para evitarse una red tan amplia en distribución, ya que se pierde mucho en la distribución."*

From an environmental point of view, governmental interview partners approved the implementation of renewable energies in the archipelago. A preliminary environmental impact study was assessed in order to determine the feasibility of the implementation of the wind park in San Cristóbal. Due to the results of this impact assessment and also to assure a safe environment for flora and fauna the location of the wind park was changed. Adrian Moreno, working for the MEER, described the situation as followed:

> *"Lo que pasa es que también el tema ambiental, o el tema de flora y de fauna es muy importante. Entonces, si el proyecto en Cristóbal que está funcionando, tuvo que moverse el sitio porque en el anterior había mayor recurso, pero había anidación de una ave, entonces ahí bien el tema ambiental del parque, quien cuida mucho esto y pues viene las indicaciones y las recomendaciones de ellos de mover o de cambiar el esquema del proyecto por la población no, es más bien la parte que coordina lo que es ambiental."*

However, according to Felipe Cruz, there is still some discrepancy between environmental NGOs and the realization of wind parks on the Islands. In his opinion the main aim is to decrease the transportation of fossil fuels to the archipelago, with the intention to reduce the risk of oil spills in the fragile environment. He states that he is willing to accept minor visual impacts, in order to achieve this goal. Further, he expresses that the quantity of species is so low, that they hardly would hit a blade of the wind turbine.

> *"Desde mi punto de vista, y mucha gente en Galápagos concuerdan con eso, es mejor un poquito de impacto visual que el riesgo que traen los combustibles fósiles. Yo creo es una opinión bastante generalizada. Siempre va a existir la opinión de la comunidad científica que les encanta predecir desastres. Y siempre sacan a relucir los problemas en Europa, Estados Unidos con los molinos de viento pero la verdad es que los molinos de viento han sido usado por años [...] entonces yo personalmente el tipo de turbinas de viento que hay ahora son extremadamente eficientes y realmente no tiene*

un impacto. Y además Galapagos tiene una singularidad, que todos los especies en realidad tienen números muy bajos [...] que la posibilidad de que lleguen a chocar con una turbina de viento son realmente insignificantes."

6.1.2 Project "Cero Combustibles Fósiles para Galápagos"

Another aim of the realization of the expert interviews was to collect information about the current conditions of the project implementation. Main focuses during the interviews were technological, communicational and political aspects of the project.

From an economic point of view, the project creates temporarily during the construction phase additional place of employment. Also after the completion of the project, additional workforce is needed in order to provide maintenance and execution tasks. However, according to Adrian Moreno, one main concern is the deficiency of sufficient educated residents in the archipelago. He states that the residents are leaving the islands to be able to visit a university on the continent, and afterwards the minority returns to Galápagos. As a consequence workforce from the main continent or abroad has to be recruited, in order to carry out the assignments.

"También limita el personal o la gente de Galápagos, no tenemos formaciones tecnicas en las islas, no tenemos una universidad que forme ingenieros eléctricos, mecánicos, la gente siempre sale. Y esa, cuando sale pues generalmente fuera del continente ya no vuelve, me toca contratar a gente de afuera para que me desarrolle los actividades."

Another important issue is the popular subsidy policy of the domestic energy consumption in Ecuador. In order to make the price of petroleum more affordable to its citizens, the Government of Ecuador provides fossil fuel subsidies. This means that customers obtain fossil fuels such as petroleum at a very low price. This subsidy policy has severe consequences not only for the increase of demand but also for the environment. The demand for petroleum in Ecuador tends to grow, because the lack of change in fuel costs fails to provide any incentive for citizens to reduce their consumption. Subsidy policies are a very sensitive issue in term of political stability. A party's popularity among the people will be changing drastically by modification or removals of subsidies. Alfredo Mena describes the situation and the consequences as:

"El hecho del costo de la energía en Galápagos es muy alto, por la transportación de combustibles y toda esta cosa, es muy alto. Pero existe una política del gobierno de que los costos finales para los consumidores sean relativamente bajos. Entonces existen subsidios muy altos para la energía especialmente en Galápagos. Entonces el costo de la gasolina, el costo del diesel, el costo de los combustibles fosiles, es muy

> *alto. Entonces existe un subsidio del estado, del gobierno, que son impuestos para compensar la diferencia de los precios del consumidor final. Entonces si el precio de la energía no es suficiente es difícil que se tenga un sistema sostenible porque no va a poder crecer solo ni mantenerse solo, en base exclusivamente a los precios. Siempre habrán más y más subsidios"*

Regarding the project communication, the results revealed differences among governmental institutions and social and environmental cooperatives. In general, governmental institutions suppose that there is a sufficient level of communication of the project towards the local residents. However, environmental cooperatives criticize that there is a lack of communication and suggest that the government, the INER, the ministry of tourism, the ministry of environment and the Galápagos National Park should intensify them. Patricia Recalde portrays the situation as:

> *"Yo creo que la comunicación, este es el punto en donde le daríamos mucha fortaleza al proyecto. Mientras más se promueva el proyecto, mientras más se difunda, mientras más se comunique a la sociedad en la que interviene es más factible que ellos la acepten, la asimilen, se apropien de las metas, entonces va a dejar de ser una meta de estado, sino una meta de las gentes que lo oyeron y eso hace que defiendan el proyecto y que este tenga la sustentabilidad requerida. Por eso es que en Galápagos se debe luchar mucho en comunicar a la gente la importancia de que ellos son parte de esta iniciativa. No solamente hacer talleres de difusión sino hacer una campaña continua de comunicación que hable de los Zero combustibles fósiles, del proyecto Floreana, del proyecto Isabela, de los proyectos fotovoltaicos, de que Galápagos sería el archipiélago líder, digamos en tener independencia energética y eso les daría mucha motivación a la gente para también apoyar el proyecto."*

Although a part of the interview partner's doubt that there is enough information, involvement and integration of the community into the project, the acceptance of the community is estimated of both groups to be positive. Moreover, they believe that the residents trust and confidence of renewable energy systems increased, as stated by Adrian Moreno:

> *"La población esta muy contenta con este tema. Sobre todo porque los proyectos que hemos ido desarrollando han permitido que tengan más confianza y tengan más confiabilidad en los sistemas. Porque ya cuentan con mayor potencia instalada como para abastecer el suministro."*

Nevertheless, the wind park project in San Cristóbal had to face some community concern. After the construction of the three wind turbines, the community had initially power blackouts due to system failures of the diesel generators. However, the community blamed the new installed wind turbines to be responsible for these power failures. Although the reason for the

power blackouts was explained to the community, there is still a lack of trust towards the wind park, which is described by Patricia Recalde as:

> *"La empresa eléctrica Galápagos obviamente necesita mejorar su red, el sistema operativo en muchas ocasiones ha dado cortos de energía, o fallas en el sistema, que la gente acusan por el proyecto, y en realidad es una falla operativa del sistema del comando energetico de la central térmica. Entonces esas cosas hay que señalar a la población para diferenciar, que no es una falla del concepto del proyecto, lo que quita la luz, es una falla operativa de la empresa, porque está cambiando el control."*

According to the majority of interview partners the main problem of the project is the lack of a solution for the petroleum necessity of tourism cruisers and boats for fishery. About 75% of the fossil fuels in Galápagos are used for the boats of tourists. However, the project does not offer a substitute for the petroleum need of these boats. Felipe Cruz characterizes the situation as following:

> *"Desafortunadamente, no llegamos a lo que se quería ser que es crecer sosteniblemente, y todavía se habla sobre el desarrollo sostenible, que no existe, es una contradición."*

Another issue of the project is that the biofuels, which are one main component of the initiative, are produced in the province of Manabí, Ecuador. These biofuels also need tanker transportation from the mainland to the archipelago. Thus, the islands would still be under threat of an oil spill. Elicier Cruz characterizes this circumstance as followed:

> *"Yo creo también tiene que discutirse el tema de cultivo de jatropha, porque es una planta que antes existía en Galápagos. Todavía existe. Es introducida, pero no es agresiva, no hace daño, y que bien manejada se podría extender en Galápagos, y podría tener un porcentaje aqui en Galápagos. Porque actualmente se produce en Manabí, y no tiene mucho sentido traer en barco de Manabí acá. Porque igual la huella ecológica es muy alta.."*

Thus, he recommends the cultivation of jathropha on the Islands themselves, in order to decrease the ecological footprint and the risk of further oil spills. This proposal seems to be very risky in the context of introduced species in such a fragile environment.

Another fundamental brake of the project are the long-lasting bureaucratic steps. According to Luis Vintimilla, this might be one crucial barrier for a fast realization of such a project. Governmental processes always include temporal changes in the authorities which might slow down the process. Therefore, he suggests to include more the private sector into the realization of the projects, in order to guarantee a fast and effective implementation.

> *"Y ahí veo yo que justamente, es el manejo burocrático, para mí las principales barreras son esas, son fundamentalmente, ya que hay cambios permanente de autoridades del gobierno, cambios permanente locales. Es decir hay que dar un mayor rol al sector privado. Y si repito creo qe ayudaría un poquito si el gobierno dejara a la parte privada realizar un mayor impulso.*

Also according to Patricia Recalde, the project has to delay their goals for a couple of years. It seems not possible to achieve until 2015 a use of zero fossil fuels in the archipelago, as until now no adequate substitute is found for the petroleum motors of the tourism cruisers and smaller boats.

> *"Lo que si estamos viendo, la fecha si esta late un poco más, por este tipo de problemas, por ejemplo el sector marino que va a requerir un poco más de investigación para encontrarle el sustuto ideal. Pero de todas formas, es la mira del gobierno de llegar al zero combustibles aunque nos hemos pasado un poco de la fecha dada inicialmente."*

A final crucial point which might be included more into the projects is the energy consumption of the residents and visitors. The more efficient use of energy at all stages of the supply or demand chain would reduce the energy consumption. At a national level, improved energy efficiency implies reduced fuel imports to the archipelago. However, after the implementation of photovoltaic panels on the island Floreana, the energy demand increased dramatically. This severe growth of energy consumption is explained by Elicier Cruz as followed:

> *"Con el proyecto energía solar que se pusó primero en Floreana, un proyecto que se hizo con el Parque Nacional, con el gobierno de Catalan, de España, se montó un sistema fotovoltaico y eólico en Floreana, donde la energía era para las 24 horas del día. Tenían todo el tiempo energía [...] Pero cuando hubo energía todo el tiempo, todos empezaron a comprar sistemas eléctricos, cocina, refrigeradores, licuadoras, etcétera. Y el consumo se triplico. Entonces el sistema colapso. Entonces creo que primero necesitan una buena campaña de comunicacion [...] y tambien sobre todo el ahorro energético. Una campaña de ahorro energético. Porque si no siempre va a estar faltando energía, no?"*

Thus, according to him, even more important than the installation of renewable energies in the archipelago is a good educational campaign about an efficient use of energy. As a main goal of the ERGAL initiative is to reduce the consumption of fossil fuels drastically, it would be reasonably to enhance and improve the energy consumption of the population and visitors in the archipelago, as energy efficiency is a key tool in the fight against energy consumption growth and climate change by reducing greenhouse gas emissions.

6.2 Questionnaire

6.2.1 Sample Characteristics

The following section provides data about the sample characteristics. The gender distribution between the samples was not consistent. Within the visitor sample, 34.5% were male and 65.5% female, whereas the residents sample yielded 28% male and 72% female samples. The gender distribution of the population of Galápagos is 50.4% female and 49.6% male (Instituto Nacional de Estadística y Censos, 2010, p.62). However, since the gender variable showed no significant effect on the response, this coincidental disproportion may be ignored. As Figure 19 shows the age group distribution of the sample varied by a maximum of 29% from that of the Galápagos population.

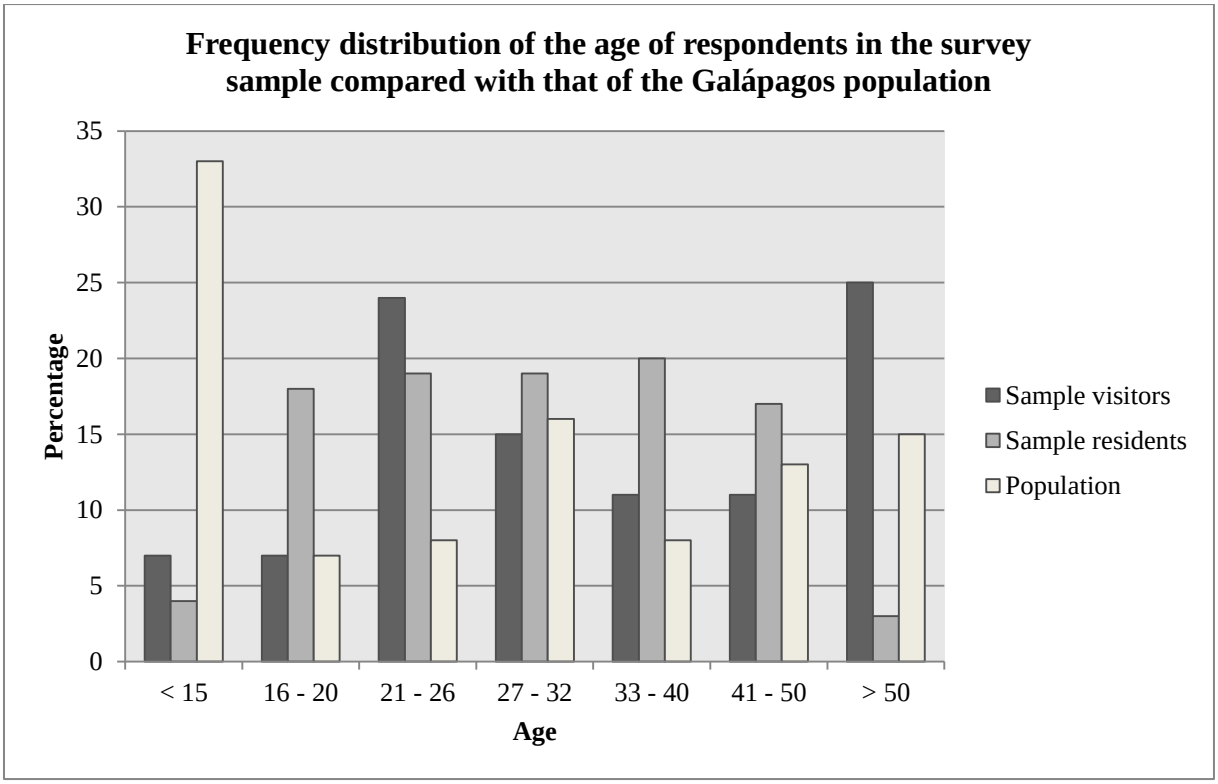

Figure 19: Frequency distribution of the age of respondents in the survey sample compared with that of the Galápagos population

Source: Instituto Nacional de Estadística y Censos, 2010, p.62

Figure 20 depicts the educational level of the sample size of the residents and visitors, as well as the general population. The figure demonstrates that 58% of the residents have a secondary level of final degree, followed by 27% with a superior level. According to the INEC (2010, p.174), the two highest groups of the level of final degree are primary (34%) and secondary (43%). The visitor sample presents an ordinary high amount of superior level (36%), followed by secondary (8%) and primary (7%).

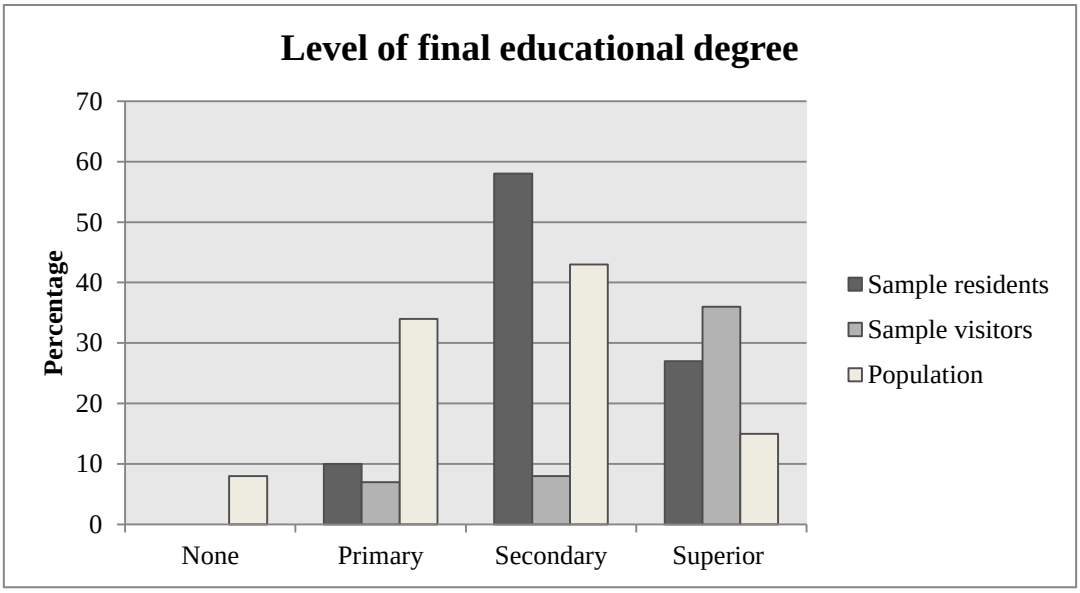

Figure 20: Level of final educational degree

Source: Instituto Nacional de Estadística y Censos, 2010, p.174

The question of income has a tolerable refusal rate. About 11% of the residents and 14% of the visitors gave no information about it. As Figure 21 shows, of the remaining 40%, of the residents and the 14% of the visitors have a monthly household income of less than US$800, 37% of the residents and 11% of the visitors have an income level between US$800 and US$1500, followed by 7% of both groups with an income level between US$1501 and US$2200, and finally 5% of the residents and 54% of the visitors with an income level higher than US$2201. There is a trend between the level of education and income. That is, the higher the education level, the higher the income.

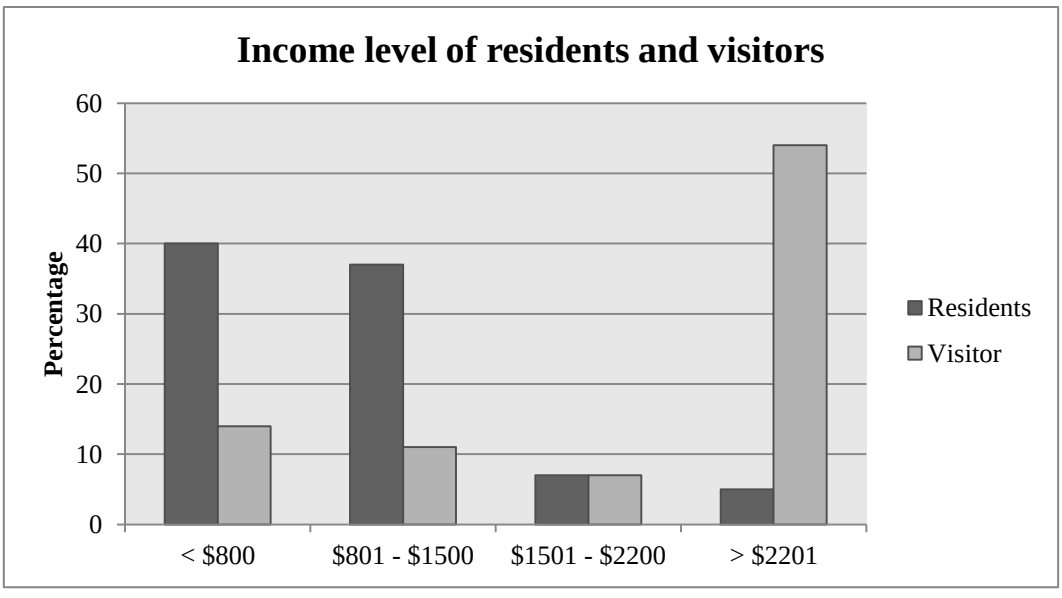

Figure 21: Income level of residents and visitors

Source: Own elaboration, 2013

6.2.2 Factor Analysis

A factor analysis is a statistical approach used to study the relationship of a set of variables. In order to justify the differences in the response behavior by means of empirical evaluation, the respondents were asked about their age, education, income, their occupational and economic background as well as to their nationality. In the following paragraph the results are presented briefly.

Annex A.7 and A.8 presents the mean rank, the standard deviation, the mode and the median of the answers of visitors and residents to 13 items. A statistical analysis has been performed utilizing SPSS (Statistical Product and Service Solutions) in order to calculate the probability of relations between answer choice and demographic characteristic. This means that the attitude towards renewable energy systems was analyzed in dependency of demographic characteristics. According to the mean values of financial income, age and education (Annex A.9), tourists and residents have quiet similar viewpoints and opinions about renewable energies. The demographic factors of financial income and age did not show qualitatively significant differences among them. This implies that among the respondent's age and financial income, no implication about the attitude towards renewable energies can be made. The factor education showed a slight qualitative distinction between the residents, in which a higher education of the respondents leads to a more positive attitude towards renewable energies.

However, via the Spearman correlation (Annex A.10 and A.11), the demographic factors were not found to be significantly related to the answer choices, with the exception of 6 items of the residents and 3 items of the visitors. The Spearman rank-order correlation coefficient "is a non-parametric measure of the strength and direction of association that exists between two variables measured on at least an ordinal scale" (Halpin *et al.*, 2012). The correlation coefficient scale reaches from –1 to 1, where –1 or 1 implies a "perfect" relationship. A positive coefficient indicates a positive trend, so that when one variable increases, the other also rises. A negative coefficient means an inverse relationship, signifying that when one variable grows, the other one decreases (CSU Bakersfield, 2013; Chock, 2010). As the significant correlation coefficients are between -0.345 and 0.245, the strength of the correlation can be described as weak. Consequently, it can be analyzed that there are no significant relationships among the demographic characteristics and the answer choices.

In general, a larger sample size would allow a more representative sample and would also enhance the analysis of correlation among the demographic factors and the questions.

6.2.3 General Environmental Attitude

In the following section the results for the questions concerning the general environmental awareness will be presented. Participants were asked about their opinion and belief regarding broad environmental issues, renewable energy topics as well as a self-classification about their knowledge about renewable energies.

According to a valuation of the variable "three most important issues in the world", most of the respondents showed concern about climate change. As depicted in Figure 22, visitor's second most concern was poverty (15%), followed by environmental issues (14%). On residents' merit, environmental issues (13%) play a more important and eminent role than drugs (10%) and poverty (9%) on the Galápagos archipelago. Respondents' were principally worried about environmental related issues. Answers about economy, globalization or aging of population were significantly less frequently chosen.

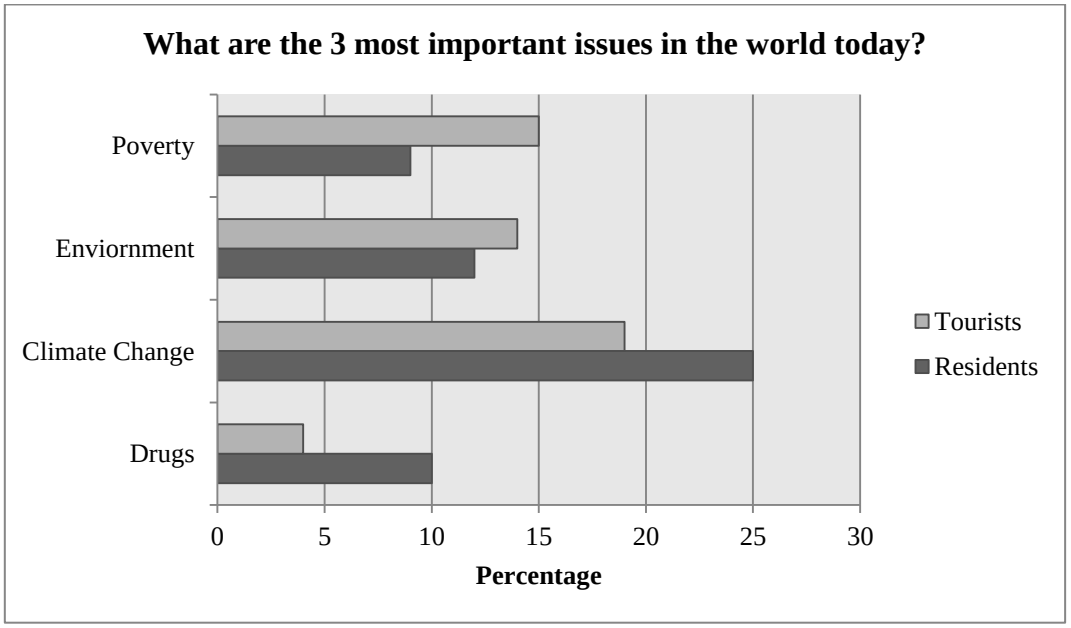

Figure 22: What are the 3 most important issues in the world today?

Source: Own elaboration, 2013

The respondents' beliefs about the three most important environmental problems were also evaluated. Figure 23 shows the results of an evaluation on their belief about important environmental matters such as air pollution, global warming, ozone depletion, water pollution, loss of biodiversity, noise and toxic waste. 23% of the residents chose global warming as the most important issue, followed by ozone depletion (20%) and water pollution (17%). On the other hand, the visitors chose water pollution (21%), global warming (20%) and then toxic

waste (15%), which implies that they are generally informed about current, global environmental concerns.

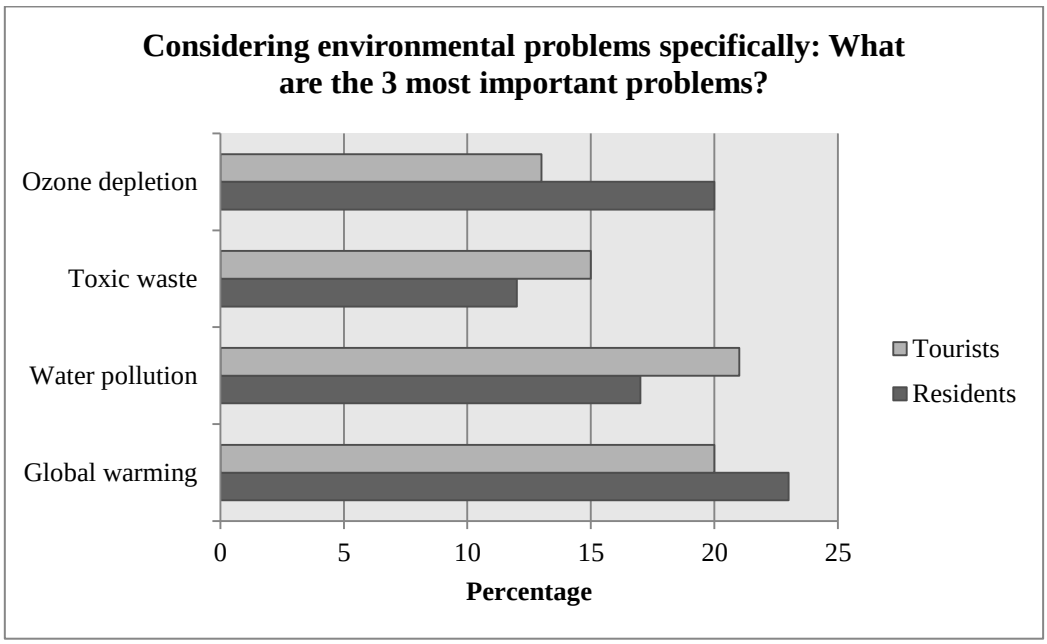

Figure 23: Considering environmental problems specifically: What are the 3 most important problems?

Source: Own elaboration, 2013

Their beliefs about consequences of renewable energies are provided in Figure 24. Both categories, residents and visitors, present a nearly even distribution within its scoring interval. Only 2% of the residents answered "No" to the question "Do you think renewable energy could contribute to solving environmental problems?" 68% of the residents and 80% of the visitors stated "Yes". This indicates a positive belief of both groups towards renewable energies.

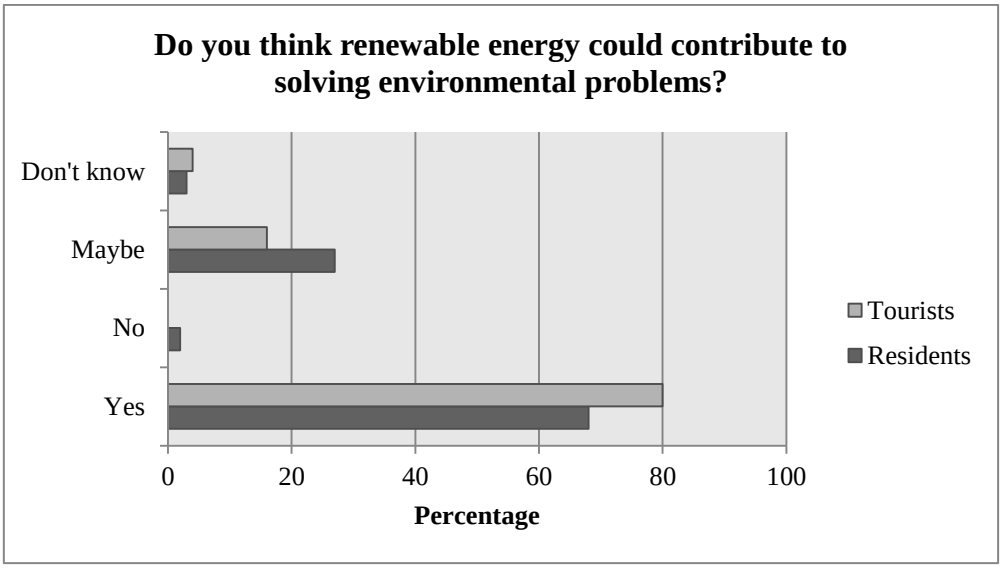

Figure 24: Do you think renewable energy could contribute to solving environmental problems?

Source: Own elaboration, 2013

The question addressing the self-classification of the respondents' knowledge about renewable energy presents a special distribution. As depicted in Figure 25, most respondents scored a medium knowledge; only 7% of the residents and 8% of the visitors scored themselves a very high knowledge. In general their knowledge about renewable energy was at a moderate level.

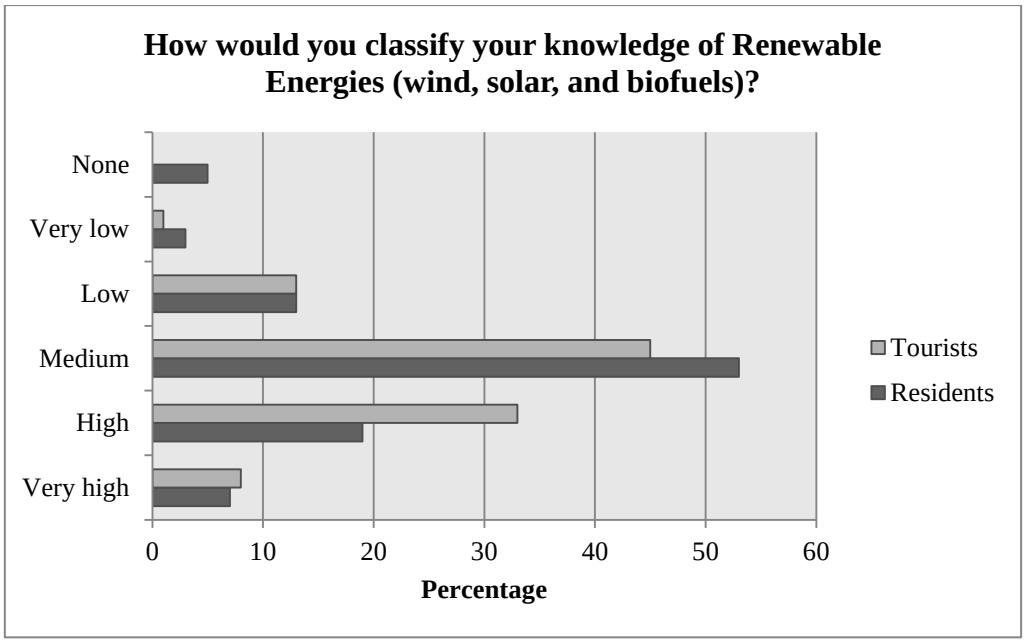

Figure 25: Self classification of knowledge of renewable energies

Source: Own elaboration, 2013

In addition, during the field work several observations were noted which may detect the understanding and knowledge of renewable energy of the participants'. In general, the Ecuadorian residents were afraid to participate in a questionnaire. This fear may arise from various reasons; such as low knowledge, analphabetism or low education. In addition, although the respondents were informed beforehand, that the questionnaire is about their own opinion, many residents tried to provide a "politically correct answer". It was hard for them to comprehend that the questionnaire is about their personal opinion. In most cases, the interviewer noticed that the Ecuadorian residents had much more trouble to answer the questionnaire. This was clearly visible during a comparison of the time needed to answer the questionnaire by the residents and visitors. This might result due to cultural and educational differences between residents and visitors. However, many visitors felt bothered to participate, due to holiday and time issues.

6.2.4 Renewable Energies on the Galápagos Islands

The next part provides an overview about participants' answers regarding specific renewable energy systems, which allows to analyze the community acceptance regarding renewable energies. In focus of this section were questions about respondents' opinion concerning financial cost, electricity security, visibility of wind and solar energy systems, noise creation, as well as beliefs about biofuels.

Figure 26 illustrates the belief of the respondents about the extra costs induced by renewable energy utilization and also presents the results of their opinion about how reliable renewable energy sources are. About 20% of the residents and 32% of the visitors *do* think developing renewable energy would increase the costs, 53% of the residents and 48% of the visitors do *not* expect an increase in costs through the implementation of renewable energy systems, and 27% of the residents and 20% of the visitors stated that they had no idea about the cost.

In spite of the moderate level of knowledge, stated attitudes of residents and visitors showed a high degree of support for renewable energy development and energy transition towards a more environmentally friendly system. When asked whether renewable energy are a reliable source of energy about 74% of the residents and 73% of the visitors answered "Yes", only 2% of the residents and 11% of the visitors expressed indifference, and 23% respectively 16% stated to have no opinion. In general, the findings implied a relatively high degree of public acceptance regarding renewable energy deployment in the Galápagos archipelago.

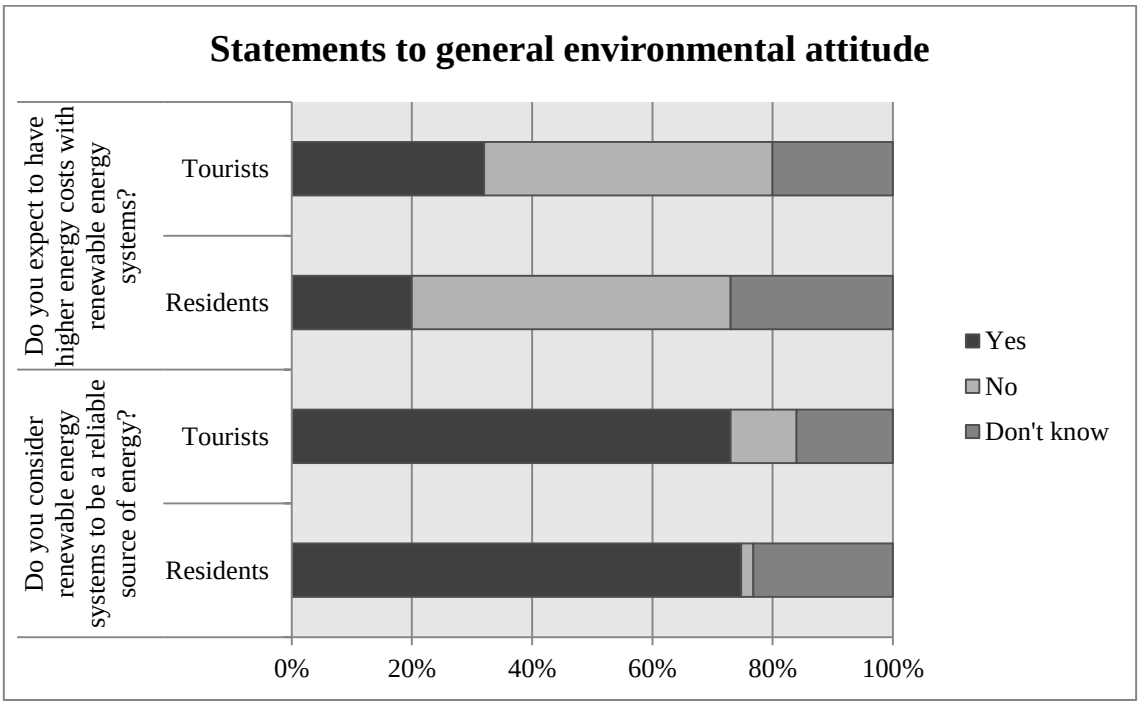

Figure 26: Statements to general environmental attitude

Source: Own elaboration, 2013

Another aspect which was analyzed was respondents' belief of wind energy in the archipelago, which is expressed in Figure 27. When asked if they think wind turbines are an attractive feature of the landscape, 41% of the residents and 38% of the visitors agreed, nonetheless 33% of the residents and 46% of the visitors indicated concern. This implies a visual distraction perceived by the visitors by wind turbines.

In both samples participants expressed a similar level of agreement with the statement: "Do you believe that wind turbines are a danger to wildlife" 28% of the residents and 32% of the visitors agreed with this statement. In both categories 38% disagreed with the statement, and 34% of the residents and 30% of the visitors did not have an opinion. The high degree of the answer choice "I don't know" shows that many participants do not have sufficient knowledge about consequences of renewable energies in order to be able to answer the question.

The aspect that wind turbines might create noise was evaluated as a disadvantage by only 17% of the residents and 18% of the visitors, while 39% and 54% did not see it as so important. A high number of residents (44%) and a smaller number of visitors (28%) do not have an idea about noise creation of wind turbine installations. The respondents' answers show a high degree of uncertainty in the opinion regarding wind energy on the archipelago.

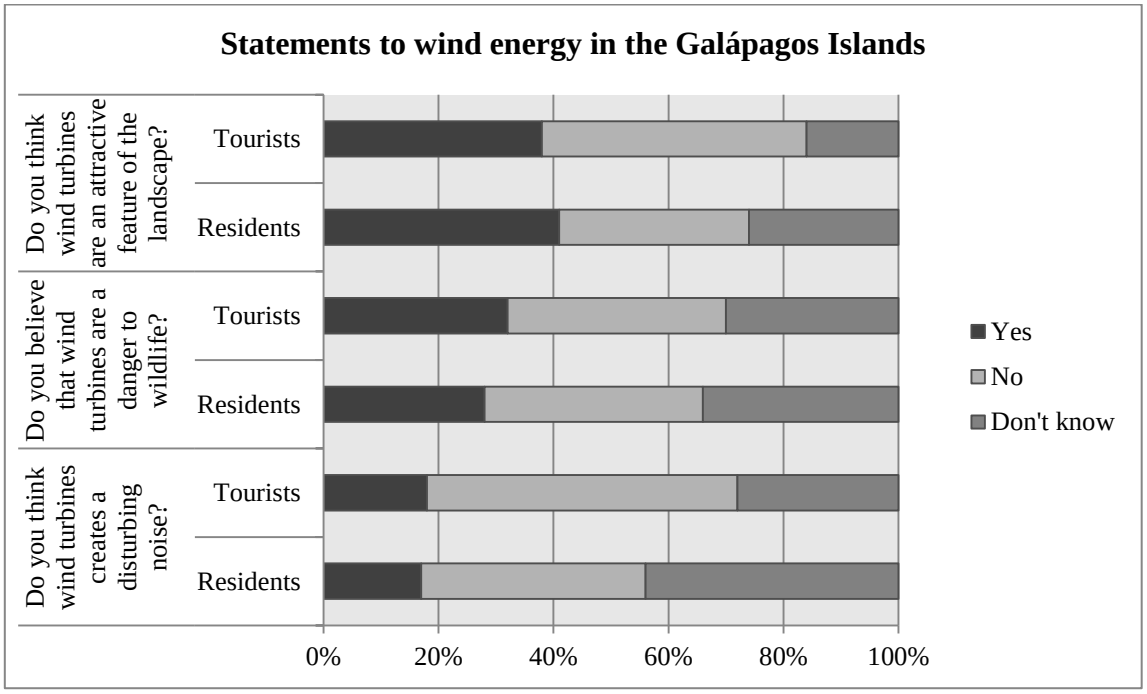

Figure 27: Statements to wind energy in the Galápagos Island

Source: Own elaboration, 2013

Further investigated was the opinion about the implementation of solar energy in the archipelago, which is expressed in Figure 28. A total of 35% of the residents and 43% of the

visitors agree that solar cells are an attractive feature of the landscape. An almost similar number of respondents i.e. 36% of the residents and 38% of the visitors think the opposite, and about 29% of the residents and 19% of the visitors did not express an opinion. This result shows almost similar percentage dispersion among the possible answers, thus no significant assumptions can be made.

Of the residents, only 29% did notice solar cells installations in the landscapes of the Galápagos Islands, while even less visitors (18%) have noticed these renewable energy systems. 38% of the residents and 45% of the visitors did not observe solar installations, and respectively 22% of the residents and 7% of the visitors did not remember. This implies that participants cannot are not disturbed by solar installations, as currently solar cells are not noticed.

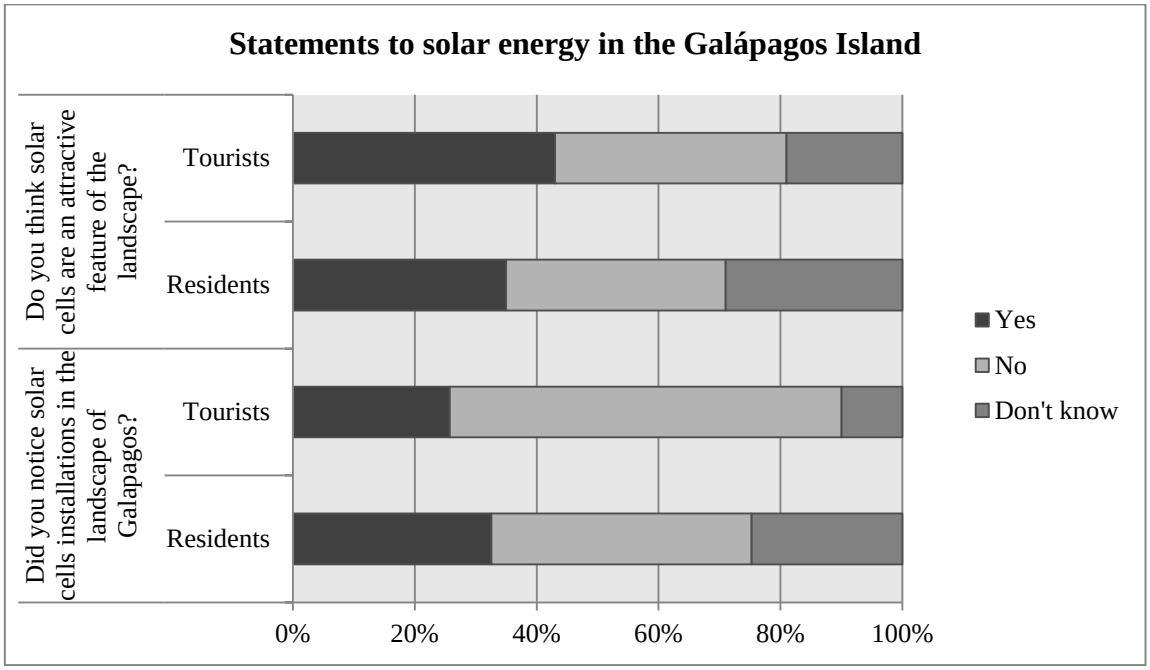

Figure 28: Statements to solar energy in the Galápagos Island

Source: Own elaboration, 2013

Also evaluated was the respondents' belief about the driving force visibility of solar and wind energy (Figure 29). According to the residents, 43% would like to see solar cells from the hotel, followed by 30% in the countryside, 12% at sea, 9% on the roads and 6% do not like to see them at all. Visitors answered in the following way: 36% in the countryside, 21% from home, also 21% on the roads, 20% at sea and 2% do not like to see them at all.

In the case of wind turbines respondents' answers varied slightly. A total of 48% of the residents would not mind to see wind turbines from home, followed by 17% at sea, 14% on roads, 10% in the countryside, and 11% do not like to see them at all. According to the

visitors 28% do not mind to see them on roads, followed by 25% from the hotel, 24% at sea, 12% in the countryside and 11% do not like to see them at all.

The results indicate that the majority of residents and tourists do not mind to see renewable energy systems (in this case wind and solar) in the countryside or near their home or hotel respectively. However, still 11% of both samples have concerns and would prefer not to see wind turbines at all.

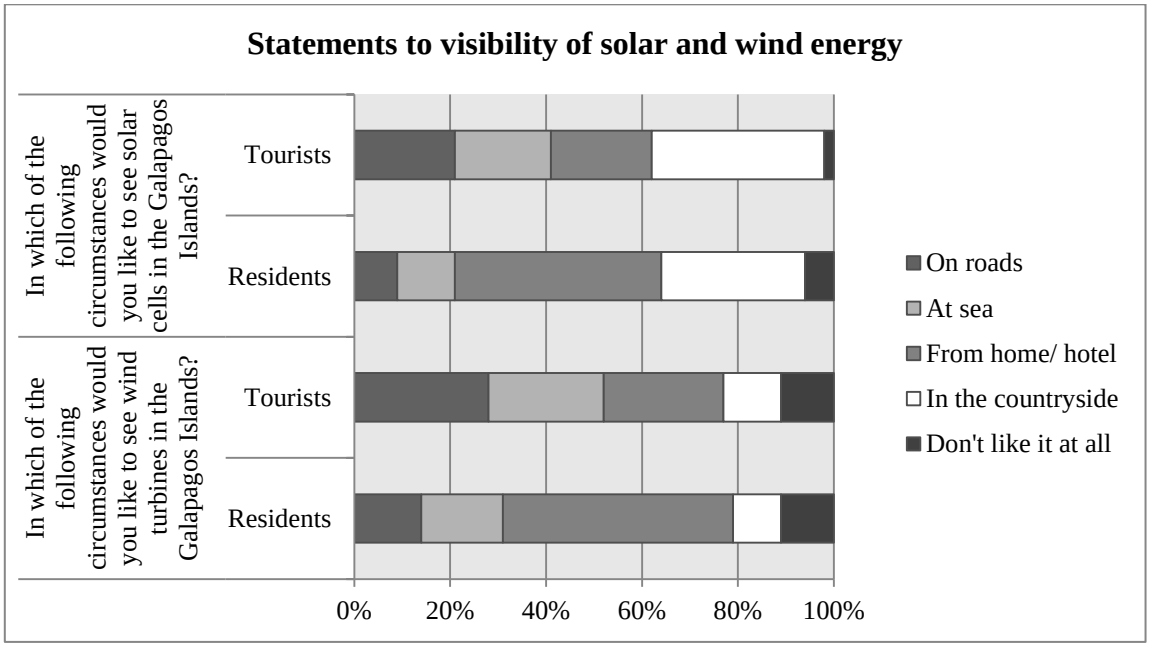

Figure 29: Statements to visibility of solar and wind energy

Source: Own elaboration, 2013

According to an evaluation on biofuels usage, most of the respondents showed no concern about consequences for the biodiversity through the use of biofuels, but 12% of the residents and 7% of the visitors expressed concerns, and yet 20% of the residents and 11% of the visitors do not have an idea about this issue (Figure 30). This suggests that the majority of respondents do not associate negative consequences, such as food insecurity, deforestation or land use fragmentation, to the development of biofuels.

When the participants were asked if they would rather use biofuels rather than the conventional diesel in the archipelago, both groups showed a nearly even distribution within its scoring interval. Of the residents 68% and of the visitors 66% agreed to this statement, only 9% in both groups disagreed, and still 23% of the residents and 25% of the visitors do not have an opinion. This result indicates that the majority of the participants would be receptive and impartial to the use of biofuels rather than diesel.

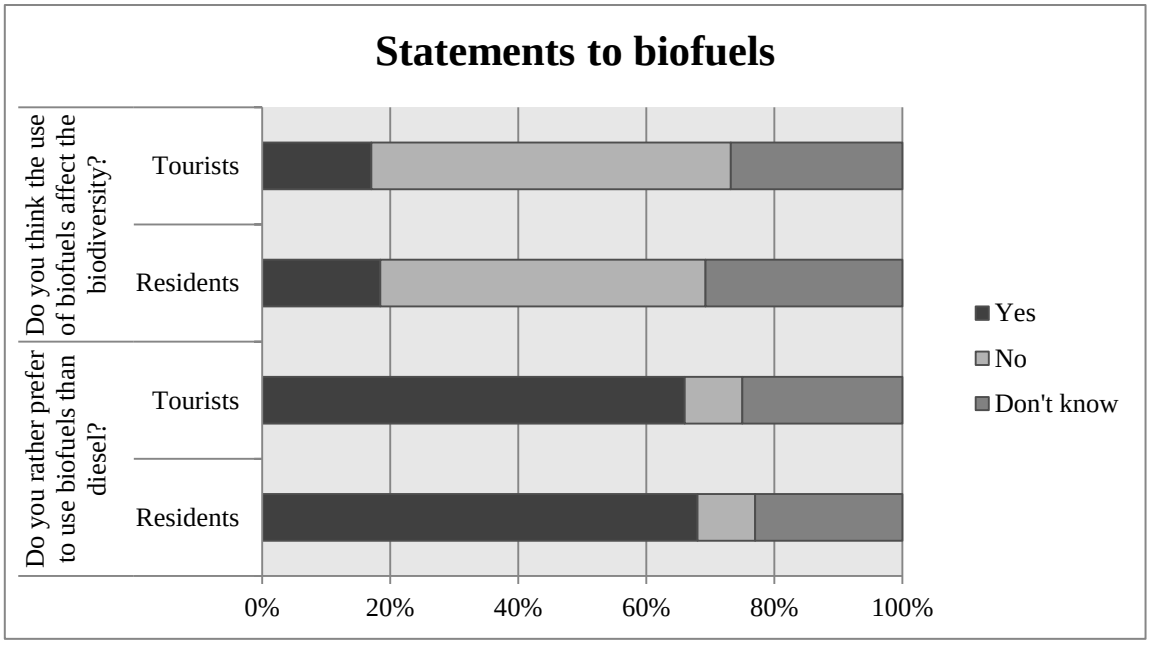

Figure 30: Statements to biofuels

Source: Own elaboration, 2013

6.2.5 Project "Cero Combustible Fósiles para Galápagos"

In the last part of the results and interpretation chapter, the outcomes of the project awareness "Cero Combustible Fósiles para Galápagos" are presented. Participants were asked a number of questions concerning their knowledge about the project aim, communication and development.

Further investigated was the level of awareness of the project "Cero Combustible Fósiles para Galápagos" as Figure 31 demonstrates the total of both samples showed that 86% of respondents agree with the statement that the population's opinion should be taken into account for the planning of a renewable energy system. Only 13% of the residents and 11% of the visitors disagreed with this statement, while a total of both groups (14%) did not express an opinion. This implies that the majority of participants believe that it is important to integrate the community in the development processes of renewable energies.

In order to analyze the knowledge about the project "Cero Combustible Fósiles para Galápagos" participants had to answer whether they have heard about it. Only 38% of the residents and 12% of the visitors supported this statement. 62% of the residents and 88% of the visitors do not associate the name of the project with the implementation of renewable energies. In spite of this low level of awareness, a total of 83% of residents and 100% of visitors would appreciate to know more about the project's idea, goals and development. These results demonstrate that over half of the population and more than two thirds of the

visitors do not have knowledge about the project; however they would like to be informed about it.

Among the 37 residents and 7 visitors who *did* know about the project, a significantly high number of 84% of residents and a 100% of visitors do *not* participate in the project, only 16% of the residents indicated that they take part in the project. This low quantity of resident participation may be due to the awareness of only 14% of the residents and 15% of the visitors of a public consultation being conducted at that time. 50% of both groups have no knowledge about any public conference, and over 30% could not give a statement to this question. Further, of both participant groups only 5% of the residents did respond to a public meeting. The results indicate that this low participation may result as respondents' are not aware of any public information about the project.

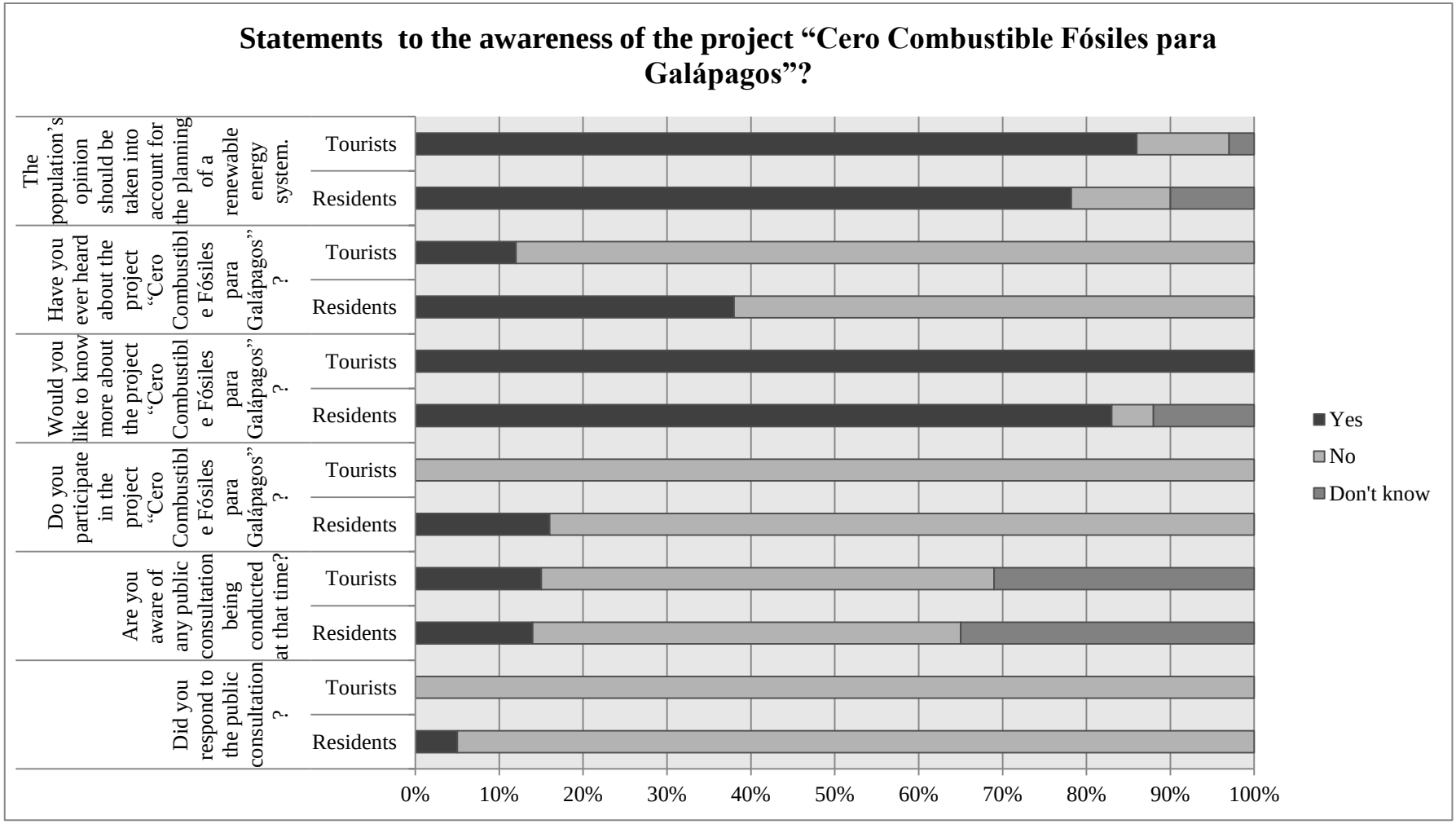

Figure 31: Statements to the awareness of the project “Cero Combustible Fósiles para Galápagos”

Source: Own elaboration, 2013

A further aspect which was analyzed in line with the project awareness was to find out by whom the participants first heard of the project "Cero Combustible Fósiles para Galápagos". The results are illustrated in Figure 32 below. It shows that a total of seven visitors, who were informed about the project, did know about it by media. According to the 37 residents 46% of them were informed about the project by media, followed by 24% by the government, 14% by other sources, 7% by electricity industry and NGOs. These results depict that the major information source is the media in form of newspapers, magazines, TV, and radio.

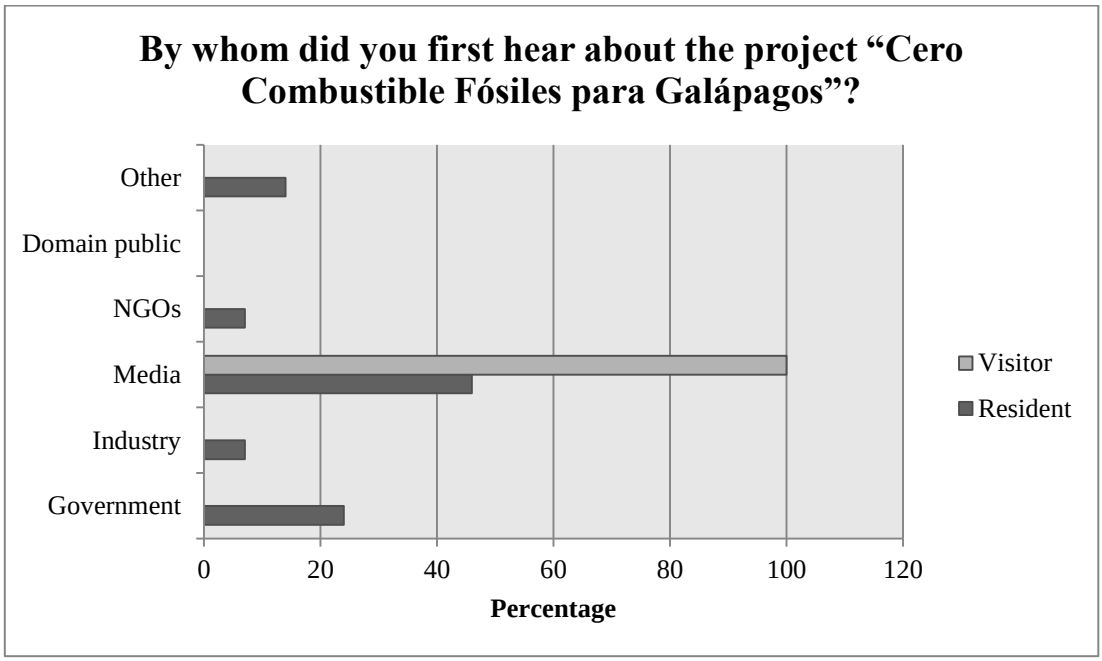

Figure 32: By whom did you first hear about the project "Cero Combustible Fósiles para Galápagos"?
Source: Own elaboration, 2013

Figure 33 shows residents answers to the question if the project is sufficiently discussed by the energy industry, the government, the media, the NGOs and the broad public. In general about two third of the respondents answered "Partially" in the categories of government (67%) and media (61%), followed by "Not at all" especially in the categories of the energy industry (55%) and the broad public (42%). This implies that the majority of the residents are only "partially" to "not at all" satisfied with the communication and information.

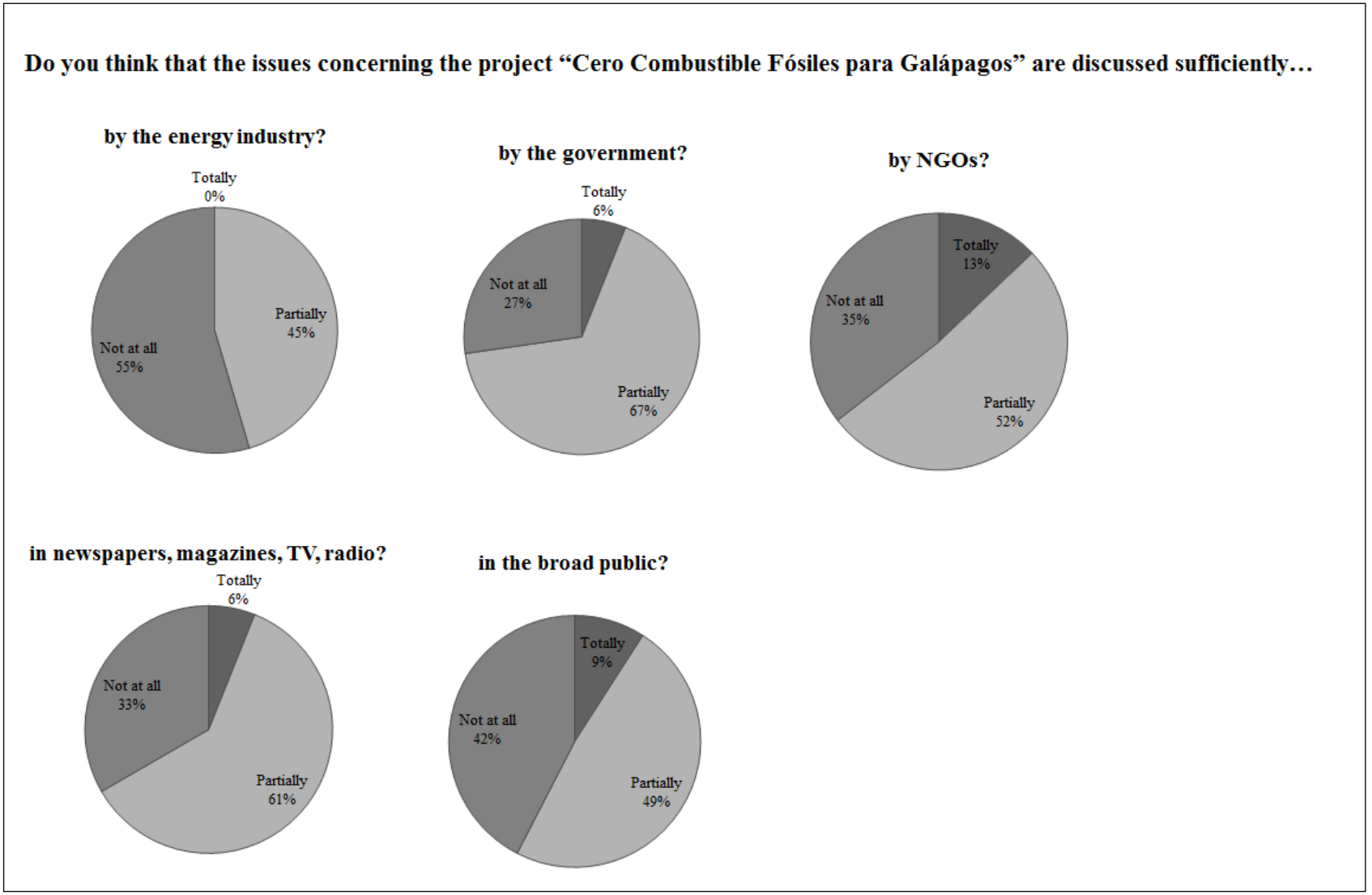

Figure 33: Communication evaluation of the project "Cero Combustible Fósiles para Galápagos"

Source: Own elaboration, 2013

7 Discussion and Interpretation

The following chapter investigates if the models “Dimension of passive to active acceptance” introduced in chapter 2.3.1 and the “Awareness and perception model of renewable energies” explained in chapter 2.4 which are based on literature review and which claim to hold a general validity, can explain the passive acceptance in the Galápagos Islands. In particular, it is important to detect if actually all the mentioned factors influence the local acceptance, and whether the factors are complete or have to be expanded.

7.1 Factors Influencing Acceptance

After the results of the study have been presented, the following provides an evaluation of the model in chapter 2.4, in order to explore its reliability. Subsequently, each possible factor influencing the acceptance (technology, communication, location, political and personality) will be examined, in order to assess its importance to the acceptance process.

In order to evaluate the *technology* factor, the questionnaire included questions about the trust in reliability and risk perception of renewable energy systems. Regarding the trust in reliability, the majority of participants stated to consider renewable energies to be a reliable source of energy and also identified a positive effect of the implementation of renewable energy projects in the archipelago. In addition, the evaluation of the risk perception also showed positive results, implying that the majority have sufficient trust in the technology. This high degree of the trust may result from the high environmental consciousness of the residents. As people in Galápagos are aware of the unique habitats within their vicinity, they feel the need to protect their environment. Thus, they may be open to new technologies which could increase the sustainable development of the islands.

Regarding the *communication* factor, participants were asked about the information, involvement and integration process as well as the possibilities of a partnership and participation in the project. About 62% of the residents and 88% of the visitors could not associate the project “Cero Combustible fósiles para Galápagos” with the implementation of renewables. Additionally, questions which asked about the partnership in the survey also showed low degrees of participation. Thus, citizens of Galápagos consider that the information about the project is insufficient. The demand of information can be explained by the fact that population, due to their dependency on fossil fuels, did not perceive wind power as an alternative energy source. Beierle and Cayfords (2002) define public participation “as several mechanisms intentionally instituted to involve the public or their representatives in

decision-making". By providing people with information about renewable energy systems, the knowledge level could be raised. If the public receives more information, it may lead to a stronger society that is able to understand other stakeholders and bring new ideas or proposals for the discussions. Not sharing all the relevant information with the actors involved could lead to a lack of trust among them. Thus, improving the transparency of the process could enhance communication, decrease the passivity and raise the support to the project.

In the case of power blackouts on the island San Cristóbal for instance, shows that people may rapidly blame renewable energy systems. After communicating to the public, that these power blackouts do not result through the wind energy, rather through some technical problems with the energy generators, people had the tendency to accept this declaration. This involvement of the public into the process influenced positively the attitude towards renewable energy systems.

The *location* factor included the indicators of noise and visual perception. Regarding the impact from noise of wind turbines, the results showed that the majority of the participants reported to have no idea about the noise creation of wind turbines. However, noise creation is in the case of the Galápagos Islands not so important, as the wind parks on San Cristóbal and Baltra are located far away from the communities and therefore do not create a noise nuisance to the communities. The analysis to visual impacts of solar and wind installations demonstrated that about half of the resident participants would agree to see renewable energy systems near their home. This finding confirms the claim made by Jones and Eiser (2010, p.9) who stated that "a gradual increase in positive attitudes towards development with increasing distances from the identified sites" may arise. However, only about one fourth of the visitors' respondents approved to see renewable energy systems in the archipelago from the hotel. And yet about 7.5% of both groups do not like to see wind turbines or solar cells at all. This could be explained by the fact that people do not want to devalue the landscape visibility of the archipelago.

The *political* factor considered the cost perception as well as the trust, transparency and fairness of the realization of renewable energy projects. The results showed clearly that 86% of the respondents' believe that the population's opinion should be taken into account for the planning of renewable energy projects. According to several authors (*e.g.* Devine-Wright, 2007; Wolsink, 2005; Geissmann and Hubert, 2011), another anticipated indicator is the economic effect of renewable energy projects. In the case of Galápagos, half of the respondents (residents and visitors combined) do not expect an increase in costs through the

implementation of renewable energy sources. This might be a reason for the positive attitude towards the transition of green technology. Also surprising might be that measures of perceived fairness did not contribute significantly to attitudes towards wind energy development in this study. It is stated widely in the literature that available project information and an accessible planning system to the public are crucial for the acceptance of renewable energy systems (*e.g.* Gross, 2007; Wolsink, 2005; Devine-Wright, 2007). Moreover, it is reported that involving the public at an early stage of the project and by offering consultation between the public and key stakeholders would increase the community's trust towards the renewable energy projects (*e.g.* Mallet, 2007; Aitken, 2009). In the case of the Galápagos Islands, the results of the questionnaire showed that the majority of participants did not know about a transition to a renewable energy system on the islands. Further, Mrs. Patricia Recalde, director of the department of biofuels in the ministry of electricity and renewable energies, stated that the population is not sufficiently informed about the project and characterized this lack of information as followed:

> *"Yo considero que en Galápagos se ha realizado difusión sobre los proyectos, sobre energías renovables, sobre las iniciativas que están registrando, y sobre los cooperantes que existen que son algunos países, no obstante estas informaciones han sido periódicas. Creo deberían reforzar el sistema de comunicación, para que sea continuo y que la gente sepa lo que se hace día a día."*

In the case of the Galápagos Islands, the issue that the government considers as important is the transparency of information; however in practice the citizens were not satisfied, as they expressed the wish to know more about the renewable energy project. Lack of relevant information and limited target groups could explain the low interest of citizens. However, the majority of respondents supported renewable energy technologies and were also in favor of an implementation in the archipelago. This is not to say that fairness does not matter in renewable energy development or community acceptance of wind energy.

With respect to the *personality* factor, the environmental perception and the general knowledge of renewable energy was determined. The respondents' attitude towards important global issues showed a tendency towards environmental concerns. Participants had multiple choices of different issues, from economic to demographic till health care. However, the majority selected environment related options. This might give an insight into the environmental awareness of the population and visitors of the archipelago. However, Felipe Cruz, director of the technical assistance of the Charles Darwin Foundation, describes the visitor development as following:

> *"Yo creo que en la gran mayoría de las turistas que llegan a Galápagos tienen un desconocimiento total, no solamente sobre este tipo de programas, si no de Galápagos en general. Uno de las evoluciones que hemos visto últimamente, es que Galápagos está convirtiendo en un turismo cada vez menos educado. Al inicio fue un turismo muy educado, y realmente iban a Galápagos porque querían aprender más sobre la historia natural, biología, etcetera. Ahora el turista va porque es un sitio de ir."*

Mr. Cruz describes that Galápagos is very popular as it is distinct due to its unique area. This statement is partially supported by the report of the Charles Darwin Foundation in 2010, which states that "the national tourist who comes to Galapagos does not demand much information from guides and does not appear to be particularly committed to the environment. They are motivated more by a desire to visit a special part of Ecuador, than to get to know the natural world of Galapagos. […] foreign visitors respect the National Park rules and are interested in conservation and scientific research, their level of knowledge about Galapagos is greater than national tourists and thus they have a great deal of interest in the nature of Galapagos" (Charles Darwin Foundation, 2010, p.135).

Similar to other studies of wind energy attitudes, this result of this thesis showed a tendency to a high level of acceptance for wind energy development within the general public. This might be surprising as the majority of residents struggled to fill out the questionnaire and preferred to answer with the "Don't know" option. This behavior might indicate that the population of Galápagos lacks knowledge and information of renewable energy systems. Environmental education promotes awareness and sensitivity to the local environment/ ecosystems and addresses potential environmental problems, which helps to acquire a variety of experiences in and gain a basic understanding of the environment and its associated problems. Further, it develops a set of values and concern for the environment and motivation for actively participating in environmental improvement and protection, which let obtain skills for identifying and solving environmental problems. Additionally, it encourages citizens to be actively involved at all levels in working towards new resolution of environmental problems (UNESCO, 1978). Thus, in order to prepare the present and future generations of the archipelago for an ecologically sustainable future, it is inevitable that the population of such an important biological hotspot should be educated in environment protective topics.

To sum up, it can be concluded that the factors of technology, communication, location, political and personality influence the awareness and perception progress. However, each factor differs in their effectiveness.

7.2 Time Dimension

The temporal scale plays an important role in shaping the attitudes towards renewable energy projects. For instance, researchers (*e.g.* Wolsink, 2005; Aitken, 2009) have argued that an initial positive attitude towards a wind park installation changes to a negative attitude during the construction time, and back to an affirmative opinion while the project is in the operating phase. Hence, the influence of the time dimension during the development of a project was analyzed, using the case study of a 6-year operating wind park in San Cristóbal.

During an interview with Mr. Luis Vintimilla, the project manager of the San Cristóbal wind project, he suggested some tension between the population and the installed wind park and described it as follows:

> *"Entonces al principio tuvimos fallas de los sistemas en general, pero por culpa de la generación con diesel. Y claro para los usuarios es sólo un paquete, entonces, como lo nuevo que se introdujo fue la generación eólica. Se hicieron explicaciones. Pero siempre quedó la precepción en ciertas instancias de que la generación eólica habría producido ciertas fallas de calidad."*

This statement affirms the findings of Wolsink (2005) and Aitken (2009) that during the implementation time the attitude of the population towards a wind installation might change. In this case in particular, a lack of sufficient communication between the electricity user and electricity generator has caused a discrepancy among the users. In the case of the wind park on the island Baltra, no attitude development could be analyzed as the majority of participants were unaware of the construction of a wind facility in Baltra.

7.3 Dimension of Acceptance

The dimension of acceptance will be evaluated with the aforementioned model of Schweizer-Riess (chapter 2.3.1), which presents the different dimensions of passive to active acceptance. As no clear boundaries exist between the different levels and as attitudes may change over time, the evaluation describes the current status-quo of the community.

In the model, the components of a person's action and appraisal level are classified in order to evaluate the degree of acceptance. The appraisal level ranges from negative to positive and the action level can be assigned from passive to active. The results showed that the majority of respondents are not participating actively in the implementation of the renewable energy systems. Only 5% of the resident participants did respond to a public meeting of the project. Thus, they can be categorized into the passive action level. Further, their appraisal towards a green innovated energy system showed positive tendencies. Consequently, according to the

model of Schweizer-Riess *et al.*, participants can be positioned in the approval level. This implies that not many people are performing rejection or resistance towards renewable energy projects, that the minority is actively participating in the project and yet the appraisal level is positive towards renewable energy technologies. However, this acceptance level is not enough for reorganizing and restructuring a sustainable energy system. The development of green energy systems requires not only a low level of rejection and high level of approval; it also requires additional support in order to become active in the participation and to reconsider the own energy consumption. This was also identified in the expert interviews. María Casafont described the situation as follows:

> *"Otros problemas es que el crecimiento de la demanda es cada vez mayor [...] sobre la reducción del consumo de energía de la gente, una cosa es que se utilcen medidas alternativas para la generación, y otra cosa es que previamente a la gente reduzcan su consumo. Entonces, sigue aumentando la demanda, e igual va a ser un punto cuando las energías renovables no van a ser suficientes."*

Therefore, the transition to a sustainable energy system does not only include the technology and construction of the systems, but it also requires the commitment and active engagement of the actors and stakeholders involved in the process. In particular, the local population has to be activated and sensitized by their awareness and behavior, as they are the energy consumers and hence responsible for a large part of the emissions produced. Therefore, the local population should be the main target, in order to change behavior and consequently reduce emissions. Thus, it is suggested to design a supporting framework and to realize energy awareness campaigns, in order to raise the consciousness and knowledge of the local population towards their energy consumption behavior. Successfully reducing the energy consumption could play a crucial role in achieving the target of zero fossil fuel emissions in the archipelago. However, one main difficulty is the unrealistic low price of energy in the archipelago, due to subsidy policies. As a consequence residents do not have incentives to reduce their energy consumption.

After presenting and evaluating the two models, the dimension of acceptance and the influencing factors of the awareness of renewable energies will be combined and interpreted as shown in Figure 34. The awareness model showed that a positive tendency towards the factors technology, location, and personality exist in the archipelago. This implies trust in the reliability of green energy sources, low risk perception of the technology and environmental impacts, openness for new technologies and a general positive evaluation of renewables. For this reason, generally the population and the visitors approve of the implementation of

renewable energy projects in the archipelago. However, the support and engagement level of the Schweizer-Riess *et al.* model was not achieved by the majority. This can be explained by the deficiency of the factors communication and political. The results showed that there is a tendency that the residents are not sufficiently involved in the project and perceive the political realization as negative. This implies that the level of public participation did not enable the public to make suggestions or to participate in the decision making process. Thus, with the purpose to increase a positive awareness of renewable energies, these two factors (communication and political) should be integrated into the project implementation process. In Galápagos, the developers did not involve the residents sufficiently with participation mechanisms, which could have led to the passivity of the public. However, the coverage of all these factors in a project generates costs and investments, not only financial, but also time and human resources.

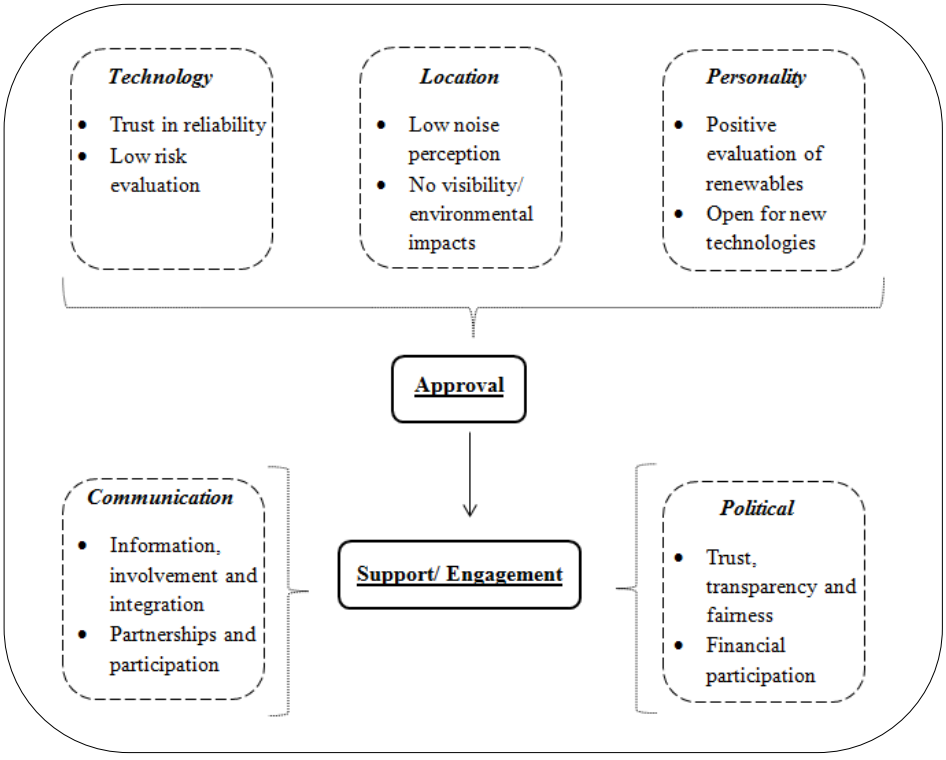

Figure 34: Evaluation of influencing factors and level of acceptance dimension

Source: Own elaboration, 2013

In order to strengthen the communication factor, the main actors could create more opportunities for the involvement of the population and include the residents with participatory elements in each step of the planning process. A bond of trust between the investors and the residents is the basis for a successful cooperation and ideally this involvement should start as early as possible in the process. In order to increase the trust

between the parties, investors should consider ideas and suggestions of residents and implement feasible proposals. In addition, demonstrating success stories and a regular exchange between different levels and stakeholders can be very supportive.

For the political factor, transparency and a trust basis play a central role in determining the perception of justice. Another supportive incentive would be the development of financial participation (*e.g.* limited partnership, stock company, private partnership, loans repaid, energy cooperatives, citizen ownership). The method of financial involvement allows the public to become shareholders and receive financial benefits as well as the right to discuss with main actors. This encourages involvement in the project, in particular due to the economical aspect. Therefore, financial involvement may be an essential tool to activate the public during the whole process, as they expect some benefits. In the Galápagos Islands, such involvement does not exist; this may explain the passiveness towards participating of people.

In particular, the green energy movement in Germany has noticed that participation of the local population increases the sentiment of fairness among the citizens. According to the German Renewable Energy Agency (2012), the acceptance of the population towards renewable energies is very positive. Wind-, solar- and bio-energy are very popular amongst the German population, as these energy systems are known to act climate protective and contribute to a more secure and sustainable energy future. Besides, the majority of the population requests a further expansion of renewable energy sources. In fact, the German government agreed that 80% of energy demand will be covered by renewable energy by 2050. Nevertheless, they are also some slight regional differences on the agreement of renewable energies. Throughout Germany emerged some initiatives and associations against the dispersion of renewable energy system, in particular wind energy (Epaw, 2013).

However, about 94% of the German population considers the expansion and the increased use of renewable energy to be important. The high acceptance towards renewable energy systems in Germany may emerge through the use of a variety of participation tools. As already mentioned before, participation may lead to greater awareness of environmental conscious behaviour and has a positive effect on the collaboration between the authorities and the local residents. Especially Germany can present a broad range of different ownership and participation models. For instance, citizen owned wind farms and citizen power plants organized as cooperatives have been particularly successful. The financial security for these collective citizen ownerships provides the policy framework with the feed-in regulation, guaranteeing buy-off of green electricity at fixed tariffs (Schreuer, 2012). In 2000, the

Renewable Energy Sources Act (Erneuerbare Energien Gesetz, EEG) was introduced to act as an important instrument for the development of renewable energy technologies. The law "obliges grid operators to give priority to the purchase of electricity from renewable energies" (BMU, 2013). Providing such incentives enhance the interaction between decision-makers and those people who want to participate.

Finally, it should be noted that projects in the renewable energy sector, experience a considerable time lag and that attitude changes require a transformation period which may require considerable time, this should be considered in the process. For this reason, a gradual expansion of renewable energy systems is recommended, as the local population has time to adapt and collect personal experiences and thus develop their opinion.

To sum up, the following suggestions attempt to increase the active participation of local residents towards renewable energy projects. Firstly, the population should be given the opportunity to join the project, if they are willing to. Not everybody may want to become a member of a cooperative or participate in the implementation process, but people should get the opportunity to satisfy their democratic rights and take part in the decision making process. Secondly, by involving the public, the level of the public education is indirectly influenced. Obtaining information may increase the public interest and acceptance of the project. Thirdly, an active dialogue between the citizens and shareholders provide transparency and understanding among each other. Educated people result in a stronger society, which is able to contribute to the decision-making process. Finally, financial participation would increase the awareness and knowledge of projects.

After the findings were presented and evaluated, the possible contribution of this study for the scientific research field should be assessed. In terms of a universal validity, the model has to be developed through further empirical studies with higher case numbers. As the questionnaires have no representative character (due to low sample size), it is not possible to make valid statements about how factors influence the local acceptance. Nevertheless, this study provides profound information about the relationship of influencing factors of the local acceptance of renewable energy systems. In addition, this thesis provides information about which factors are in particularly relevant to the population and therefore need to be investigated in more depth. However, this thesis is not only relevant for the scientific debate, it may assist different actors (investors, government agencies, initiatives, energy companies, etc.) involved in the planning, by providing ideas and incentives for a successful collaboration with the local population.

8 Conclusion

Climate change and increasing CO_2 emissions are among the main challenges faced by the 21st century. It is known that the energy sector contributes substantially to the increase in CO_2 emissions and therefore, a transition of the existing energy systems towards a more sustainable and environmentally friendly provision is essential. The use of renewable energies has increased in the past decade, enabling new opportunities and approaches towards achieving the goal of a green energy transition. During the implementation processes of such new systems many actors are involved, ranging from the political frameworks, to governmental incentives until public involvement. Hence, the energy transition takes places simultaneously on many levels (economic, technical, social, and environmental among others). In order to ensure a successful implementation of such projects, all actors should be identified and involved to a certain extent. Research has shown that public participation can contribute to the successful implementation of renewable energy projects. Especially in the Galápagos Islands, which represent a pristine and unique landscape, characterized by its rich fauna and flora diversity, it is crucial to become less dependent on fossil fuels. In order to develop a sustainable energy system, all possibilities in the field of renewable energies and energy efficiency should be taken into account. Not only in the Galápagos Islands but also worldwide, environmental protection and climate change are universal challenges. Energy efficiency measures and new renewable energy projects are approaches to tackle environmental impacts and the decline of resources. The Galápagos Islands have the chance, as a microcosm, to cover their power demand by 100% renewable energies and thus, could play a pioneering role for the world.

The aim of this thesis was to identify possible factors influencing the acceptance towards renewable energy systems of the participants. By applying a mixed method approach, the results showed the current status quo of the attitudes of the residents and visitors towards the transition to a green energy economy.

The review of the energy situation of Galápagos showed that the Islands are not only facing a steady increase in the consumption of energy, but are also currently undergoing a change of their energy system. The former diesel generators will gradually be exchanged or transformed for the use of biofuels, for power generation. The energy demand of the island San Cristóbal is already partially produced by wind energy, the island Floreana utilizes a mixed diesel-biofuel generator, the island Isabela is currently calling for an international tender for a hybrid

power plant (biodiesel generated power with photovoltaic power) and the island Santa Cruz is at present under construction implementing a wind park.

Involving the local population in a community-based transformation to a green energy movement is a crucial point to a comprehensive sustainable energy management. Furthermore, the ERGAL initiative identified five dimensions of sustainability (effectiveness, elasticity, security, adaptability and coexistence), in order to realize an implementation successfully. One of the main components of the dimensions is the increase of energy efficiency in the end users. However, the energy subsidy strategy of Ecuador does not give any incentives to residents to reduce their energy consumption. As the energy price on the archipelago is as low as in the continent of Ecuador, residents probably do not realize how much effort it is to transport the fossil fuels to the Islands, as these costs are not included. Yet, during the research study no educational energy awareness campaigns were identified. As they are also responsible for a part of the emissions produced, the local population should be encouraged to change their behavior. By conducting energy awareness campaigns, the knowledge and consciousness of the residents may be increased and thus would successfully reduce the energy consumption on the Islands.

The study identified that the perception of the main actors regarding the renewable energy projects differs between the stakeholders. A common consensus is that the archipelago has to change to a sustainable energy management, but stakeholders disagree on how to realize this transformation. The energy demand (excluding land transportation) of the communities could be covered by the use of renewable energies. Yet, non-governmental interviewees proposed the application of different energy systems, in order to ensure a reliable energy supply on the Islands. Further, a main issue remains, which is that of the marine sector. Yet, the governmental body is already underway to investigate possible and adequate solutions on how to substitute fossil fuels from tourism cruisers or small fisher boats. This represents a deficiency in the project and is the source of the project's delay in achieving its fossil fuel target. Moreover, the biofuel solution for the terrestrial sector is still under observation and remains an issue as it also has to be transported from the continent of Ecuador to the archipelago. To sum up, the project needs to find an ideal energy systems solution, in order to guarantee a 100% green energy supply in the archipelago.

A positive finding was that the local population showed a positive attitude towards renewable energies. Although two main components (political and communication) which influence the process development of the perception of renewable energies are not adequately represented

within the project. With respect to the communication factor, the majority of participant's do believe that it is crucial to integrate the community in the development processes of the projects. Moreover, the majority claims that the community has no information about the project. According to the literature, these factors are in general very important for the appraisal of the community. Thus, this could explain the passivity of the participants towards renewable energy systems. Moreover, this low participation implies a negative perception towards trust, transparency and fairness of the project. Yet, the community perceive the implementation of renewable energy systems positive, as they are generally aware of the special and unique location of Galápagos and are eager to protect their environment.

While the general viewpoints of participants of renewable energy techniques were positive, the information and communication process between the project and the end energy users still needs to be strengthened. Dialogue and participation are among the most important prerequisites to improve social responsibility towards energy sustainability. According to the governmental body of Ecuador, the promotion of renewable energies in the archipelago has been supported by online publications, and campaigns of NGOs, the ERGAL initiative and ELECgalápagos. However, it was also admitted by the government that the communication of renewable energy projects and the community has to be intensified. Better communication mechanisms provide that the community may participate in the project and fully support the fundamental ideas of it. With reference to the increasing number of visitors and the steady increase of energy consumption, it seems inevitable to include the population into the project, as energy efficiency is one factor of a sustainable energy system. Preventing unnecessary consumption of energy or selecting the most applicable technology to reduce the cost of the energy, benefits the decrease of individual energy consumption without decreasing individual welfare.

The rapid expansion of renewable energies in the Galápagos Islands goes hand in hand with new challenges. These challenges can only be overcome, if a variety of factors reach their desired goals. Although the focus of the project is currently on the construction of the energy systems, it should not be forgotten that the projects can only be implemented if the population at the local level accept them. Therefore, the findings of this study support that the local population should be involved at an early stage in the project, in order to bring renewable energy generation and greenhouse gas reduction targets closer. Without doubt, possible conflicts about the location of renewable energy facilities must be anchored within a broader social and political context. Yet, understanding the values and viewpoints of the public that

influence them will also play an essential role in understanding the “social gap” which often exists in the development of renewable energy systems.

8.1 Outlook

The study is a solid start for understanding the relationship between values, beliefs and attitudes towards the development of renewable technology. Yet it also proposes the need to explore this area for future research. To enhance the understanding between the relationships among values, attitudes, and support or opposition of renewable energy systems, data in the long-run should be collected in the local population throughout the development process of the project. Furthermore, the realization of questionnaires and the collection of data at multiple islands would allow a comparison among the inhabited islands in multiple contexts. This study represents an initial base-line study, which should be expanded in order to verify the results to achieve a representative account of the status quo, as only a limited quantity of questionnaires were carried out due to time and resource constraints. Therefore, the further collection of data is crucial, in order to get a representative sample, and thus to be able to get more specific results.

For a renewable energy movement in the Galápagos Islands all reasonably technologies should be used, in order to guarantee a fast and adequate realization of the project. Therefore, the entire value chain has to be considered. Another important point is that not only the central projects should be considered, which involve mostly high investment costs and long implementation times. In order to provide incentives to green energy and also to inspire the population to environmental friendly energy, smaller projects should be executed, as their implementation is realized fast. In order to promote small projects of renewable energy systems, a long-term representation of a relevant renewable energy institution in the archipelago should be developed. Such an organization could coordinate and expanse small projects. Further, expertise, responsibilities and trained installers would make it possible for residents to build their own small renewable energy systems.

In addition to further exploration of each factor and their influence on the intensity of local acceptance, the scientific research has to explore concrete methods and measures for the realization of the factors. For instance, how could participatory elements be organized to involve the local populations? Or in which form financial participation schemes could be designed for the residents? These questions will need to be explored further to give relevant stakeholder’s help in the planning process and to improve the cooperation with the local population.

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Annex

A.1 Guideline for semi-structured expert interviews

1. Introduction
- Thanks for willingness to participate in the interview.
- Brief information about the thesis and relation to the project.

2. General opinion about renewables
- What is your general attitude on renewable energy?
- Which factors favor/block the implementation of renewable energy?

3. Future Travel
- Renewable energy by 2050 in Galapagos: please describe how this might look like in your opinion.

4. Infrastructure
- Which infrastructure is needed for the planned renewable energy scenario?
- What is your opinion about the acceptance of the infrastructure of the renewable energies?
- Do result critical factors for the acceptance of renewable energies due to the infrastructure?

5. Economy
- Will the electricity prices increase/ stay the same/ decrease?
- Will be the electricity price higher in the islands than in the mainland?
- Are new jobs created through the project?

6. Participation
- Is the population included or involved during the process?
- Should one include the population more into the project?
- How can the individual citizens be motivated to participate more actively during the energy transition?
- What can companies do to gain more public acceptance for their projects?
- Which sources do you think are relevant/ useful for the general public to find out about renewable energy?
- Do you think that the people of Galápagos are informed sufficiently about the project "Cero combustibles fósiles para Galápagos"?
- Who would have to communicate the energy transition? Politicians, Investors or Implementers?

7. Acceptance in Galápagos:
- Do you think that the people in Ecuador are very skeptical about certain technologies?
- How do you estimate the current acceptance of the project in the population?
- Do you expect changes in the mood among the population in the coming years?
- At which point citizen should be participating?
- Was the local acceptance constant from the beginning of the project or did it change over time? Was there at the beginning concerns / resistance among the population?
- Especially wind turbines lead often to conflicts at the local level. Was there more resistance of wind turbines than the other renewable energy systems during the planning process?
- How to turn affected people into involved parties?
- How can the political level help to strengthen local acceptance?

8. Problem Assessment:
- In which areas are the strongest barriers for the future implementation of renewable energy?
- Worldwide are examples about opposition of the population to projects in the field of renewables. How do you assess the acceptance of the local population on the transition to renewable energy?
- Where do you see problems or risks in the electricity generation by wind turbines?
- Where do you see concrete deficits of the project?
- Some citizens approve renewable energies. However, on the other side they protest against renewable energies in their surroundings. Can one resolve this contradiction?
- Why does the population reject certain technologies?

9. End:
- What can other communities with similar projects learn about Galápagos?
- What other comments do you have on the topic?

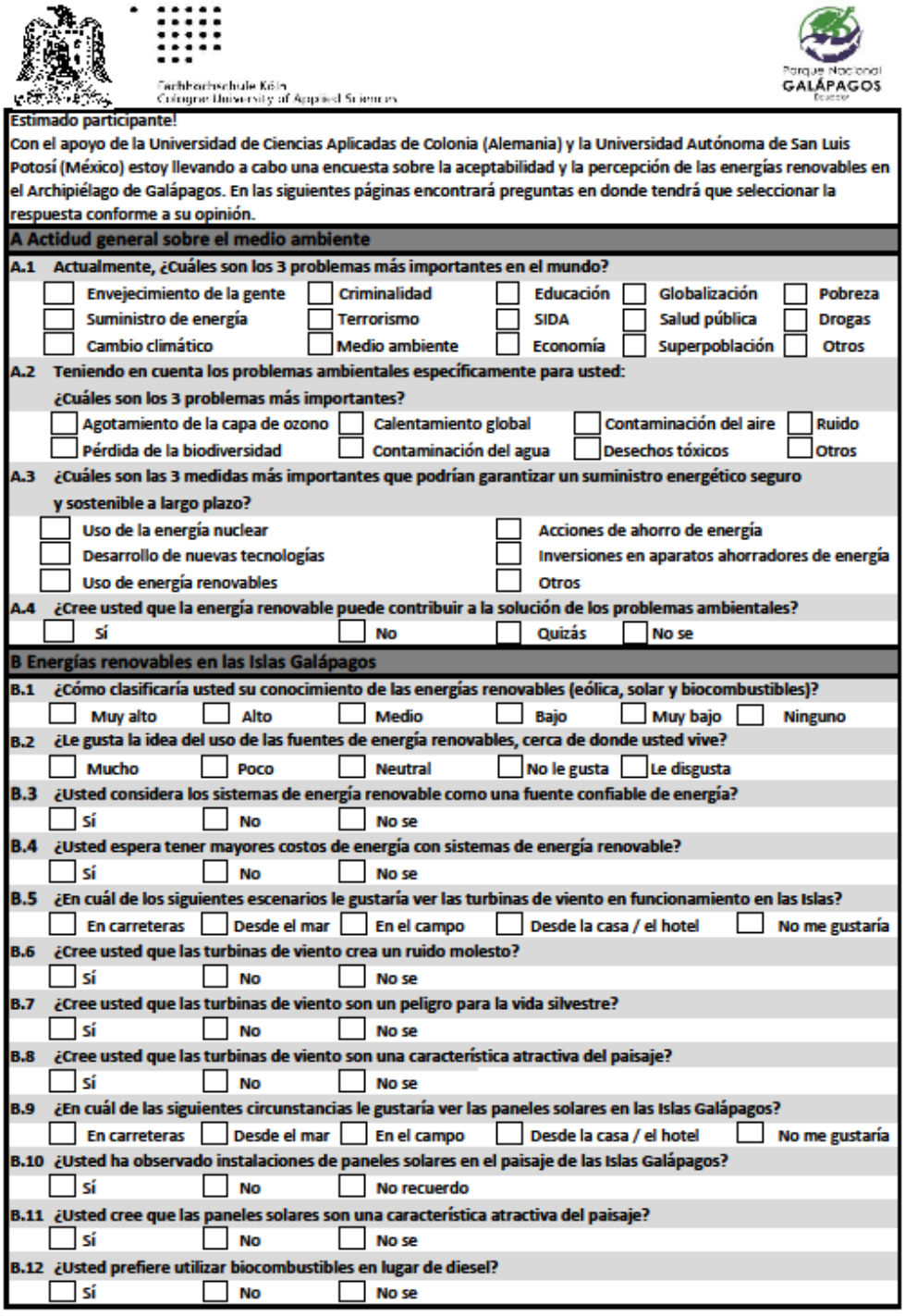
Figure 35

A.2 List of Interview partners

Table 23

Name	Position	Location	Date of Interview
Marcelo Neira	Instituto Nacional de Eficiencia Energética y Energías Renovables (INER): Executive Director	Quito	25.02.2013
Andres Montero	INER: Head of Technology Transfer	Quito	25.02.2013
Adrian Moreno	Ministerio de Electricidad y Energía Renovable (MEER): Renewable Energy and Energy Efficiency Analyst	Quito	25.02.2013
Alfredo Mena	Corporación para la Investigación Energética: Executive Director	Quito	26.02.2013 27.02.2013 01.03.2013 04.03.2013
Alfredo Samaniego	MEER: State Secretary	Quito	27.02.2013
Patricia Recalde	MEER: Director of Biofuels	Quito	27.02.2013
Roque Sevilla	Metropolitan Touring: Chairman of the Board	Quito	28.02.2013
Diego Bonilla	Conservation and Development Foundation: External Consultant	Quito	01.03.2013
Felipe Cruz	Charles Darwin Foundation: Director of Technical Assistance	Quito	01.03.2013
Luis Vintimilla	EOLICSA: Project Manager	Cumbayá	04.03.2013
María Casafont	National Park Galápagos: Tourism Department	Puerto Ayora, Santa Cruz	20.03.2013
Eliecer Cruz	WWF: Eco-regional Director	Puerto Ayora, Santa Cruz	20.03.2013
Maximilian Martín	WWF: Environmental Management	Puerto Ayora, Santa Cruz	20.03.2013
Carlos Zapata	Fundar: NGO Executive Director	Puerto Ayora, Santa Cruz	10.04.2013
Fernando Naranjo	San Cristobal Wind Project: Operation Manager	Puerto Villamil, San Cristóbal	17.04.2013
Roberto Robles	ELECGalapagos: Head of Distribution	Puerto Ayora, Santa Cruz	15.04.2013

A.3 Sample tourist and resident questionnaire



Fachhochschule Köln
Cologne University of Applied Sciences

Parque Nacional GALÁPAGOS Ecuador

Estimado participante!

Con el apoyo de la Universidad de Ciencias Aplicadas de Colonia (Alemania) y la Universidad Autónoma de San Luis Potosí (México) estoy llevando a cabo una encuesta sobre la aceptabilidad y la percepción de las energías renovables en el Archipiélago de Galápagos. En las siguientes páginas encontrará preguntas en donde tendrá que seleccionar la respuesta conforme a su opinión.

A Actidud general sobre el medio ambiente

A.1 Actualmente, ¿Cuáles son los 3 problemas más importantes en el mundo?

☐ Envejecimiento de la gente ☐ Criminalidad ☐ Educación ☐ Globalización ☐ Pobreza
☐ Suministro de energía ☐ Terrorismo ☐ SIDA ☐ Salud pública ☐ Drogas
☐ Cambio climático ☐ Medio ambiente ☐ Economía ☐ Superpoblación ☐ Otros

A.2 Teniendo en cuenta los problemas ambientales específicamente para usted: ¿Cuáles son los 3 problemas más importantes?

☐ Agotamiento de la capa de ozono ☐ Calentamiento global ☐ Contaminación del aire ☐ Ruido
☐ Pérdida de la biodiversidad ☐ Contaminación del agua ☐ Desechos tóxicos ☐ Otros

A.3 ¿Cuáles son las 3 medidas más importantes que podrían garantizar un suministro energético seguro y sostenible a largo plazo?

☐ Uso de la energía nuclear ☐ Acciones de ahorro de energía
☐ Desarrollo de nuevas tecnologías ☐ Inversiones en aparatos ahorradores de energía
☐ Uso de energía renovables ☐ Otros

A.4 ¿Cree usted que la energía renovable puede contribuir a la solución de los problemas ambientales?

☐ Sí ☐ No ☐ Quizás ☐ No se

B Energías renovables en las Islas Galápagos

B.1 ¿Cómo clasificaría usted su conocimiento de las energías renovables (eólica, solar y biocombustibles)?

☐ Muy alto ☐ Alto ☐ Medio ☐ Bajo ☐ Muy bajo ☐ Ninguno

B.2 ¿Le gusta la idea del uso de las fuentes de energía renovables, cerca de donde usted vive?

☐ Mucho ☐ Poco ☐ Neutral ☐ No le gusta ☐ Le disgusta

B.3 ¿Usted considera los sistemas de energía renovable como una fuente confiable de energía?

☐ Sí ☐ No ☐ No se

B.4 ¿Usted espera tener mayores costos de energía con sistemas de energía renovable?

☐ Sí ☐ No ☐ No se

B.5 ¿En cuál de los siguientes escenarios le gustaría ver las turbinas de viento en funcionamiento en las Islas?

☐ En carreteras ☐ Desde el mar ☐ En el campo ☐ Desde la casa / el hotel ☐ No me gustaría

B.6 ¿Cree usted que las turbinas de viento crea un ruido molesto?

☐ Sí ☐ No ☐ No se

B.7 ¿Cree usted que las turbinas de viento son un peligro para la vida silvestre?

☐ Sí ☐ No ☐ No se

B.8 ¿Cree usted que las turbinas de viento son una característica atractiva del paisaje?

☐ Sí ☐ No ☐ No se

B.9 ¿En cuál de las siguientes circunstancias le gustaría ver las paneles solares en las Islas Galápagos?

☐ En carreteras ☐ Desde el mar ☐ En el campo ☐ Desde la casa / el hotel ☐ No me gustaría

B.10 ¿Usted ha observado instalaciones de paneles solares en el paisaje de las Islas Galápagos?

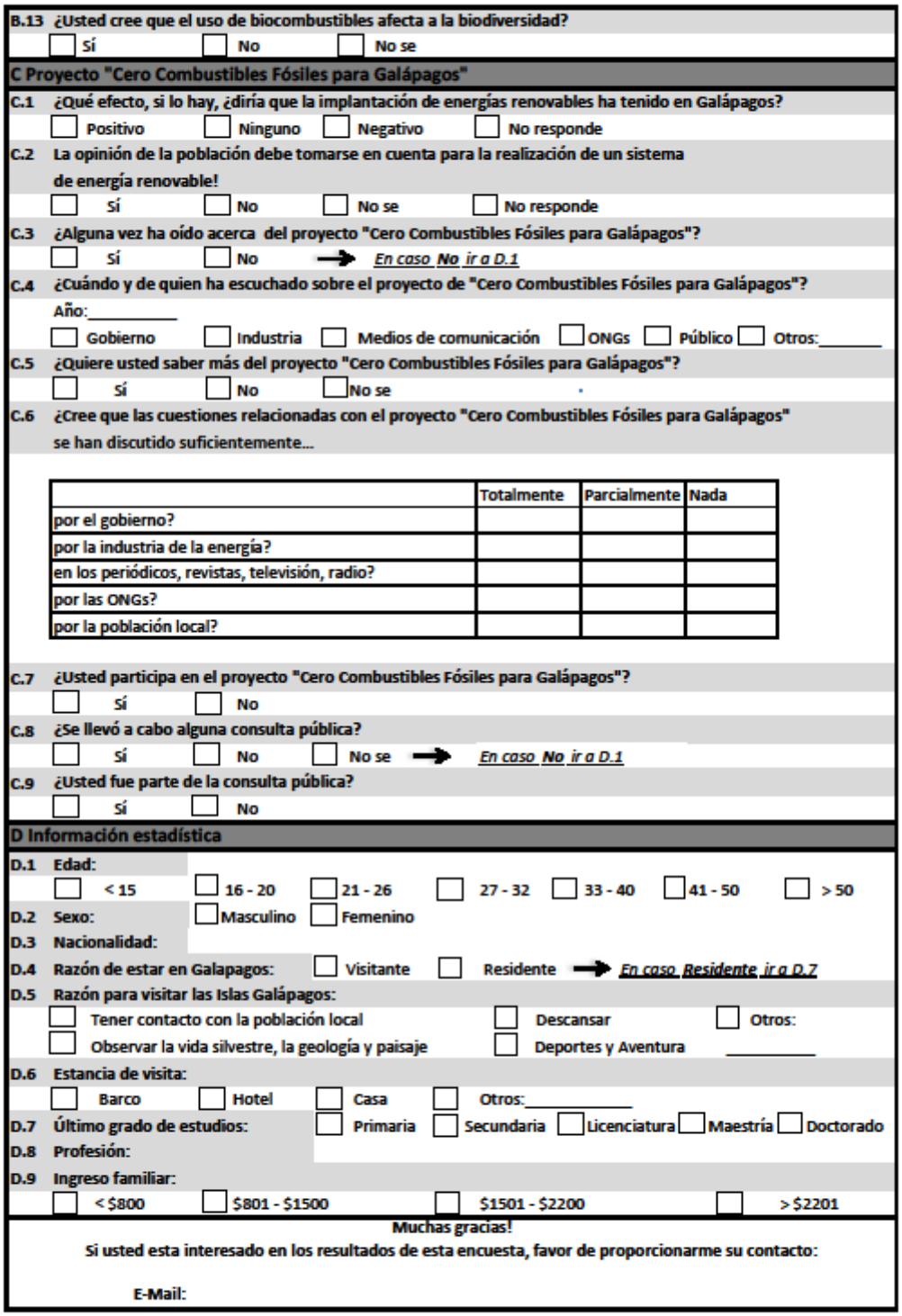
☐ Sí ☐ No ☐ No recuerdo

B.11 ¿Usted cree que las paneles solares son una característica atractiva del paisaje?

☐ Sí ☐ No ☐ No se

B.12 ¿Usted prefiere utilizar biocombustibles en lugar de diesel?

☐ Sí ☐ No ☐ No se



B.13 ¿Usted cree que el uso de biocombustibles afecta a la biodiversidad?

☐ Sí ☐ No ☐ No se

C Proyecto "Cero Combustibles Fósiles para Galápagos"

C.1 ¿Qué efecto, si lo hay, ¿diría que la implantación de energías renovables ha tenido en Galápagos?

☐ Positivo ☐ Ninguno ☐ Negativo ☐ No responde

C.2 La opinión de la población debe tomarse en cuenta para la realización de un sistema de energía renovable!

☐ Sí ☐ No ☐ No se ☐ No responde

C.3 ¿Alguna vez ha oído acerca del proyecto "Cero Combustibles Fósiles para Galápagos"?

☐ Sí ☐ No → *En caso No ir a D.1*

C.4 ¿Cuándo y de quien ha escuchado sobre el proyecto de "Cero Combustibles Fósiles para Galápagos"?

Año:_____

☐ Gobierno ☐ Industria ☐ Medios de comunicación ☐ ONGs ☐ Público ☐ Otros:_____

C.5 ¿Quiere usted saber más del proyecto "Cero Combustibles Fósiles para Galápagos"?

☐ Sí ☐ No ☐ No se

C.6 ¿Cree que las cuestiones relacionadas con el proyecto "Cero Combustibles Fósiles para Galápagos" se han discutido suficientemente...

	Totalmente	Parcialmente	Nada
por el gobierno?			
por la industria de la energía?			
en los periódicos, revistas, televisión, radio?			
por las ONGs?			
por la población local?			

C.7 ¿Usted participa en el proyecto "Cero Combustibles Fósiles para Galápagos"?

☐ Sí ☐ No

C.8 ¿Se llevó a cabo alguna consulta pública?

☐ Sí ☐ No ☐ No se → *En caso No ir a D.1*

C.9 ¿Usted fue parte de la consulta pública?

☐ Sí ☐ No

D Información estadística

D.1 Edad:

☐ < 15 ☐ 16 - 20 ☐ 21 - 26 ☐ 27 - 32 ☐ 33 - 40 ☐ 41 - 50 ☐ > 50

D.2 Sexo: ☐ Masculino ☐ Femenino

D.3 Nacionalidad:

D.4 Razón de estar en Galapagos: ☐ Visitante ☐ Residente → *En caso Residente ir a D.7*

D.5 Razón para visitar las Islas Galápagos:

☐ Tener contacto con la población local ☐ Descansar ☐ Otros:

☐ Observar la vida silvestre, la geología y paisaje ☐ Deportes y Aventura _____

D.6 Estancia de visita:

☐ Barco ☐ Hotel ☐ Casa ☐ Otros:_____

D.7 Último grado de estudios: ☐ Primaria ☐ Secundaria ☐ Licenciatura ☐ Maestría ☐ Doctorado

D.8 Profesión:

D.9 Ingreso familiar:

☐ < $800 ☐ $801 - $1500 ☐ $1501 - $2200 ☐ > $2201

Muchas gracias!

Si usted esta interesado en los resultados de esta encuesta, favor de proporcionarme su contacto:

E-Mail:

Figure 36

Source: Own Elaboration

A.4 Ley de régimen especial para la conservación y desarrollo sustentable de la provincia de Galápagos

Registro Oficial No. 278
18 de marzo de 1998
No. 67
Congreso Nacional el plenario de las comisiones legislativas
Ley de Régimen Especial para la Conservacion y Desarrollo Sustentable de la Provincia de Galápagos
Titulo preliminar

Art. 2 Basic Regulations for the establishment of policies and plans for the province of Galápagos

The development of policies and plans and the execution of public and private works in the province of Galápagos and in the area constituted by the Galápagos Marine Reserve will be governed by the following principles:

1. Preservation of ecological systems and biodiversity in the Province of Galápagos, especially native and endemic diversity, while allowing the continuation of the evolutionary processes of these systems with minimal human interference, in particular taking into account the genetic isolation of the islands and between the islands and the mainland;
2. Sustainable and controlled development within the bearing capacity of the Galápagos province ecosystems;
3. Privileged participation of the local community in development activities and in the sustainable economic use of the islands on the basis of the incorporation of special production, education, training, and employment models;
4. Reduction of the risk of introducing diseases, plagues, and exogenous plant and animal species into the province of Galápagos;
5. Quality of life of residents in the province of Galápagos should match the exceptional features of this Natural Heritage of Mankind;
6. Interaction between inhabited areas and protected land and marine areas should be recognized, as well as the need to ensure the integrated management thereof; and
7. Caution should be used when executing works and activities that may harm the environment or island ecosystems

Capitulo IV: Craft industry
Titulo IX
Art. 73 Glossary

Sustainable Development:

Sustainable development is a dynamic process in which the management of natural resources, citizen empowerment and involvement, scientific and technological advances, the formulation of new legal and administrative schemes, the direction of the economy and of the ethical principles of environmental liability strengthen the options to meet current basic needs without destroying the ecological base on which depend the socioeconomic development and the quality of life of future generations.

The specific requirements for the sustainable development in the case of the province of Galápagos are:

1. To maintain its biodiversity;
2. To maintain its evolutionary processes; and
3. To prevent the direct or indirect introduction or diffusion of exotic species.

Figure 37

Source: National Congress Ecuador, 1998

A. 5 Installed power stations in the archipelago

Table 24

Island	Electricity generation	Potential	
		Nominal (kW)	**Efectiva (kW)**
San Cristóbal	Total Thermal	650	520
		650	520
		650	520
		310	160
		1100	880
	Wind turbine MADE	800	192
		800	190
		800	188
	Total installed	***5760***	***3170***
Santa Cruz	Total Thermal	650	520
		650	520
		650	520
		1100	880
		910	728
		1700	1360
		1700	1360
	Total installed	***8010***	***6408***
Isabela	Total Thermal	650	520
		545	436
		310	160
		545	436
		510	410
	Total installed	***2560***	***1962***
Floreana	Total Thermal	76	56
		76	56
	Total installed	***152***	***112***
Total Islands installed		**16.482**	**11.652**

Source: Elecgalapgos, 2013

A.6 Emitted tons of CO_2 by resources in 2012

Table 25

Resource	Islands	Total
Diesel (Kwh)	San Cristobal	4.913,93
	Santa Cruz	13.696,69
	Isabela	2.003,26
	Floreana	156,74
	Total	***20.771***
Biofuel Piñón (Kwh)	Floreana	49,73
	Total	***49,73***
Wind	San Cristobal	1589,88
	Total	***1589,88***
Photovoltaic	San Cristobal	11,10
	Total	***11,10***
Total emitted tons of CO2		**22.241,33**

Source: Elecgalápgos, 2013

A.7 Statistical Values (Residents)

Table 26

Question		q1	q2	q3	q4	q5	q6	q7	q8	q9	q10	q11	q12	q13
N	Valid	98	99	99	100	100	100	89	100	100	66	100	100	100
	Missing	2	1	1	0	0	0	11	0	0	34	0	0	0
Arithmetic mean		1,79	1,27	2,32	2,22	2,10	1,92	2,10	2,01	1,41	2,32	1,91	1,22	1,63
Standard error of the arithmetic mean		,107	,049	,080	,072	,081	,086	,092	,085	,065	,095	,087	,058	,049
Median		1,00	1,00	3,00	2,00	2,00	2,00	2,00	2,00	1,00	2,50	2,00	1,00	2,00
Mode		1	1	3	2	3	1	3	3	1	3	1	1	2
Standard deviation		1,058	,491	,793	,719	,810	,861	,867	,847	,653	,768	,866	,579	,485
Variance		1,119	,241	,629	,517	,657	,741	,751	,717	,426	,590	,749	,335	,235

Source: Own elaboration, 2013

A.8 Statistical Values (Visitors)

Table 27

Question		q1	q2	q3	q4	q5	q6	q7	q8	q9	q10	q11	q12	q13
N	Valid	56	56	56	56	56	56	39	56	56	23	56	56	56
	Missing	0	0	0	0	0	0	17	0	0	33	0	0	0
Arithmetic mean		1,66	1,48	2,16	2,36	2,36	2,09	2,38	1,95	1,50	2,39	1,61	1,18	1,88
Standard error of the arithmetic mean		,100	,149	,119	,103	,212	,123	,140	,121	,102	,163	,101	,063	,045
Median		1,50	1,00	2,00	3,00	2,00	2,00	3,00	2,00	1,00	3,00	1,00	1,00	2,00
Mode		1	1	3	3	3	3	3	1	1	3	1	1	2
Standard deviation		,745	1,112	,890	,773	1,589	,920	,877	,903	,763	,783	,755	,471	,334
Variance		,556	1,236	,792	,597	2,525	,846	,769	,815	,582	,613	,570	,222	,111

Source: Own elaboration, 2013

q1: Would you like the idea of renewable energy sources close to where you live?
q2: Do you consider renewable energy systems to be a reliable source of energy?
q3: Do you expect to have higher energy costs with renewable energy systems?
q4: Do you think wind turbines create a disturbing noise?
q5: Do you believe that wind turbines are a danger to wildlife?
q6: Do you think wind turbines are an attractive feature of the landscape?
q7: Did you notice solar cells installations in the landscape of Galapagos?
q8: Do you think solar cells are an attractive feature of the landscape?
q9: Do you rather prefer to use biofuels than diesel?
q10: Do you think the use of biofuels affect the biodiversity?
q11: What effect, if any, would you say the implementation of renewable energies has had on the Galapagos?
q12: The population's opinion should be taken into account for the planning of a renewable energy system.
q13: Have you ever heard about the project "Cero Combustible Fósiles para Galápagos"?

A.9 Factor analysis

Table 28

Question/ Statement	Scale	Sample	Mean Values														
			Financial Income				Age							Education			
			< $800	$801 - $1500	$1501 - $2200	> $2201	< 15	16 - 20	21 - 26	27 - 32	33 - 40	41 - 50	> 50	Primary	Secondary	Bachelor	Master
Would you like the idea of renewable energy sources close to where you live?	1= Really like it; 5= Don't like it at all	Resident	1,85	2,00	1,29	1,20	2,00	1,53	1,47	1,61	1,9	2,18	3,00	2,70	1,88	1,35	1,29
		Visitor	2,00	1,83	1,25	1,52	2,00	1,75	1,85	1,75	1,67	1,83	1,27	2,00	1,63	1,67	1,52
Do you consider renewable energy systems to be a reliable source of energy?	1= Yes; 2= Don't know; 3= No	Resident	1,28	1,24	1,14	1,60	1,00	1,06	1,26	1,32	1,37	1,35	1,67	1,50	1,24	1,25	1,00
		Visitor	1,38	1,50	1,50	1,55	1,50	2,75	1,54	1,25	1,17	1,50	1,33	1,43	2,00	1,28	1,48
Do you think wind turbines are an attractive feature of the landscape?	1= Yes; 2= Don't know; 3= No	Resident	1,98	1,78	1,57	2,60	2,00	1,56	1,74	2,05	2,10	2,18	1,67	2,10	1,93	1,95	1,57
		Visitor	1,37	2,17	1,75	2,35	1,50	2,25	2,00	2,75	1,83	2,17	2,00	1,57	2,13	1,83	2,52
Do you think solar cells are an attractive feature of the landscape?	1= Yes; 2= Don't know; 3= No	Resident	1,92	2,05	2,14	2,20	2,75	1,67	2,00	1,84	2,25	2,12	2,00	2,30	1,93	2,05	2,29
		Visitor	1,38	2,33	1,50	2,23	1,50	2,25	2,08	2,25	1,83	2,17	1,67	1,71	2,25	1,89	2,00
Do you rather prefer to use biofuels than diesel?	1= Yes; 2= Don't know; 3= No	Resident	1,50	1,38	1,14	1,60	1,25	1,11	1,58	1,42	1,45	1,41	2,00	1,80	1,29	1,30	2,14
		Visitor	1,50	1,5	1,25	1,52	1,00	2,00	1,77	1,00	1,33	2,00	1,17	1,29	2,13	1,33	1,48
What effect, if any, would you say the implementation of renewable energies has had on the Galapagos?	1= Positive; 2= Don't know; 3= None; 4= Negative	Resident	1,98	2,00	1,57	2,40	2,00	1,33	1,95	2,16	2,35	1,65	2,00	2,10	1,93	1,90	1,71
		Visitor	1,75	2,33	2,00	1,39	2,00	1,50	1,69	1,63	2,00	1,17	1,47	2,14	1,38	1,50	1,57
The population's opinion should be taken into account for the planning of a renewable energy system.	1= Yes; 2= Don't know; 3= No	Resident	1,18	1,30	1,00	1,00	1,25	1,28	1,05	1,11	1,50	1,18	1,33	1,40	1,21	1,20	1,00
		Visitor	1,00	1,50	1,25	1,13	1,25	1,25	1,23	1,00	1,17	1,00	1,27	1,29	1,00	1,22	1,14
Have you ever heard about the project "Cero Combustible Fósiles para Galápagos"?	1= Yes; 2= No	Resident	1,65	1,65	1,43	1,80	1,75	1,56	1,74	1,68	1,75	1,35	1,67	1,70	1,64	1,60	1,71
		Visitor	1,88	1,83	2,00	1,94	1,50	2,00	2,00	1,88	1,67	2,00	1,87	1,57	1,88	1,94	1,95
AVERAGE		**Resident**	**1,66**	**1,67**	**1,41**	**1,80**	**1,75**	**1,39**	**1,60**	**1,65**	**1,83**	**1,67**	**1,92**	**1,95**	**1,63**	**1,58**	**1,59**
		Visitor	**1,53**	**1,87**	**1,56**	**1,70**	**1,53**	**1,99**	**1,77**	**1,69**	**1,58**	**1,73**	**1,50**	**1,63**	**1,80**	**1,58**	**1,70**

Source: Own elaboration, 2013

A.10 Correlation coefficient Spearman (Residents)

Table 29

	q1	q2	q3	q4	q5	q6	q7	q8	q9	q10	q11	q12	q13
Age	**,245***	**,265****	-,143	-,054	-,044	**,206***	**,305****	,105	,158	-,053	,172	,067	-,101
Education	**-,363****	-,100	-,004	,091	-,008	-,095	,032	-,012	,038	,147	-,100	-,120	-,067
Financial Income	-,136	,006	,119	,113	,135	,007	,056	,077	-,107	**,250***	-,137	,040	-,055

Source: Own elaboration, 2013

A.11 Correlation coefficient Spearman (Visitors)

Table 30

	q1	q2	q3	q4	q5	q6	q7	q8	q9	q10	q11	q12	q13
Age	**-,345****	-,064	-,251	-,168	,024	,015	-,012	-,106	,014	-,406	-,122	-,026	,020
Stay	,068	-,130	-,038	,025	**,337***	-,214	-,058	-,230	,037	-,259	,061	,059	,027
Education	-,172	,053	-,091	-,214	-,182	**,271***	-,024	-,005	-,053	-,089	-,086	-,004	,182
Financial Income	-,021	-,072	-,037	,099	-,085	,204	,350*	,058	,036	,269	-,183	-,005	-,160

Source: Own elaboration, 2013

**. Correlation is significant at the level 0.01 (two-tailed)

*. Correlation is significant at the level 0.05 (two-tailed)

q1: Would you like the idea of renewable energy sources close to where you live?
q2: Do you consider renewable energy systems to be a reliable source of energy?
q3: Do you expect to have higher energy costs with renewable energy systems?
q4: Do you think wind turbines create a disturbing noise?
q5: Do you believe that wind turbines are a danger to wildlife?
q6: Do you think wind turbines are an attractive feature of the landscape?
q7: Did you notice solar cells installations in the landscape of Galapagos?
q8: Do you think solar cells are an attractive feature of the landscape?
q9: Do you rather prefer to use biofuels than diesel?
q10: Do you think the use of biofuels affect the biodiversity?
q11: What effect, if any, would you say the implementation of renewable energies has had on the Galapagos?
q12: The population's opinion should be taken into account for the planning of a renewable energy system.
q13: Have you ever heard about the project "Cero Combustible Fósiles para Galápagos"?