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**Understanding the driving factors of social acceptance towards renewable energy
projects**

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Resumen

El siguiente trabajo se realizó con el fin de identificar los factores que influyen en el grado de aceptación de comunidades para la implementación y sostenibilidad de proyectos de energías renovables. También, se busca identificar la relación entre los términos aceptación y sostenibilidad. La metodología que se usó para la realización de este proyecto fue mediante un análisis de datos secundarios extraídos de diferentes Informes científicos.

De esta manera, se revisó el "Sustainable Livelihoods Framework" y se estudiaron los datos recolectados a través de la extensa revisión de literatura con el fin de extraer los factores más influyentes en la ejecución de proyectos. Así mismo se llevó a cabo la elaboración del diagrama causal, pieza principal de este proyecto, que resume los elementos que tienen relación con la problemática y permite explicar el comportamiento observado.

Se logró el objetivo planteado, pues se lograron identificar los factores más influyentes y como estos dificultan o impulsan la implementación de estas tecnologías en comunidades. Por otro lado, se pudo concluir que la relación entre aceptación y sostenibilidad es directa, pues es un ciclo que tiene un refuerzo positivo.

Es por lo anterior que se concluye que existen factores que influyen en la implementación de proyectos de energías renovables. A pesar de conocer el efecto positivo que tendría expandir el uso de estas energías a nivel mundial, las partes interesadas carecen de

conocimiento sobre estos factores y por esta razón los proyectos fracasan o son abandonados con el tiempo.

Summary

The following work was performed in order to identify the factors that influence the acceptance level and sustainability of renewable energy projects in communities. It also seeks to understand the terms acceptance and sustainability and how they are related. This will be done by a profound literature review of scientific articles related to the subject of study.

Thus, "the sustainable livelihoods framework" and data collected through an extensive literature review were used in order to extract the most influential factors in the implementation of projects. Having identified the key factors, the development of causal diagram took place, which summarizes the elements that relate to the problem and can explain the observed behavior.

The stated objective was achieved, as it was possible to identify the most influential factors and how they impede or drive the implementation of these technologies in communities. Furthermore, it was concluded that the relationship between acceptance and sustainability is direct, it is a cycle that has a positive reinforcement.

It is for this that it is conclude that there are factors that influence the implementation of renewable energy projects. Despite knowing the positive effects of expanding the use of these energies worldwide, stakeholders lack knowledge about these factors and for this reason projects fail or are abandoned over time.

Palabras Claves

Español:

Aceptación, sostenibilidad, energía renovable, factores sociales, comunidades.

Ingles:

Acceptance, sustainability, renewable energy, social factors, communitites.

Understanding the driving factors of social acceptance towards renewable energy projects

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Abstract

A rapid growth population and a rising concern of improving the living standards in impoverished communities, without damaging the natural environment, have drawn attention to the adoption of renewable energy technologies around the world. Despite this global trend, the implementation of these projects has not succeeded completely due to several factors, including social barriers faced at the time of their execution. These social barriers lead to poor acceptance of the projects and their consequently abandonment. Acceptance is a social construct that may be influenced by factors which may vary upon each community. Understanding these key factors is important to achieve successful and sustainable results with future energy solutions. In this paper, we develop a conceptual framework based on the principles of causal loop diagrams, for understanding the key factors that drive social acceptance and the causal relationships between them. The framework is constructed based on a literature review about social acceptance of renewable energy technologies in both, developed and developing communities. Finally, a discussion is held about what are the implications of this framework and how can it be used to inform future energy planning and decision-making.

1. Introduction

Renewable energy has become a top priority for governments and countries around the world. Some of the reasons for this unexpected shift from traditional energy sources to renewable ways of producing energy originate from the fact that environmental laws and overall awareness are demanding greener practices in energy production and consumption. Thus, the continuous growing demand for energy worldwide has incentivized regions to become less dependent on fossil fuels in order to reduce their carbon footprint (Cherni et al., 2007). As a result, countries have taken an initiative towards the efficient use of resources and to add greener energy technologies to their portfolio of energy supply options. Renewable energy is then seen as an alternative to conventional energy to prevent negative environmental consequences and also to improve the quality of life of those disadvantaged communities located in developing countries (e.g. Schmidt, Cancellata, Pereira, 2016; Caspary, 2009).

Although renewable energy has the potential to be used worldwide as to provide energy with sustainability for a constant growing population, different cultural and societal factors in general get in the way of the implementation of these technologies and compromise their future sustainability. It has been observed that the acceptance and approval rate of this type of projects is not as expected due to several barriers posed by the inhabitants of the hosting communities, for instance, in Venezuela the inefficacy of bureaucracy makes it hard to complete projects, causing community disappointment and desire to abandon projects (Peotrosevoli, 2013). Therefore, it is crucial to identify and understand the key factors that drive major social barriers which may affect the acceptance and therefore implementation of renewable energy technologies. Hence, in order to address this gap, the purpose of this paper is to identify the different factors that stand in the way of implementing such technologies in both developed and emerging economies, and understand the dynamics of the relationships among them.

The next section provides a brief overview of different types of renewable energy sources. Then, a discussion is held around the term acceptance and how it is defined differently

depending on the context where it is used. Subsequently, the importance of acceptance is presented as a determining factor for the sustainability of renewable energy projects. Through a literature review, a list of major factors are identified, allowing us to understand how they may interact with each other and influence social acceptance of renewable energy source (RES) projects, and how these may be different in developed and emerging economies; this information serves as a broad overview of the problematic differentiating cultural and economic factors between countries. Thereafter, we select the most representative key factors that may act as social barriers and developed a causal loop diagram model to represent, in a simple way, the dynamics of how these barriers interact with each other. Lastly, discussions and conclusions of the framework are presented.

2. Renewable Energy Sources

Renewable energy is considered nowadays a valuable and feasible source for energy generation and it is gaining share in the nation energy fuel mix across both developed and less-developing economies mainly because of the growing concern over environmental issues, causing a shift from traditional energy to new technologies, (AHM Shamsuzzoha, 2012). This is due to their low impact on the environment, particularly regarding the production of greenhouse gases emissions to the atmosphere (Rabindra, 2012). This type of energy comes from natural resources, which continually replenish such as sunlight, wind, rain, waves and tides. This section provides a brief overview of the most widely known types of renewable energies, their main advantages and drawbacks and which countries have experience with their implementation.

Wind energy

Wind energy describes the process by which the wind is used to generate electricity. Wind turbines convert the kinetic energy of the wind into mechanical power. These wind turbines have blades which turn with wind, spinning a shaft that is connected to a generator that creates electricity. Renewable energy from wind technology has been implemented in several parts of Australia because of its wind resources; however, there

have been mixed reactions slowing down the implementation in certain locations of Australia mainly because of concerns regarding noise, threats to flora, fauna and wildlife, (Webb, 1994).

Solar

This type of energy is effective in countries where a high level of solar radiation is received. The solar PV technology has been used for lighting, radio, TV and telecommunication in the rural areas of developing countries. For instance, Cambodia has on average 6.8 h of sunlight available per day and consequently 2490 h per year, (2013, M. Sarraf). Although Cambodia has a great solar potential, obstacles in the advancement of this industry are: accessibility to a hybrid system, awareness and affordability, (Williamson, 2004). Caspary (2009) analyzes the price situation in Colombia and makes a comparison between conventional energy and renewable energy; due to higher costs, Solar PV technology is not seen as to become competitive in the near future. However, this is subject to change due to a visible trend in the decrease of prices.

Hydropower energy

Hydropower energy consists in using natural water cycles to generate electricity. There are several types of hydroelectric facilities and they are all powered by the kinetic energy of flowing water. One of the most common ones requires the construction of a dam that can be described as a man made barrier that is placed in a flowing river to store water. This type of projects has both advantages and drawbacks. One of the advantages is that water that can be transformed into energy can be stored for future use, which is particularly useful for dry seasons. It also prevents excess floods in downstream communities. Nevertheless, it also brings negative ecological impacts caused by the flood of a large territory where communities, flora and fauna used to coexist with each other, affecting the bio-diversity of the region. The second most common way to produce hydropower energy is by the construction of a free flow spillway that does not require a dam, but instead the river needs to be deviated to produce the energy in a turbine. Colombia, for example, has about 70% of its energy capacity has water resources for hydropower development with nearly 70% of capacity; the total hydro-power potential is estimated at 93,000 MW, (Valencia, 2009)

Biomass energy

There has been renewed interest in biomass as a renewable energy source worldwide. Biomass energy includes agricultural residues, fuel wood, animal wastes, municipal wastes and other fuels derived from biological sources. Biomass is converted into electric power mainly through direct combustion of agricultural residues that include rice husks and other agricultural residues, woody materials. This process makes biomass unattractive in some cases because of emissions produced, this process must be carefully monitored and controlled.

Geothermal energy

Geothermal energy is about taking advantage of the heat that comes from the center of the earth. Geothermal energy may be used effectively in both on- and off- grid developments, and is especially useful in rural electrification schemes and direct applications like space heating, cooking, bathing and swimming, industrial process heat, agricultural drying, greenhouse and open ground heating, etc. The geothermal resources have been mapped and the Geological Survey of India estimates the potential to be of the order of 10,600 MW (Mahesh A et al, 2013). Most of the current usage of geothermal energy is for direct use for bathing and swimming.

Tidal Wave Energy

Tidal wave energy is produced by the the rise and fall of tides where a significant tidal range is present, that being the difference between high tides and low tides. Tidal wave energy is produced by three types of generators: tidal streams, barrages and tidal lagoons. Tidal streams and barrages cause a great impact on the environment while tidal lagoons can be constructed naturally causing less harm to the environment but also generating less energy.

3. Acceptance of Renewable Energy

It is known that humans have some basic needs to fulfill in order to live and progress. Sustainable livelihood is defined as the capabilities, assets, and activities required for a means of living. This framework has three key dimensions: Sustainable livelihood assets,

vulnerability context and techniques and interventions. Assets are fundamental building blocks divided in five categories that contribute to making a sustainable livelihood. These assets are: financial assets, social assets, human assets, physical assets and personal assets. The vulnerability context is explained by the factors that contribute to the occurrence of poverty and clarifies the need to make organizational, community and policy changes. Finally, practical interventions such as counselling programs, education, employment training, economic literacy are offered in order to build livelihood assets while strategic interventions work on social and economic change at the systematic level using methods like alliance building and policy work. Based on this definition, the role of energy provision to the fulfillment of such basic needs is key because having access to energy, or in particular electricity, improves the aspects of the assets mentioned above. For instance, human assets especially the health of women and children is improved by lowering indoor air pollution (Terrapon, 2014); having access to health services such as vaccine refrigeration may also better conditions. Education may improve due to the access of technology (computers) and longer hours for study at night. Social assets may be influenced positively due to an increment in time for leisure, additionally the involvement of inhabitants becomes more frequent creating partnerships and relationships of trust among the community. Energy may also enhance financial assets, creating jobs for locals and increasing their income and at the same time having access to clean affordable energy. All of this results in boosting their emotional well-being and motivates people to overcome poverty.

The term acceptance is often used but rarely defined in a clear way. Wüstenhagen et al. (2007) identifies three dimensions of social acceptance, including socio-political acceptance, community acceptance, and market acceptance to have a better understanding of the term. According to the authors, policy makers, key stakeholders, and technologies and policies make part of the socio-political acceptance. The community acceptance refers to the specific acceptance of siting decisions and renewable energy projects by local stakeholders, particularly residents and local authorities (Wüstenhagen et al. 2007). When community residents are involved in the decision making process, including consultation during project proposal development, decisions about siting of wind

turbines, and continued engagement for policy responsiveness and options (Hindmarsh and Matthews, 2008), it is less likely that later on they will reject the project once it is established. Hizeroth et al. (2013) refer to the term "acceptance" as a range of positive attitude parameters adopted by subjects of acceptance (parties concerned by planning) as to an object of acceptance (planning project). The choice of a certain attitude parameter results from socio-culturally influenced perceptions and experiences as well as from expectations emerging within a certain context based on an individual assessment process. It is important to identify and understand the different social groups within a community as they may share homogeneous attitudes in the acceptance scope.

In summary, the meaning of social acceptance can not be determined in a single definition, however for the development of this paper it will be defined as the approval or agreement to an act or conduct imposed. The sustainability of energy projects largely depends on the degree of acceptance of its host population. It includes the appropriation of technology, which can only be achieved through people, their motivation to take care of the technology, understanding, interest, commitment, and organization that make possible a successful development, (Troncoso et al, 2007). The lack of consideration by the stakeholders to the social acceptance of a community may be a determinant for the failure of a renewable energy project. In conclusion, people's acceptance must be considered in order to have a positive impact upon communities and provide a sustainable solution in time.

A literature review was conducted in order to identify the main factors that play an important role in slowing down or on the contrary, speeding, the process of these projects. To have a broad understanding of these barriers, the revision included both developed and developing countries. After an analysis, those factors that were frequently repeated in the different journal papers were then classified and categorized in six different dimensions: social, human, political, technological, environmental and economic/financial (Cherni et al, 2007). Each of these dimensions is defined below according to the livelihood framework to facilitate the understanding of the criteria used to develop the causal loop

model in the following section. The political dimension was added because its relevance was significant in the literature review.

Social

Due to the importance in community engagement during the implementation process, social capital plays an important role. Social capital is understood to be relationship between members of a community. Networks increase people's trust and ability to work together creating relationships of trust. At the same time, these close groups can take mutually-agreed decisions and accept group norms. By implementing energies, inhabitants will need to work together as a group, sharing knowledge to facilitate the innovation process.

Human

Human capital represents the ability to labor having the skills, knowledge and health conditions required to achieve their livelihood objectives, (DFID). These objectives can be accomplished by having access to high quality education, technologies and support in nutrition and health issues. When renewable energy projects are employed, both education and health matters are confronted. Providing communities longer hours for education can lead to an increase in the amount of trained labor force, allowing them to be more competitive and at the same time having a better income which can be reinvested in education. Health problems can be treated and solved through access of technologies which then leads to a healthier community with capacities to work.

Political

A country's welfare can be determined by two main actors, (economics and politics) that must work together in order to assure positive results. An economy can be driven or held back by governmental policies. This also applies to technological improvements and in general progress in all other aspects. Having adequate policies and incentives will contribute to build trust in the community and stakeholders interested in investing will be safer.

Technological

Technology can be defined as the basic infrastructure and producer goods needed to support livelihoods. These include changes in physical environment and also tools or equipment that help people be more productive. By having this physical capital, inhabitants will have access to secure building, adequate water supply and clean affordable energy. Not having access to these basic needs such as water and energy directly affects education, health and income generation.

Environmental

Natural or environmental resources can be intangible such as atmosphere and biodiversity or tangible assets like trees and land. There is a close relationship between natural resources and the vulnerability of humans, events such as earthquakes and forestall fires can cause serious downfalls in people's life. The most common renewable energies require natural sources, not having a representative amount of sources can also slow down progress within a community.

Economic/Financial

Financial resources are used to achieve livelihood objectives. These can be available stocks which refers to credits or regular inflows of money which are transfers from the state such as pensions. Access to credits are not easily attainable to the poor, but can be supported by organizations developing saving plans, institutions can find alternatives to overcome lack of collateral of the poor, and lastly regulatory reforms can be done to help governments provide financial safety for the poor. Financial resources not only affect inhabitants but also stakeholders who plan on realizing renewable energy projects because of high initial costs and lack of government subsidies.

4. Framework- Causal Loop Diagram

A causal-loop diagram is a tool used to represent the vicious or virtuous cycles that contribute to exacerbate or reduce a problem. This diagram consists of variables connected by causal links, shown by arrows that denote the causal influences among the

Social

With renewable energy projects comes a change in women's role in society. This is evident in cases where women are responsible for cooking and feeding their families. With traditional energy, these daily tasks take longer and are more exhausting, practically taking up the whole day. Having RES, this situation changes allowing women more free time and the opportunity to spend time in different activities like teaching their children or simply enjoying time off to interact with neighbors. Social engagement among members of a community allows sharing of knowledge which can lead to new ideas and possible business creations. If business are created, income of these women increases and there will be positivism towards projects.

Having energy production can also benefit the health conditions of humans. This happens because advanced health technologies require energy in order to function, therefore health conditions are affected positively.

Human

The social factors identified in the literature review that serve as barriers to renewable energy projects include the education level of the population, knowledge about renewable energy resources and community engagement throughout the process of implementation. Education level of the population and the lack of knowledge provoke uncertainty due to changes in the living conditions of a community. The lack of importance in taking into consideration the thoughts and concerns of communities at all stages of the project also leads to rejection. As shown on the diagram, if access to education decreases, knowledge of renewable energies is limited causing inhabitants to refuse projects.

Political

It is clear that governments play a fundamental role in the development of projects, especially in those transforming a community's wellbeing. Although benefits of renewable energy projects are well known, the lack of commitment by the government and the absence of policies that incentivize private stakeholders to invest in RES are main

constraints. If politicians gave incentives and subsidies, the initial investments would lower becoming more attractive for stakeholders to develop the needed infrastructure.

Technology

Technology plays a major role in renewable energy, it is important to have the right infrastructure, equipment and knowledge to have a successful result at the end. The lack of awareness of technology, research and development work and local and national infrastructure are all barriers slowing down the process of employment.

Environmental

Depending on the country, the absence of natural resources and geographic conditions are barriers to execute a renewable energy project. Without natural resources such as water or wind for example, it is difficult to implement a hydropower plant or wind turbines. Geographical conditions are also fundamental, In countries where climate is favorable, installing solar energy plants will be beneficial, otherwise, these would not solve the electricity inefficacy.

Economic/Financial

In both developed and developing countries cost of renewable energy projects is a major barrier. The high initial costs, along with maintenance and operational costs are answers to why communities reject projects.

5. Discussions and Conclusions

Renewable energy has caught the attention of all the countries in need of energy sources to vast the population. It is considered an important resource to improve the difficult situation of over two billion people, (World Bank, 1999), mostly located in rural zones, where access to traditional energy is limited or non existant. Natural resources are fundamental to expand this process worldwide. Depending on the geographical conditions of a country, there are more or less natural resources available to produce renewable energy. However, natural resources and geographical conditions are not the only important factors to succesfully implement these energies.

Through the extensive literature review and development of a loop causal diagram, it was possible to identify the key barriers that influence the sustainability of projects and that need be overcome in order to increase the acceptance of renewable energy technologies. This work helps understand the most important variables to consider at the time of implementation and will help stakeholders have a higher acceptance from the community towards renewable energy allowing the effective sustainability of projects.

This framework will allow managers to focus primarily on aspects where they lack knowledge and study ways overcome barriers. Governments may study the need to make changes in their policies to incentivize the employment of projects improving the quality of life of the population and at the same time solving global warming and electricity shortage problems.

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