Examining the Accessibility of the Development of Non-Conventional Renewable Energies within the Electric Grid in Panama

Final Report

Host

CATHALAC (Vía Vieja De Gajllard, Ciudad del Saber, Clayton, Ciudad de Panamá, Panama)

Supervised by

- Lilian Suarez Donoso, Especialista en Energía y Desarrollos Sostenible. Tel: +507 3173212. Email: lilian.suarez@cathalac.int
- Cristina Tedman, División de Educación. Tel: 507-317-3245 / Fax: 507-317-3299. Email: cristina.tedman@cathalac.int

April 14th, 2016

Claire Bucki - #260551449
Matthew Loxley - #260476875
Patrick Van Wagenen - #260347512

Full days spent in the project in Panama → 20
Full days spent on the field → 5
Introduction

There is no denying the importance of energy in the modern world. Nations require access to energy in order to supply their citizens with the benefits of modern technologies. Since the industrial revolution of the 19th century, societies have been using greater quantities of fossil fuels and other energy sources in order to meet the demands created by advances in technology (Ponting, 284). As industrial processes, transportation, and other energy intensive practices have increased through the last century, so has our dependency on energy. Between 2000 and 2014 global energy consumption has increased by 2.2%, with global net consumption reaching 13,737 million tonnes of oil equivalent (Enerdata, 2015). With the global population still firmly on the rise, energy demand is destined to increase.

While energy consumption provides many benefits, some energy sources come with social and environmental costs. Fossil fuels, which have been the primary source of energy since the industrial era, have many known detrimental effects on the environment through the emissions of CO2 and other greenhouse gases. Furthermore, these fuels are non-renewable sources of energy in finite supply, and they are quickly being depleted by global demand for energy (Bose, 2013). Finally, with the increased scarcity of fossil fuels, particularly petroleum, electricity produced through these energy sources is becoming increasingly expensive. These three factors call for a change in consumption habits, different sources of energy, or both. As a result, a growing market for renewable energy sources is emerging, and many countries are shifting towards their development. In 2014, 22.9% of the energy produced worldwide was from renewable sources (Enerdata, 2015). Renewable energy sources are now seen as not only viable, but possibly the only solutions
to transition from fossil fuels and carbon-intensive energy into a cleaner and more environmentally respectful alternative.

Renewable energy sources are distinct from non-renewable sources in that they are inexhaustible, originating from flows of energy that occur in nature. They involve harnessing energy from wind, solar radiation, geothermal heat, biomass, and water waves, tides and movement to convert into electricity (Bose, 2013). Moreover, renewable energies can be split into two categories: conventional and non-conventional. Hydroelectricity, harnessed on a large scale, is the only conventional renewable energy source. Thus, non-conventional renewable energies come from all of the other above mentioned sources, and includes hydroelectricity that is harnessed on a small-scale for personal use in one’s home (Bose, 2013). There is a substantial amount of research for development in this field, especially to increase its cost-effectiveness, which may spark interest in consumers. Developing countries have the opportunity to develop their energy sector through investment in renewable energies, curtailing dependence on fossil fuels while reaping the long-term benefits of being energy-independent.

The current developments in energy use in Central America are crucial not only to the economic expansion of these countries, but also to the environmental health of the planet. As a result of the development currently underway in Central America, energy demand in the region is rising (Dolezal et al., 2013). How these countries address their growing energy demands will undoubtedly affect their own sustainability, as well as the capacity for the world to achieve global emissions reductions in the efforts for climate change mitigation. On the plus side, Central America has been one of the most prominent users of renewable energy sources globally. According to the 2013 report “The Way
Forward for Renewable Energy in Central America,” 62% of electricity in Central America’s grid comes from renewable sources. Hydropower has been the dominant energy source, but almost all renewable energy sources could serve the region greatly. Geothermal power alone, if used to its full potential, could supply the region with double its projected energy needs through 2020. Estimates gauge the current use of wind energy as only one percent of the region’s potential for wind power. Furthermore, most countries in Central America receive twice to three times the solar radiation than the current principal users of solar technologies (Dolezal et al., 2013). Unfortunately, most Central American countries are planning to increase imports of fossil fuels to meet their growing needs for transportation and generation of electricity (Dolezal et al., 2013). Although these countries could satisfy their energy demand entirely through renewable energy sources, the region continues to rely on fossil fuels.

Panama occupies an interesting space in the Central American system of energy generation and consumption. Due to economic growth, electricity consumption in Panama has been rising by six to seven percent annually for the past decade, leading to greater domestic use of oil and petroleum. In 2013, these fossil fuels represented 69% of total energy consumption, and their use has increased at a faster rate in Panama than any other country in Central America (Dolezal et al., 2013). In contrast to this, Panama has some of the most ambitious renewable energy projects in the region. Panama has seen seven new hydropower plants in 2011 alone, and the country has also begun to electrify its public transportation (Dolezal et al., 2013). On top of this, Law 44 of April 2011 promises to bring significant future investment in wind energy by offering financial incentives, such as tax deductions, to make wind energy projects more advantageous than
fossil fuels in the energy market (Asamblea Nacional, 2011). Later in 2011, as a result of Law 44, the first wind energy tender in Panama took place, wherein 121 megawatts (MW) of wind energy were auctioned off for a period of 15 years. The fierce competition observed during this tender clearly indicates interest in Panama for renewable energy sources (Palencia-Calvo, 2012). Since then, the government has issued over 800 MW in wind licenses (Dolezal et al., 2013). Aside from constructing renewable energy, Panama has also implemented intensive policies to reduce emissions and adapt to climate change.

In order to create an effective plan to ensure energy security in Panama’s future, the government must determine what future challenges face the country. The Plan Energético Nacional (PEN) 2015 – 2050 uses data collected from 1970 to 2014 by the Secretaría Nacional de Energía, as well as projections of the price of combustibles and some macroeconomic variables from a number of organizations, to predict the future of energy consumption in Panama. This information is then used to create an energetic program for the next 35 years, with the intent of improving energy security (PEN, 2015). This PEN had been impulsed by the government as a result of numerous meetings between the Programa de las Naciones Unidas para el Desarrollo (PNUD) and the Secretaría Nacional de Energía, gathering hundreds of people from the public sector, indigenous communities, private sector and the public. The plan estimates that at least 70% of the energy should come from the renewable energies by 2050, with an emphasis on solar and wind energies (ASEP). To calculate projections for the future of energy demand in Panama, the Secretaría Nacional de Energía has broken down the growth of energy into two scenarios for the PEN. The reference scenario predicts Panama’s future if growth continues in a similar fashion as it has been in the past 45 years, taking into
account improvements in the efficiency of future technologies; the SNE foresees an annual growth rate of 4.9% in the demand for electricity from 2015 to 2050 (PEN, 2015). The second scenario, or alternative scenario, takes into account various factors that can affect energy demand in the 35 year period, as well as different sources of energy that Panama may take advantage of.

Perhaps most significant to this study is this difference between the two scenarios with respect to sources of energy. The reference scenario has Panama supplied with the same hydroelectric energy plants already constructed, with no more being constructed from 2015 to 2050. On top of this, there are large projected increases in the use of carbon and liquefied natural gas. These combined sources of energy will not be efficient enough to meet Panama’s energy demands; thus, energy sources will also need to be imported (PEN, 2015). In contrast, the alternative scenario has slight increases in the use of hydroelectric plants, and large increases in future use of solar and wind energy technology. The PEN predicts 44.5% of the energy demand of Panama in 2050 will be supplied by non-conventional renewable energies: 30.9% will be solar, and 13.6% will be wind (PEN, 2015). These numbers represent tremendous increases in the use of both of these energy sources for Panama. Renewable energy sources will not be able to meet the entire energy demand for Panama in 2050, and thus carbon, liquefied natural gas and imported sources will still be required. Despite this, these projections represent substantial savings for Panama economically and significant improvements in reducing the country’s carbon footprint. Renewable energies not only promise Panama economic savings, but huge reductions in its greenhouse gas emissions.
Using information from the PEN 2015-2050, the government created a strategy focusing on mitigating climate change. The Estrategia Nacional de Cambio Climático de Panamá (ENCCP) aims, partly, to guide Panama to a developmental model that is lower in emissions. It also seeks to enhance the ability, especially of the most vulnerable populations, to adapt to climate change, by implementing specific steps for adaptation (ENCCP, 2015). The Panamanian government seeks to accomplish the goals of the ENCCP by focusing on three main components, the first being adaptation strategies focusing on the security and resilience of a number of sectors. Specifically, it addresses energy, food, water, marine/coastal and logistics security, as well as resilient districts (ENCCP, 2015). Aside from adaptations, the ENCCP includes steps for development in the reduction of emissions. Again, this broad objective is broken down into strategies tailored to different sectors: energy, urban mobility, REDD+ (Reducing Emissions from Deforestation and forest Degradation), emissions trading, and green government initiatives (ENCCP, 2015). The last component of the Estrategia Nacional de Cambio Climático de Panamá is the development of capacities and the updating of technologies that will better serve the nation in the future. As stated in the ENCCP, there is a shortage of information as well as technologies that address adaptation to and mitigation of the harmful effects of climate change. Thus, this final component seeks to address this shortage by strengthening the utilization and the capacities of the latest technologies in this field (ENCCP, 2015). However, the possibility of using non-conventional renewable energies within urban areas that already have access to the power grid is commonly overlooked, as this option is not well known to the general public nor has it achieved sufficient awareness in the large electricity-generating companies in Panama.
Therefore, it is assumed that barriers exist preventing the development of NCRE. These barriers could include, but are not limited to: social, lack of skills/skilled labour, costs/investments, market, norms, institutional/political, lack of information/knowledge, technological (ability to import the technologies), and barriers to the electricity system. There exists a need to identify which barriers are present in order to properly allocate resources and develop appropriate strategies. These are the initial steps towards a transition to renewable energies.

This project will investigate the barriers to and the requirements for the use of non-conventional renewable energy sources in urban areas of Panama, in particular Panama City. The purpose of this study is to determine:

What are the barriers to, and the requirements for, developing non-conventional renewable energies within the established power grid in urban settings in Panama?

In order to answer this question, the study will explore access limitations and barriers to the use of non-conventional renewable energy in Panama. In addition, the laws, norms and regulations that govern the use of NCRE will be examined. Finally it will determine the level of interest in the general population and businesses for utilizing NCRE. The results of this study will provide the appropriate information in order to establish a strategic action plan addressing the barriers to NCRE development.

### Methods

1. **Research design**

The objective of this study as proposed by CATHALAC is to define the requirements for the generation of electricity using non-conventional renewable energy
sources for urban settings established within the electrical grid, especially in terms of regulations and policies. Three different methods are used to answer the research question: conducting public surveys (see Annexe 1 for a sample), cross-sectional, semi-structured interviews with officials here in Panama (see Annexe 2), and literature review.

1. Public surveys

In order to explore public opinion, awareness and perception regarding the research objectives, public surveys are used to collect information anonymously, effectively, and efficiently. Due to limitations of both time and spatial constraints, only a sample portion of the total population is surveyed. While this sample size only reflects a portion of the population’s opinions, it can be extrapolated to make inferences regarding larger populations. Surveys are a primary source of information, meaning the information is collected directly from the source, which adds credibility to the results. Thus, sample surveys had been orally conducted, to a population sample of 100 individuals. This sample size is selected because it is large enough to be representative, while realistically achievable in the allocated study time. Moreover, a sample size of 100 is convenient for statistical analysis. Public surveying also allows for uniform data collection as the questions are standardized amongst individuals surveyed. The surveys are conducted through a random, convenience sampling method, as no particular portion of the population is targeted. The survey is organized in a strategic manner and is of appropriate length in order to ensure people are willing to participate (14 questions), while being precise and diverse in questions asked in order to obtain the answers and opinions crucial for the study. Thus, the survey begins with two demographic questions (sex and age range), and continues with simple and broad closed-ended questions related
to non-conventional renewable energies, the overall topic of the survey (knowledge about NCRE, utilization of any of them within the house, or desire to use any in the future).

These questions are sometimes followed by an open-ended question to add more details to the answer. Questions incorporating multiple choices and a Likert scale are also included to standardize responses. The final questions are regarding the laws that influence the implementation of NCRE and an eventual perception of government incentives and initiatives towards implementing these energies sources. Finally, some sensitive demographic questions such as the residential area or the salary range of participants for the purpose of correlation statistics is left to the end of the survey, allowing participants to leave if they chose without affecting the rest of the survey.

2. *Interviews with Officials*

The second method involves two cross-sectional, face to face, semi-structured interviews aimed at officials here in Panama. These interviews are aimed at investigating incentives and programs encouraging the use of NCRE, as well as the laws and regulations that govern them. The interviews are composed primarily of open-ended questions, with a few closed-ended questions and a multiple-choice question as well. However follow-up questions are asked whenever further information is necessary. The interviews, composed of 14 questions, begin with an introduction to the role of the interviewee and their entity, in regards to the energy sector. Then, this introduction is followed by basic questions regarding NCRE and electricity in the country. As a semi-structured interview, there is not a specific procedure and therefore the information that is gathered is dependent on what the interviewee chooses to share. However, the interview
is guided by a series of questions in order to obtain information of interest to the study. Finally, a more precise question about their perception of barriers to the implementation of NCRE in Panama is asked. For better comprehension and analysis, the interviews are recorded on a voice recorder, assuming consent is given.

3. Literature review

A literature review is judged as useful in order to understand the context of the study and explore more on subjects mentioned during the interviews. Thus, through the exploration of websites and links provided in the interviews, as well as law extracts online going more in depth regarding access to NCRE, a more complete understanding of the accessibility of NCRE as means of generating energy within the power grid in Panama can be obtained.

2. Study sites and populations

1. Public surveys

The public surveys conducted are aimed at Panamanians living in urban settings, principally within the city of Panama where the surveys are conducted. They are designed to gauge awareness of these energy sources, as well as willingness and feasibility to adopt them, while identifying the presence of any barriers to the utilization of NCRE. This survey was initially aimed at individuals, schools officials and business owners, but the scope of the study has been reduced to focus on the public perspective exclusively. This survey was originally supposed to be conducted in five different locations through the city of Panama. However, after conducting a pilot study in La Plaza within La Ciudad
del Saber, it was determined that surveying in locations of high population density and diversity would result in more efficient data collection while maintaining high demographic diversity. Therefore, survey efforts are focused in Albrook Mall, a transportation hub and one of the largest malls in Panama that brings together people from a wide range of backgrounds. This allows for a diverse sample of survey participants. The scope of our project was mainly limited to Panama City due to logistics of conducting surveys in person.

2. **Interviews with officials**

The number of officials interviewed is determined by the availability of the contacts given to us by our host. All potential-interviewees are sent an introductory email by CATHALAC to present the context and objectives of the research and to ascertain their willingness to participate. Organizations in contact with CATHALAC include the Secretaría Nacional de Energía, the Operations Division of Ciudad del Saber, ASEP (Autoridad Nacional de los Servicios Públicos) and MIAMBIENTE (Ministerio de Ambiente de Panamá). In the end, two organizations responded and agreed to interviews: two correspondents from the Secretaría Nacional de Energía, and a correspondent from the Operations Division of Ciudad del Saber.

3. **Data collection protocol**

   1. **Code of Ethics and Conduct**

   As for any research method involving human subjects serving as a data source, a code of research ethics must be respected through the course of the study. One of the
most important principles to adopt in any study involving human participation is the respect of the participant’s autonomy, privacy and dignity. This means that any researcher must value the dignity and worth of all persons equally and respect them and their individual and cultural differences. Moreover, researchers have a clear duty to respect the privacy and self-determination of participants, as well as a responsibility to develop and follow procedures for valid consent and confidentiality. Conforming to these standards, the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans Course on Research is completed (see annexe 3), and research is carried out following the Code of Ethics and Conduct of McGill University.

2. **Consent**

For the public surveys, in order to respect the Code of Ethics and Conduct of McGill University in this research, a standardized oral consent statement is administered before each survey. This includes an explanation of the nature of the research as well as the surveyor’s identity and affiliations. It asks for consent to participate in the study and makes it clear that participants may withdraw at any time after having agreed to participate. Finally, it states that all of data procured from the survey would remain confidential and that the data will only be used in the context of the study. Furthermore, the survey is anonymous, without any identifying questions, to respect the participants’ privacies.
3. **Permits**

In order to be able to conduct our public surveys through Albrook Mall, we had to query for an official permit from the mall. Supported by a letter from our supervisor, Ariel Espino, explaining the scope of our research through our class at McGill University, we have successfully been able to obtain a permit from Albrook which allowed us to complete our public surveys on Thursday, April 7th (*Permit shown in Annex 4*).

4. **Data analysis**

   1. **Public Surveys**

      In order to analyze the surveys, a statistical analysis of the data collected is accomplished, and graphs are created from this analysis. Moreover, while emphasizing the significant trends of the answers collected, correlations are explored between responses regarding opinion and demographics in order to determine patterns in the responses.

   2. **Officials surveys**

      The two interviews are conducted in an exploratory scope. Upon transcribed the notes from the interviews and the voice recordings, the data collected is used to compare the perception and knowledge of the officials regarding the NCRE to the perception and knowledge of those same NCRE that has been extracted from the public surveys. Information regarding the laws and regulations regarding NCREs, as well as any other information pertinent to the study is used as is appropriate.
Results

1. Public survey results

The results of this section are based on 100 public surveys. Out of the 100 surveys conducted, 39 were males and 61 were females, falling under a fairly even distribution amongst the different age ranges. The participants lived predominantly in Panama City and the surrounding areas, but were not concentrated in one particular area (shown on the map below). There were also participants from outside of Panama City, principally Colón.

![Map of Panama City showing distribution of participants](image.jpg)

*Figure 1: Distribution of the participants in Panama City*

Over 50% (57) of participants knew what NCRE were, and could name at least one type. Some did provide water or hydro as an example of a NCRE which, while not
falling into the spectrum, were recorded as well. The most commonly known NCRE was solar panels, with 37 occurrences. Following closely behind was wind energy, with 29 mentions. The remaining 18 were split between hydroelectricity (9), biomass (7) and tidal or ocean (2). This answers are depicted on graph 1.

While over half of the participants knew of at least one form of NCRE, only 8 participants said they were currently using NCRE in their home. Of those, 4 were using solar panels, while the remaining 4 could not provide the information. An additional 2 participants were unsure of whether they used NCREs or not, while the remaining 90 participants did not use NCRE at home.
Although the number of current NCRE users is low, there was significant interest in using NCRE, with 55 individuals saying they plan to use NCRE in the future. The most common response was that they planned to install solar panels (33), particularly if they became more affordable. Six participants plan on using wind turbines, while the remaining respondents would be interested in implementing NCRE if it became feasible for them to use them.

To the affirmative statement that the access to NCRE is limited in Panama, the majority of the participants agreed, with 39 individuals agreeing and 30 individuals strongly agreeing with the statement. In comparison, 15 and 8 individuals disagreed and strongly disagreed, respectively. Two participants were indifferent to the statement, while the remaining six did not know. These results are depicted in the graph 2.

![Graph 2: Perception of whether access to NCRE is limited](image-url)
To the question asking participants what they perceive to be the barriers to developing NCRE in Panama, considering multiple responses per individual could be recorded resulting in the total responses exceeding 100, the barrier most commonly mentioned was “lack of knowledge” (56). “Financial” barriers, including cost of investments, was mentioned 52 times; of those that thought financial barriers existed, 50 would be interested in implementing NCRE if it became more economical than conventional energy sources in the future. “Infrastructure” was identified as a barrier 22 times by participants, while restrictions from laws and regulations were identified 16 times. “Lack of time” was mentioned on 7 occasions. Other barriers that were identified by participants were “unsuitable conditions in Panama” (3), “lack of will or interest” (3), “not enough government support” (2), and “difficulty to implement the technology” (2). The remaining three participants believed barriers to the use of NCRE did not exist. Results are depicted in graph 3.

Graph 3: Perceived Barriers to NCRE
Responses to the question regarding opinion on the price of electricity in Panama is depicted in graph 4. It shows the relatively even split between responses of very expensive, expensive, and reasonable, 39, 25, and 32 respectively. Responses of “cheap” and “very cheap” were received twice each.

When asked about knowledge of laws, norms and regulations that govern the use of NCRE in private homes, 14 of the 100 participants replied that they had some knowledge; Seven of them provided examples of actual laws, mostly related to hydroelectric generation. While the frequency of existing knowledge regarding the laws and regulations is low, almost all participants (94) said they would be interested in
learning more about NCRE technologies and the laws and regulations that govern them. Finally, 27 participants believe there is political initiative to promote public use of NCRE, while 64 believe there isn’t and the remaining 9 participants stated that they were unsure.

2. **Interviews with officials**

   1. **La Secretaría Nacional de Energía**

   La Secretaría Nacional de Energía is in charge of making the norms, regulations, and laws for the energy sector, in particular regarding the use of wind, solar, biofuel and bio-combustible energy forms in Panama. They also create laws that provide incentives and benefits for investors in the energy sector. The interview with officials from La Secretaría Nacional de Energía helped identify these regulations governing the use of NCRE as well as incentives provided. The interview also helped to identify possible barriers to the use of NCRE that are present within Panama, and gave opinions from the “official’s” perspective that can be used in comparison with the public opinions gathered through the surveys. The focus of the interview was on solar panel energy, as they believe it to be the most accessible and promising for development due to energy production that match peak demand periods during the day.

   Three legislations governing the use of NCRE in Panama were found to be relevant to this study:

   Law 37, which was approved by the National Assembly on June 10th, 2013, establishes a number of incentives to encourage the adoption of solar power technologies. Under this new law, anyone looking to construct solar energy equipment or facilities are
exempt from duties, income taxes, levies, liens, and other government fees that would otherwise be imposed when purchasing these materials and equipment, either within Panama’s national market or imported. This applies to both photovoltaic and thermal solar energy systems, thus solar water heaters, solar collectors, solar panels and individual solar cells are all exempt. Also exempt are solar inverters, solar accumulators, and any other equipment or software that is used for solar energy projects.

Law 45 states that the individuals who develop individual central generation systems of clean and renewable generation (such as hydraulic, solar, wind and biomass energy) with up to 500 kW of installed capacity shall enjoy exemption from import duties, levies and charges, as well as any transfer tax that could be caused by the importation of equipment, machines, materials and other necessary item for its construction, operation and maintenance.

Finally, resolution 5399 governs the Net-metering program. This program is used in conjunction with NCRE connected to the power grid. The electricity that is generated by the NCRE is bought by the electricity companies at market price, and it is sent back to the grid for general use. Individual electricity generation and use is kept track of through a two-way electricity meter, and at the end of each month the user pays the net difference between energy used and energy produced. The Net-metering program only encompasses renewable energy systems up to 500kW in capacity, however a system with that capacity exceeds what would cover the energy use in a residential homes.

Aside from the above laws and resolution, which act as incentives for the use of NCRE, no other existing laws or regulations were encountered from this interview. No regulations were identified that may limit the use of, or prevent access to, NCRE.
The greatest barrier to the development of NCRE as identified by the officials of La Secretaría de Energía is improper infrastructure. This barrier has many dimensions. First, housing in this region is built with the intention of withstanding weather phenomena such as flooding, not oriented towards the use of NCRE. This results in inadequate structural integrity of many houses to support the weight of solar panels on their roofs. Changing infrastructure in response to Resolution 5399 has also increased house vulnerability to extreme weather conditions, again primarily flooding during the rainy season.

Another challenge to adopting NCRE, particularly solar panels, is limited space, as many houses have water storage on their roofs. This introduces a trade-off between water storage and renewable energy, as in most cases the roof cannot accommodate both. It would therefore require infrastructure change for those that already have water storage built on their houses, further increasing costs as well as introducing the additional challenge of relocating their water storage equipment.

The lack of knowledge and relevant education presents a significant barrier to the development of NCRE on two fronts. First, inadequate knowledge of NCRE in the general public leads to a lack of trust in the benefits of NCRE, which reduces public willingness to install them in their homes. Second, there is limited access to education in technical fields related to NCRE. Post-secondary education programs that train technicians are scarce, or not even offered in Panama. Programs existed in the past, but post-graduation employment levels were low and therefore the programs were discontinued. Furthermore, technicians working with NCREs must work with direct current, but this is only taught in high school; university programs teach alternating
current. Technicians don’t want the responsibility of working with direct current, further contributing to the shortage of technicians. These are significant problems, as they reduce the supply of skilled labour in this field capable of providing technical support necessary for the installation and maintenance of NCREs. Maintenance and installation of these systems thus become very difficult and costly, further averting public interest. Currently solar panel companies that are in the market are only obligated through their contract to provide maintenance over a certain time period, after which they leave it up to the owner to organize maintenance. This leads to deterioration of equipment after contracts expire, as there are few maintenance programs available.

Yet another barrier is the incapability to purchase materials and equipment, due to issues of finances of general access. All NCRE equipment in Panama is imported; only distribution companies are located in the country. This creates the challenge of actually acquiring the equipment, as the market is located outside of Panama. However, there are subsidies (Law 37 & Law 44) that encourage importation of renewable energy materials, creating incentives and reducing financial barriers that might otherwise exist. Therefore the problem is not strictly financial, but may just be a concern of accessibility.

Solutions and potential ways forward offered by La Secretaría Nacional de Energía include better education and increased outreach for the general public to reduce misconceptions of NCRE, increase trust in NCRE, and initiate changes in infrastructure to accommodate them. La Secretaría Nacional de Energía also suggests increased efforts to provide sufficient curriculum to support the technician workforce in charge of maintenance and upkeep. They are actively working towards this goal through seminars and outreach events, focusing on NCRE education in universities and other settings.
2. **Operations Division of la Ciudad del Saber**

The City of Knowledge (CDS) in Clayton, Panama is a non-profit organization dedicated to promoting education, technology, and sustainability. It consists of a 300-acre campus with over 200 buildings, leased by companies and NGOs that embody those three components. The role of the operations unit of Ciudad del Saber is to ensure the city is sustainable as a whole. While individual companies are in charge of their own initiatives, Operations at CDS advises organizations on their investments and execution of renewable energy initiatives, and overlooks any structural changes that are implemented. Operations also manages the public buildings in CDS, and have recently installed solar panels on two of their main buildings, with plans to expand the capacity of these installations in the future. The purpose of the interview was to determine the process of acquiring, installing, and financing solar panels for personal use in order to identify potential barriers and to determine how accessible the process may be to the general public.

In the interview, the process for acquiring solar panels for residential buildings was outlined. Once a solar panel company has been chosen, a series of permits and building schematics must be acquired. These include a drawing of the electrical layout of the building for purposes of a price quote, and a permit from the fire department. The electric company then certifies that the schematics are correct before installation of the panels commences. Additional certification may be required by a civil engineer to ensure the roof can withstand the weight of the solar panels, as the solar panel company does not take any responsibility for risk of structural failure. The costs for the engineer’s certification is covered by the owner. However, the rest of the procedures for acquiring
the necessary permits and certifications, including the costs, are covered by the solar panel company. The entire installation and certification process for the solar panels takes approximately 2 months, however the electricity company is in charge of installing the two-way meter and connecting the panels to the power grid to ensure the energy produced is properly tracked. This process can extend the time period needed.

A commonly perceived barrier to using solar panels is finances, as they are seen as a very complicated, expensive technology. However, prices have gone down over the last few years, and financing programs are now offered by these companies to mitigate the costs. These programs, in conjunction with the net-metering program, consist of the solar companies making the upfront investment and risk, while using the savings received from the electricity company through the net-metering program to finance the costs of the panels. Once the costs have been covered, along with any interest and profits, the ownership of the panels is transferred to the property owner, who then begins to experience the savings.

Limitations may also exist in the form of lack of advertising of these NCRE for homeowners, though companies and larger corporations may be approached by solar panel companies. This presents an area where increased knowledge and awareness would be beneficial for the development of NCRE.

**Discussion**

Currently, the most accessible source of non-conventional renewable energy for private use in Panama is solar photovoltaic. A market for this technology already exists within Panama; several companies currently supply solar panels to businesses and individuals. Materials must be
imported, which does present a potential access limitation to these technologies. Furthermore, relying on imported equipment may present limitations depending on fluctuations in the market and other external factors. However, subsidies and other incentives encouraging the importation of renewable energy technologies work effectively to combat this restriction. The actual process for acquiring and installing solar panels is not particularly complicated for the consumer once they have found a provider. The entire process is managed by the solar panel company, with the exception of obtaining a structural evaluation by a civil engineer which is based on the discretion of the consumer. The time period for installation is also relatively short; the entire process can be completed within two months. The entire process makes acquiring solar voltaic systems accessible for citizens of various backgrounds and removes restrictions that may arise from limited knowledge of, or ability to obtain, the series of permits required for installation. Furthermore, accessibility is not restricted by laws or regulations. On the contrary, the laws and regulations in place, of which many were passed within the last decade, work to increase accessibility through reducing restrictions and increasing incentives and benefits for implementing them. Law 37, for example, provides tax exemptions for anybody purchasing materials and equipment for the construction of any solar power systems, whether photovoltaic or solar thermal.

Awareness of NCRE was fairly high in the public surveys, with 57 people being able to identify a type of NCRE. Solar panels were the most commonly known type of NCRE by those surveyed; this implies that solar technology may be quicker to popularize on a broad scale, as it is already recognized by the general public. While photovoltaic solar energy seems to be highly accessible, actual use of solar energy and other NCREs is low according to the surveys. Only 8 of the 100 participants surveyed saying they currently use a form of NCRE, of which 4 seemed unsure as to which kind they used. Additionally, the majority of those interviewed (69) believed that access to NCRE is limited in Panama. These two results may be connected: the general public deems NCREs as inaccessible, and as a result they do not access them. From this there
seems to be a disconnect between the actual accessibility of NCRE and the perceived accessibility, likely impacting their usage. As a result, public opinion regarding NCRE may be the greatest limitation to their development within the energy grid in Panama.

Unfavorable public perception of NCREs can be accredited in part to lack of knowledge. This barrier was not only cited 56 times in public surveys, but was also specifically mentioned by officials. Furthermore, lack of knowledge can be associated with several other findings from this study. For example, barriers related to finances and investment were commonly recognized amongst participants, however this sentiment was not shared by the officials. Over half of the participants (52) believe financial barriers exist to potential investment in NCRE, with many comments related to the cost of the technology, particularly solar panels, being too expensive. In spite of this, financial programs are available that make NCREs affordable to implement, and once the equipment is paid off, the consumer receives significant savings on their electric bill. Other programs such as net-metering also supplement the costs of electricity, thus the consumer would incur minimal costs through these programs. This is significant as the majority of respondents thought electricity was too expensive. Furthermore, 96% of the respondents who believed financial barriers existed would be willing to implement NCREs if they were more economical than conventional energy sources in the future. It is very likely to assume that these participants would be interested in taking advantage of the opportunity presented by these financial programs; unfortunately, they do not seem to be widely known. Considering these factors, increasing awareness of these programs would most likely result in greater use.

The difference in perceived barriers between officials and the public represents another area where lack of knowledge is present as a barrier. It demonstrates that better communication between the two entities, as well as more efficient and consistent sharing and distribution of information, would significantly benefit the shift towards more NCREs. This is apparent in the lack of knowledge about laws and regulations regarding NCRE use, particularly those that provide incentives and benefits to their use, such as the subsidies and benefits from Law 37 and
Resolution AN-5399. Laws and regulations were actually deemed a barrier by 15 individuals, and while this represents a small percentage of the sample size, it further demonstrates misconceptions about the laws governing the accessibility of NCRE. Furthermore, few participants knew of existing laws, with only 14 individuals saying they had any knowledge. Of these, 7 participants mentioned laws that strictly apply to hydroelectricity. The lack of knowledge regarding the laws and regulations that govern their use, particularly because they increase access rather than limit it, could be a barrier to the development of NCRE. The public surveys show 64% of participants believe there is little to no government initiative to promote public use of NCRE. Yet this does not reflect recent government activity, as many of these laws have been passed recently and should be well known by the public. There is however a strong response to learning more about these laws, with 94 participants saying they would be willing to learn more about the laws and requirements for implementing NCREs. If these laws were advertised more effectively, the public would likely change their views of NCREs as inaccessible and expensive. Until there is better sharing of information, the development of NCRE within established energy grid will be limited. Education in these areas should therefore be an avenue to explore as a way forward.

Infrastructure was expressed as the major barrier to developing NCREs by officials, though less commonly expressed as a concern in the surveys, with only 22 individuals. This may also represent the most challenging barrier to overcome. The nature of this problem could be very widespread, affecting a large number of housing structures. New legislation may also be hard to implement as infrastructure is already well established and may then only be applicable to newer buildings. Both of these factors would result in the barrier becoming very expensive to deal with. However, until infrastructure changes, the barrier will persist.

There were minimal correlations found within the results of the public survey. Both age and salary were factors used in combination with other responses to determine any trends in the results.
The most significant distinction within the age correlations was age of respondent and knowledge of NCRE. The age group of 15-25, one of the smallest ranges, had the largest difference between knowing (2) and not knowing (17) what NCREs were. Other age ranges responded generally with higher knowledge of NCRE than lack of knowledge. This represents a potential area of focus for future education initiatives. Other responses were more difficult to come to any conclusive correlations with demographics due to limited number of responses or not equal distribution of participants within each demographic. All graphs are shown in the Appendices (annexe 5, Graph 5 to 14).

Conclusions

While little information was found on other sources of non-conventional renewable energy, solar panels were found to be accessible for public use in Panama. There are several government policies aimed at providing incentives and benefits for those who install solar energy installations in their homes. Despite this, extensive implementation is impeded by a lack of knowledge surrounding many aspects of solar panels in the general public. This may stem from poor communication on the part of the government and solar panel companies to potential consumers. In general, there is a willingness from the public to learn more about these technologies, and even to implement them if it was feasible considering their individual circumstances.

Infrastructure represents the most concrete barrier to the proliferation of solar technologies. Overall this source of energy is new in Panama, and it may simply take time for legislation and government policy to overcome infrastructural barriers. Furthermore, it will be difficult and expensive to implement large scale change to infrastructure that is already established. In the meantime, educational initiatives, from
both the government and from solar energy companies, will help increase employment of solar technologies where infrastructure does not present an insurmountable barrier.

**Recommendations**

Education for youth to develop a better base knowledge of NCRE, as well as proper post-secondary programs regarding NCRE engineering, would greatly benefit a shift towards using NCRE in the future. Educating the youth in the benefits of using NCRE is essential, as they represent potential future consumers. This is also an important age group to focus on because unlike other groups, they showed a distinct lack of knowledge in NCREs. Other age groups were fairly evenly split in knowledge of NCRE (graph 5), though all could benefit from educational outreach. Offering adequate post-secondary programs to increase the workforce able to maintain these NCREs also benefits future development, as this will supply sufficient technical support. However, this may require either government initiative or a growing demand in the labour market before it comes to fruition.

**Limitations**

Throughout the course of the study, we encountered a few limitations that may have affected our results. Our study, due logistical and temporal constraints, was only conducted in Panama City, and most of the public surveys were conducted in Albrook Mall. While Albrook is a transportation hub as well as a large shopping center that assembles people of various backgrounds from many areas of Panama, we recognize the limits this imposes on the results of our project. Indeed, it could influence our results in ways that have not been identified. Moreover, being now aware that some permits may be
necessary to survey within certain places could help save time in anticipating some of these procedures.

Given the time constraints that came along with the course of this study, the survey sample size was kept to a manageable but small number. However, a bigger sample size would undoubtedly provide a better representation of public opinion and knowledge and more conclusive correlation analysis.

Another element which could be a limitation to the study is the limited perspectives we got from officials. Both parties were extremely helpful to our study, and their testimonies and knowledge added an analytical side to our research. However, with a greater number of points of view from officials, it would be more attainable to investigate a more advanced thematic analysis, revealing additional trends of information, and giving strength to the existing results we received.

While a pilot study was conducted in order to eliminate most issues with our survey, some participants still misinterpreted some of the survey questions. We ended up noticing during the process of surveying that a few of the questions could have been understood differently than what we aimed for. For example, when asked if they were planning to use a source of NCRE for their home in the future (question 5), a majority responded that they would. However, this question could have been interpreted two different ways: whether they had actual plans to install such equipment, or if they only were wishing to do it someday. Similarly, we had a recurrent vocabulary issue with the third question, in which we asked if the participant knows what NCRE are, and if so which ones. Indeed, we came to the conclusion that some participants were thrown off by the phrase “non-conventional.” In actuality they knew what renewable energies are, and
the vast majority of responses given, such as solar and wind, fall under the category of NCREs. However, participants may not have understood what was meant by non-conventional, and as a result replied that they were not familiar.

Related to this, a significant language barrier was present which may have affected the results of this study. Due to a limited knowledge of the Spanish language, it was more difficult to record every detail given by those surveyed, as well as to clarify any confusion they may have had regarding the questions. Although this limitation was encountered during interviews with officials as well, these meetings were recorded, allowing us to revisit the discussion later at a slower pace. Furthermore, with the help of some very kind classmates with a better grasp of the language, we were able to understand the information given to us by the patient and very helpful officials.
Annexe 1 : Public Survey (Encuesta sobre las Energías Renovables No-Convencionales)

1. Sexo: □ Femenino □ Masculino

2. Edad: □ 15 – 25, □ 26 – 40, □ 41 – 65, □ 66 y más

3. ¿Conoce usted las Energías Renovables no-convencionales? □ Sí □ No
   En caso afirmativo ¿Cuáles?

4. ¿Está utilizando algún tipo de ERNC? □ Sí □ No □ No sabe
  En caso afirmativo ¿Cuáles?

5. ¿Planea utilizar ERNC para su vivienda o negocio? □ Sí □ No
  En caso afirmativo ¿Cuáles?
6. ¿Cree usted que el acceso al uso de las ERNC es limitado?

☐ Totalmente en desacuerdo

☐ En desacuerdo

☐ Indiferente

☐ De acuerdo

☐ Totalmente de acuerdo

☐ No sabe

7. ¿Cuáles cree usted que sean las barreras para el uso de las ERNC?

☐ Financiero (inversión)

☐ Infraestructura

☐ Falta de conocimiento

☐ Cuestiones de leyes y normas

☐ Cuestiones de tiempo

☐ Otras razones? Explique:

__________________________________________________________________
8. ¿Si la razón es financiera, estaría usted interesado en implementar ERNC, si fuese más económico frente a las energías convencionales, en el futuro?  □ Sí □ No
 □ No sabe

9. ¿Que cree usted sobre el precio de la electricidad en el país? Es…
 □ Muy barato □ Barato □ Razonable □ Caro □ Muy caro □ No sabe

10. ¿Tiene usted conocimiento de leyes, normas y regulación que rigen el uso de las ERNC?  □ Sí □ No

En caso afirmativo ¿Cuáles?


11. ¿Quisiera usted conocer más sobre los requisitos necesarios para la implementación de ERNC para su vivienda o lugar de trabajo?  □ Sí □ No

□ No sabe. En caso afirmativo ¿Cuáles?


12. ¿Cree usted que en Panamá existe una real voluntad política para impulsar las ERNC?  □ Sí □ No □ No sabe
13. ¿En qué área reside?

14. ¿Cuál es su salario mensual?

☐ < $300
☐ $300 - $900
☐ $900 - $1500
☐ $1500 - $3000
☐ > $3000
☐ No quiere responder

Annexe 2 : Officials Interview (Encuesta sobre las Energías Renovables No-Convencionales)

1. ¿En qué sector se encuentra su organización? ¿Qué hace su organización?
2. ¿Qué es su opinión sobre la provisión de energía en Panamá?

3. ¿Sabe usted qué son las ERNC? □ Sí □ No. En caso afirmativo, ¿cuáles conoce?

4. Si existe en Panamá, ¿sabe el porcentaje de las residencias que están utilizando ERNC?

5. ¿Qué formas de ERNC son disponibles para uso público?

6. ¿Su organización utiliza algún tipo de ERNC? □ Sí □ No. ¿En caso afirmativo, cuál(es)?
7. ¿Cuál es el proceso de solicitud para obtener ERNC?


8. ¿Cuánto tiempo toma, y cuanto cuesta?


9. ¿Cualquier persona puede aplicar? Existen restricciones?


10. ¿Hay incentivos, subsidios o programas establecidos para fomentar el instalación de ERNC? □ Sí □ No. En caso afirmativo, ¿cuáles son?


11. ¿Qué requisitos o permisos necesita el usuario para cumplir con las empresas de distribución eléctrica e implementar un equipo de ERNC?
12. ¿Recurren muchos ciudadanos a preguntar por los requisitos para el uso de ERNC en sus viviendas y/o negocios que estén ubicados dentro de la Red Eléctrica?

☐ Sí  ☐ No

13. ¿Cree usted que existen barreras para impulsar las ERNC? ☐ Sí  ☐ No.

En caso afirmativo, ¿qué tipos?

☐ Técnicas (i.e. no existe mano de obra calificada)

☐ Costos / inversión

☐ Mercado

☐ Normativas

☐ Institucionales

☐ Información

☐ Tecnológicas (i.e. se necesita importar la tecnología

☐ Barreras del sistema eléctrico

☐ Sociales

14. ¿Cree usted que existen debilidades del sistema eléctrico para acoger las ERNC?
Annexe 3 : Ethical certificates from the Tri-Council online course:

Certificate of Completion

This document certifies that

Claire Bucki

has completed the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans Course on Research Ethics (TCPS 2: CORE)

Date of Issue: 29 February, 2016

Certificate of Completion

This document certifies that

Patrick Van Wagenen

has completed the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans Course on Research Ethics (TCPS 2: CORE)

Date of Issue: 1 March, 2016
Certificate of Completion

This document certifies that

Matthew Loxley

has completed the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans Course on Research Ethics (TCPS 2: CORE)

Date of Issue: 11 April, 2016
Annexe 4: Permit to do surveys in Albrook Mall

Annexe 5: Graphs of correlations

Graph 5: Knowledge of NCRE by Age Group
Graph 6: Willingness to use NCRE in the Future by Age

Graph 7: Use of NCRE by Age Group
Graph 8: Perception of Whether use of NCRE is Limited by Age Group

Graph 9: Perceived Barrier to NCRE by Age Group
Graph 10: Knowledge of NCRE by Monthly Salary Range

Graph 11: NCRE Use by Monthly Salary Range
Graph 12: Willingness to use NCRE in the Future by Salary Range

Graph 13: Perception of Whether NCRE is Limited by Salary Range
Graph 14: Perceived Barriers to NCRE by Salary Range
References


Other sources

Plan Energético Nacional 2015 – 2050 (Powerpoint provided to us by Ariel Espino)