RENEWABLE ENERGY MARKET ACCEPTANCE: LISTENING TO PUERTO RICO INVESTMENT STAKEHOLDERS[1]

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Abstract

Multiple international and local conditions have led Puerto Rico (PR) to the urgent development of renewable energy (RE). But in the middle of a deep economic crisis, it is imperative to create an attractive environment for private investment in renewable energy on an industrial scale (REIS). The PR's emerging renewable energy market experience may be beneficial to other countries with similar conditions. With the use of semi-structured interviews, this article explores the opinions and perceptions that REIS pioneers formulated from their experience in a new market with distinct conditions. RE market acceptance was studied using, as key concepts, the market's failures, barriers, and risks that the companies have to consider before making the decision to invest. The findings of this research positions Puerto Rico as an attractive investment location with excellent opportunities, however, deficiencies in agreements regarding the interconnection to the grid, and PR's inability to make decisions related to economic incentives may adversely impact the "hot spot" position that PR currently has. The study concluded that by 2013, suitable conditions existed in international and local markets for investors to venture into this type of project, however, if even one of the components that integrate this type of project, such as interconnection (Minimum Technical Requirements) is unfavorable for investors or poorly managed, this could be detrimental to market growth.

Keywords: renewable energy, market acceptance, Puerto Rico.

Resumen

Múltiples condiciones locales e internacionales apuntan a un desarrollo urgente de energía renovable en Puerto Rico (PR). Sin embargo, en medio de una profunda crisis económica, es imperativo crear las mejores condiciones para las inversiones privadas en energía

renovable a escala industrial (EREI). La experiencia del mercado emergente de energía renovable en PR podría ser beneficiosa para otros países con condiciones similares. Mediante entrevistas semiestructuradas, este artículo explora las opiniones y percepciones que los pioneros en EREI tuvieron según su experiencia en un mercado nuevo con condiciones distintivas. La aceptación de mercado de la energía renovable se estudió utilizando como conceptos claves los fallos, barreras y riesgos del mercado que estas compañías tuvieron que cosiderar antes de tomar la decisión de invertir. Los hallazgos de la investigación posicionaron a PR como un destino de inversión con excelentes oportunidades, pero las deficiencias en los acuerdos de interconexión a la red eléctrica y la falta de poder de decisión sobre instrumentos económicos de promoción podrían lacerar la posición de hot spot que Puerto Rico tiene. El estudio concluye que para el 2013, PR tenía a su favor condiciones adecuadas en los mercados internacionales y regionales para que los inversores se aventuraran en este tipo de proyectos, igualmente se encontró que si al menos uno de los componentes que integra este tipo de operación como, por ejemplo, el de interconexión (Requisitos Técnicos Mínimos) es gestionada pobremente o resulta desfavorable para los inversores, esto podría ser perjudicial para el crecimiento del mercado.

Palabras clave: energía renovable, aceptación de mercado, Puerto Rico.

1. Introduction

Currently, societies are facing major changes and challenges. Humanity seems to be mired in a race for survival resulting from its poorly planned actions which now threaten essential resources that are necessary for life. In recent decades, the results of studies have highlighted greenhouse gasses as a main threat to life (Pachauri & Reisinger, 2007). Changes in ocean temperatures, precipitation, heat waves, sea levels and other climate upheavals, as well as ecosystem variations, reveal the necessity, more than ever, for a modification of human consumption of resources (Watson, Zinyowera, & Moss, 1996).

Among the essential resources necessary for human existence, energy is recognized as the one that has the most economic, political, social and environmental influence. Strategic energy management requires the attention of governments, businesses, and the general public. The situation is complicated further by the possible reduction of fossil fuel deposits, supply becoming increasingly difficult to

extract, and increases in energy consumption patterns. In response to the global energy situation, renewable energy arises as part of the solution. It seems that the world needs a clean energy revolution. Such a revolution would enhance global energy security, promote enduring economic growth and tackle environmental challenges such as anthropogenic climate change (Kerr, 2011). The environmental, economic and social implications of the urgency to switch to less harmful sources of energy are undeniable.

Nowadays, there are market and political conditions that have increased the viability of renewable energy (RE) projects. Rapid growth, particularly in the power sector, is driven by several factors, including the improving cost-competitiveness of renewable technologies, dedicated policy initiatives, better access to financing, energy security and environmental concerns, growing demand for energy in developing and emerging economies, and the need for access to modern energy (REN21, 2015). The World Energy Outlook 2015, forecasts that consumption of marketed RE will increase by about 3.6 quadrillion Btu's in the reference case, from 9.0 quadrillion Btu's in 2013 to 12.5 quadrillion Btu's in 2040, with the electric power sector responsible for most of this growth (EIA, 2015). Global investment in RE continue to increase. In the year 2015 was set a new record for global investment in RE, with capital investment committed to renewables projects increasing by 5% to $285.9 billion, exceeding the previous record of $278.5 billion achieved in 2011 (FS-UNEP, 2016). Also, wind and solar energy will account for the 64% of the 0.6 TW of new power generating capacity added worldwide over the next 25 years, and almost 60% of the $11.4 trillion invested (Bloomberg, 2016).

In the current scenario of serious economic challenges, it is reasonable to think that the solution cannot come only from the government sector, considering that their limited resources should be spent on a range of social needs in addition to energy. The evolution of the global energy mix, in which renewable energies play a more crucial role, must be achieved in conjunction with private sector investment. The aim of this article is to explore the opinions and perceptions of industrial scale pioneers in renewable energy investments. These opinions and perceptions were formulated from their experience in a new market, with distinct conditions such as: no interconnection with other grid, no previous experience with renewable energy utility scale, an electric system controlled by only one entity, Puerto Rico Electric Power Authority (PREPA), high electricity prices, and American dollar currency made the investment in Puerto Rico unique. The Puerto

Rican experience in the emerging renewable energy market may be beneficial to other countries with similar circumstances.

This article is structured as follows. The next section explains the market acceptance concept, its definition and the importance of the inception of this idea on academic research. Section three introduces the three core concepts of market acceptance; Market Failures, Market Barriers, and Risk. The Puerto Rican electricity sector's particularities are reviewed in section four followed by a review of the methodology, result and discussions. The last section presents the most important conclusions derived from this research.

2. Market acceptance

The transition from fossil fuels to renewables and the promise of sustainability clashes with the reality of scarce resources - not only energy but also economic resources. The initial investment in infrastructure involves significant capital commitment, which presents a challenge considering the current economic crisis. Furthermore, postponement of change will result in higher costs (Stern, 2007). In the current global economic environment, the role of the private investment sector assumes a more prominent position because governments must increasingly deal with the difficult balance between social needs such as health, housing and education, and the complexities of an evolving energy market. For this reason, a wider understanding of market acceptance is advisable.

Market Acceptance may be defined as "the result of the assessment of the economic, financial and political factors related to investment and development of renewable energy projects, which is reflected in the level of development of the industry in a specific geographic region" (Jaramillo-Nieves, 2015). The issue of market acceptance, with respect to investors, has attracted the attention of some scholars who understand it as a cornerstone of the development of the renewable energy market for several reasons. For Thaler (1999), adding the human element to the analysis of financial markets may lead to a better understanding of the underlying mechanisms of market behavior. The discussion on the preferences of investors can provide information on both, the implicit and explicit decisions of several actors (Loock, 2012). According to Bürer and Wüstenhagen (2009), understanding the perception of investor risk (and opportunities) associated with specific energy and climate policy can provide policy makers with an opportunity to leverage private investment to achieve the stated objectives regarding climate change and renewable energy. In the other hand, Aguilar and Cai (2010) appealed to the community

and market acceptance when they mentioned that the study of preferences of RE private investors deserves attention to determine potential opportunities to stimulate economic development in conjunction with public support (Aguilar & Cai, 2010).

The influence of policy on RE investment is questioned by experts (Wüstenhagen and Menichetti, 2012) who mentioned that the discussion is separated by one side that sees policy as the essential driver of RE investment and the other that emphasizes the role of private capital seeking opportunities with or without policies. Masini and Menichetti (2012) highlighted the lack of emphasis on the preferences of investors, which sheds light on the process of allocating investment capital to RE projects. Likewise, they indicated that to maximize the impact of future public policies, policy makers should have a better understanding of the behavior of investors and how they make decisions, particularly regarding key psychological factors that might influence their behavior and actions. Similarly, Dinica (2011) mentioned that taking into consideration the investor's perspective on the analysis of RE support systems, contributes to the academic discussion, as it helps open the black box between policy design and policy results. Based on these research projects, this paper attempts to answer a key question regarding RE, which is, what triggers or dissuades investors from being part of the emerging RE sector in a country without previous experience?

3. Market pitfalls for RE Investment

The process of evaluating potential investment in RE is complex, multidisciplinary and heterogeneous, being addressed in various ways depending on the nature of the investors or the investment firm. However, three concepts should always be present when considering investments; barriers, risks and market failures that give rise to government intervention through policies to promote RE. Without the elimination of these concepts and eventually the "correction" of prices in this type of technology, RE can hardly be favored by investors to become an alternative to conventional energy sources beyond a niche energy market (de Alegría Mancisidor et al., 2009; Reddy, 2003).

3.1. Market failures

Market failures occur when there is a defect in the way that markets operate. These are market conditions that violate one or more assumptions of neoclassical economics that define the ideal products and services as rational behavior, free transaction costs,

and perfect market information. Generally speaking, the defect in the way RE operates is the lack of internalization of negative externalities in the prices of fossil fuels (Watson, Zinyowera, & Moss, 1996). To correct these defects, government intervention is required through instruments which promote renewable energy and reduce production costs, or through taxes that incorporate the negative externalities of fossil fuels in an approximation of the cost of renewable energy, thus minimizing the influence of cost on investment decisions. But this solution tackles only one type of market failure. For Brown (2001) market failure in this sector may be misplaced incentives, distorted fiscal and regulatory policies, unpriced costs, unpriced benefits or insufficient and inaccurate information (Brown, 2001). From the economic perspective, the reluctant RE deployment may be due to two market failures; also known as the double externality problem (Rennings, 2000; Newell & Pizer, 2008). The first one is the lack of valuation of avoiding negative environmental externalities (Greenhouse gas emissions) and the second are the positive technological externalities such as the benefits of innovation (Del Río, 2010b).

In the energy sector, these market failures are related to various types of externalities, including, but not limited to, the environmental externality and positive externality that occurs in the innovation process (Del Río, 2010b). Therefore, these are not referred to as classical market failures. Other common market failures in the energy sector include imperfect information[3] or the principal-agent problem[4]. For the purpose of this research, market failures are defined as "defects in the local energy market that do not allow fair competition for investment resources between renewable and fossil fuels."

3.2. Market barriers

The term "market barriers" relates to obstacles that are not based on market failures, which nevertheless contribute to a slow rate of diffusion and adoption of clean energy technologies (Levine, 1995; Brown, & Busche, 2008). On the other hand, barriers may also be defined as those created by human factors operating between RE's development potential and its reality (Verbruggen et al., 2010). A similar definition was provided by Pachauri and Reisinger (2007), which defines a barrier as any obstacle to achieving the goal, adaptation or mitigation potential that can endure or be mitigated through policies, programs, and measures.

Liao et al. (2011) points out that RE has failed to become a prominent contender for fossil energy technologies, as there are

barriers to the implementation of renewable energy technologies. These barriers are usually divided into four groups: (1) economic and financial; (2) institutional and policy; (3) technical (4) awareness and information, all of which must be eliminated in order to promote the emergence of innovative policies to seize the potential of more efficient RE. Similarly, other academics have recognized the existence of barriers to renewable energy development and have mentioned that these barriers (or even the perception thereof) must be identified and addressed in order to design innovative policy approaches to help exploit the potential of renewable resources (Reddy, 2003).

The discussion on this topic is bolstered with the concept of "carbon lock-in" as a central idea tabled by Brown (2007). Barriers to the development of technology and its eventual commercialization take different forms, such as: (1) the need to fix existing or current technologies (conventional or fossil), (2) increased risks associated with business innovation and (3) increased transaction costs associated with the change from fossil technology to low-carbon technology. These three barriers reinforce each other. The dynamics are as follows: Positive feedback systems between governments, financial institutions and supply, support and maintain the status quo of fossil technologies, even when clean energy alternatives appear to be superior. This presents a number of obstacles in the market for investment and innovation, and because of this, clean technologies are perceived as new, and these obstacles can have a substantial impact on them. This results in investment and innovation being out of favor since they need to be economically attractive. In addition, the funding associated with obtaining and processing information, permits, design, and enforcement of contracts might be unavailable in the early stages of the deployment of this technologies (Brown, & Busche, 2008).

3.3. Risks

To undertake investments in RE it is necessary to address the risks, looking for the maximum possible gain (Muñoz, 2009). Risk can be defined as the chance of loss (Megill, 1988; Dinica, 2006). Risks can also be seen as the probability of not obtaining the projected return on investment in the time and quantity that was expected (Dinica, 2006). Maruyama (2004) identified the power purchase agreement[5] as the greatest risk for RE companies. Other risks mentioned were: (1) technology efficiency risk (related to the renewable energy equipment efficiency, (2) operational risk, related to the operation and management of the power plant (3) renewable resource availability

risk and (4) supply risk, related to the inability to provide the agreed between the provider and the utility.

RE has its risks too, which are considerable. Investing in, and financing of RE projects is widely influenced by the risks of project performance. Like all investments, RE projects must at least cover the costs and provide a profit for the developers. The difference here is that, at the same time, it must compete for funding against conventional energy projects which are "cheaper" and better tested (Dinica, 2006; 2011).

For Sadorsky (2010), the balance between profitability and risk for RE is precarious. RE companies are often among the highest investment risks and therefore a good understanding of the risk factors is necessary. The risks associated with RE are technological, financial and regulatory in nature. The technical challenge is due to intermittence of some types of RE like solar and wind and the fact that the energy must be "harvested" from great tracts of land in specific locations, which hinders project development (Faúndez, 2008). One of the biggest drawbacks of RE in the competitive energy market is its high price tag, which reduces its competitiveness (Bhattacharyya, 2010).

The above risks are added to those related to economic instruments used to promote renewable energy. Barradale (2010) conducted a case study on how public policy uncertainty discourages investment and found that instability and expectation of promotion instruments could add a new risk to those already existing. Dinica (2006) presents the same argument, suggesting that RE support systems could involve - intentionally or not - risks to project profitability which could discourage certain types of economic and financial players from investing in this kind of business.

Many of these risks can be reduced by monopolistic regulations, pre-established in the form of Power Purchase Agreements (PPA), fee agreements ("tolling agreements")[6]. Other ways of reducing risks at the corporate level could be technological diversity, regional diversity, and debt restructuring or asset exchange. Investors may also lower their risk with a diversified portfolio of investments in the energy sector, which includes low-risk RE to help reduce the overall risk of the investment portfolio (Bhattacharyya, 2010).

4. Puerto Rico's industrial RE market

Puerto Rico is a self-governing commonwealth in association with the United States. Its electricity sector is controlled by the Puerto Rico

Electric Public Authority (PREPA), a public corporation in charge of nearly 82% of the electricity system generating capacity. Additionally, PREPA is in charge of the transmission, distribution and sale of electricity to commercial, industrial and residential customers. This public utility can be defined as a self-regulated monopoly, and is able to pass on all its costs to its customers, with no incentives whatsoever to streamline its operations (Marxuach, 2009). Another important fact is that PREPA has accumulated a debt of 9 billion dollars, which complicates the modernization of its outdated infrastructure (PREPA, 2016).

The electricity mix is composed mainly of fossil fuels and nearly 2% of renewable energy (hydroelectric, solar and wind) (PREPA, 2015). The characteristics of the electricity sector in Puerto Rico, such as high power consumption, high electricity costs, an energy mix dominated by fossil fuels and an electrically isolated network, all tend to support the strategy of the development of renewable energy as a sound one. However, Puerto Rico does not have a National Energy Plan that could facilitate the transition from the current state towards one based on renewable energy.

In the current international scenario, where countries make pacts such as the Paris Agreement 2015, in which they commit to stem their greenhouse gas emissions in the coming century, countries that rely mainly on fossil fuels with limited RE capacity pose a great challenge. The question that Puerto Rico is facing at the present time is, how, in the middle of the deepest economic crisis that this country has ever had, will it meet the electricity sector transformation that it needs?

Acknowledging the importance of RE development and deployment, the government of Puerto Rico passed two acts that have shaped the industrial market. The first one, Public Policy on Energy Diversification by Means of Sustainable and Alternative Renewable Energy in Puerto Rico (Law 82, 2010), creates Renewable Portfolio Standards and compulsory RE development goals for the short, medium and long-term, as well as Renewable Energy Certificates (RECs) that can be traded on the local and the USA green certificate market. The second act is the Puerto Rico Green Energy Incentives Act (Law 83, 2010), which created the Green Energy Fund. This fund offers rebates for up to 40% of the eligible costs for Tier 1 (0-100 kW) renewable projects and up to 50% for Tier 2 (101 kW - 1 MW) renewable projects.

In late 2010, several power purchase agreements (PPA) were signed with PREPA. By the time this research was conducted, 22 projects had been approved under the RE category (wind and solar).

By mid-2015, PREPA had signed contracts with private enterprises for the purchase of 1,656.8 MW, distributed in 62 RE projects around the country. However, only four of these projects are fully operational, connected to the electricity grid and selling electricity to PREPA. The remaining projects are in the development or construction phase.

Taking into consideration all the elements of the electricity sector discussed above, it is evident the need to understand the elements involved in making investment decisions regarding industrial scale renewable energy projects in Puerto Rico. This knowledge will allow us to make suggestions towards increasing the success rate for renewable energy projects in Puerto Rico, as well as creating a better energy policy.

5. Methodology

This research was conducted using semi-structured interviews in which the questions were provided to respondents beforehand so that they could prepare for the interview and have any queries answered. A technique of structured questions was used, since the data collected was very specific (See Table 1). Interviews with 10 investors or representative were conducted in person, between March 2012 and February 2013, except for one that was made by telephone. Respondents were representatives or investors of industrial-scale projects for renewable energy, whom already had PPAs with PREPA. The total number of companies by 2012 was 22. The contact information was provided by the Puerto Rico State Public Policy Energy Office. First, all the twenty-one representatives or investors were contacted by email and phone calls. Of those, ten responded via email accepting to take part in the study. The companies surveyed represented 44 percent (515) of the megawatts contracted by PREPA. Even though the sample of participant is limited, the data collected in this investigation is of great value due the specificity. This is the first research conducted in Puerto Rico that studies the perception and opinion of key stakeholders in renewable energy market. The sampling used was non-probabilistic, denominated “cases-types” used in qualitative research. Its primary objective is the richness, depth and quality of the information, not the quantity or any standardization (Hernandez Sampieri et al., 2006).

6. Results and Discussion

The characteristics of the sample are as follows: Five of the companies were local, three from Spain, one from France and one

from the United States. The technologies used were solar (8) and wind (3). Capacities fluctuated between 20 MW to 64 MW. The lowest investment was 60 million US Dollars, and the highest was 250 million US Dollars. Most of the projects were in the construction phase, and all the financing was commercial debt and company equity.

The reasons given by respondents to invest in RE in Puerto Rico can be classified as either (a) economical or (b) political. Among those economic reasons given, were: the opportunities for obtaining economic incentives as production contribution credits (PTC) and investment contribution credits (ITC), exemption from municipal taxes or cash grants. In addition, the PREPA's high cost of producing electricity in Puerto Rico (due to the high oil and natural gas prices) leads to a higher cost per KWh, which in turn increase the price that PREPA must be willing to pay above the price paid by many other public utilities in the United States. According to the respondents this makes Puerto Rico a good place to invest. This point, as one respondent expressed, gave both the "here" - that is, where to invest; and the "now". They stated some circumstances such as the reduction of costs in renewable energy equipment and the creation of a viable public energy policy that promotes investment. Politically, it was mentioned that the regulatory framework in PR is "aligned" to make investment in RE attractive, starting with the Executive Order of Energy Emergency issued by the Governor, followed by laws 82, 83 2010 and the Permits Act. Similarly, federal legislation has forced PREPA to open the network to this type of energy generation. The political and economic relationship that Puerto Rico has with the United States as a territory also gives a level of security to the investor that no other country in Latin America can match. The answers are in agreement with several researchers who indicated that the objectives of policies and incentives have a strong influence on the decisions of investors at the time of allocating capital to projects RE (Masini & Menichetti, 2012; Barradale, 2010) Among the strategic factors for investing mentioned in the literature, this research found matches to Gross et al. (2007), who mentioned two strategic factors for investing in RE: (1) entering a new market or acquiring plant in order to consolidate market position, and (2) the expectation of a new policy regarding a particular technology. Both cases appear to be present in Puerto Rico, although some projects were solely RE organizations wishing to enter the local market, while others had previous experience in the telecommunications or construction local market, and saw RE as an excellent opportunity for investment. In other words, it seems that the confidence in the proven effectiveness of the technologies weighed more than the absence of an articulated market for renewable energy

in order to invest. Respondents expressed confidence that public policies supported investments. The decision to invest in a new market like Puerto Rico, where the public policy is newly created also coincided with Masini and Menichetti (2010) who found that previous beliefs on the technical effectiveness of the investment opportunities play a much greater role than market beliefs in driving investments, thus implicitly suggesting that agents consider the proven reliability to be a key factor.

The market failures that do not allow fair competition between renewable energy and fossil fuels, were not identified by the respondents as current market elements but were identified as past elements. In the international market, respondents mentioned that advances in research and development (R&D) prevented RE from competing fairly with fossil fuels. On this issue, one respondent stated: "Machinery that did not exist before allows a good capacity factor in places where there is limited wind; this was not possible due to PR's wind situation and the technology which was available at the time. Now it is starting to be profitable because the cost of fuel is rising and there are more incentives." In this aspect, the respondent mentioned that the political relationship with the United States went against the development of RE in Puerto Rico. Specifically, energy policies in the United States were cited as an indication that the market development of RE in Puerto Rico responds to the reality of the United States, which did not take such forceful action as Spain or Germany. These two European countries invested an extraordinary amount of money and created a successful public policy that responded to the Renewable Energy Directive that sets rules for the European Union to achieve its 20% renewables target by 2020. Meanwhile, United States created voluntary initiatives as a Renewable Portfolio Standard. Another market failure is that the low cost of fossil fuels kept this type of investment out of favor. During the time that fuel was relatively cheap, renewable energy did not attract developers and investors.

Research on RE market failures focuses primarily on the need to eliminate the elements that prevent fair competition between RE and fossil fuels, focusing on their theme of the internalization of negative externalities. But contrary to what is indicated in the literature review, in Puerto Rico government intervention to tax the use of fossil fuels in an effort to correct defects in the market did not seem necessary. A Pigouvian tax on the electricity sector, already with one of the highest prices in the world, would be a mistake with grave consequences for Puerto Rico's economy. In fact, the high cost of electricity has already had an adverse impact on the country's competitiveness, as indicated

by the latest Report on the Competitiveness of the Economy of Puerto Rico (2012).

Market barriers were defined as preventing expected success. The Liao (Liao et al., 2011) classification was used in this investigation, which identified the barriers to implementation of renewable energy technologies as (1) economic and financial, (2) institutional and political, (3) technical and (4) awareness and information. Financial and Economic: it was found that there were no significant financial or economic barriers, as the conditions within international renewable energy markets place Puerto Rico in a good position to invest. The European market is saturated, specifically in countries such as Spain, France, and the UK. These countries have reduced or eliminated economic promotion instruments. The United States on the other hand, has been lagging, and the penetration of foreign companies is more complicated than in Puerto Rico. Finally, when comparing Puerto Rico with the rest of Latin America, the political and economic relationship with the United States provides certainty to investors. According to one respondent, "Doing business in PR compared to the rest of Latin America represents a much lower risk for the currency. It provides known financial stability and is sheltered by the US. "

Institutional and political: The support of the central government was perceived by respondents as important and positive. The recent approval of acts related to this market show the political will of the government, as respondents indicated. PREPA is the only institution that did not match this perception as stated, as it does not yet seem prepared for the development of the renewable industry. Technical: All respondents cited the technical topic as a major barrier, directly related to institutional and political elements, specifically PREPA. The main technical issue discussed concerned the Minimum Technical Requirements (MTR) that are required by PREPA in order to ensure the stability of the power grid. PREPA's primary concern is the changes in the voltage and frequency associated with the network interconnection (as mentioned in several interviews). In each of the interviews, the same experience was expressed. The companies negotiated a Power Purchase Agreement, which is in fact a Power Purchase Agreement and Operations because it includes terms for the interconnection requirements of machinery and substation maintenance and other issues. The contracting parties (companies and PREPA) signed this document, and the financing of the projects was requested. According to most respondents, the situation was complicated because, after signing the contracts, PREPA required changes to the interconnection requirements. Variations in the MTR

increased upfront costs, consequently changing the conditions of the project's financing and reducing return on investment. The option of having a fixed 20-year contract with a fixed price gives security to developers and investors, but the price per kWh is not the only factor in the equation of return of capital, which is essential. There are other operational costs, such as MTR, that may affect this equation and this is where the PREPA's PPA fails. It seems that, the recommendation that Barradale (2010) offered to encourage RE investment using long-term contracts is valid if terms and conditions are fully and clearly negotiated from the beginning. Subsequent amendments should be avoided, to the extent possible.

Finally, the issue of Consciousness and Information was not identified as a significant barrier to projects. It was noted that the central government clearly understands the reality of electricity generation and supply in Puerto Rico. They are aware that they cannot supply all the electricity required solely utilizing RE. They also understand the related technologies as well as the costs. At a local community level, the representatives of the companies followed established procedures for periodic reporting, personally attended public hearings and openly announced the projects, thus avoiding any rejection expressed by the community. Further research should be conducted to prove if the community's silence is a passive acceptance or quiet resistance (Dethloff, 2004).

Risks are defined as the possibility of not recovering the investment amount within the expected time and were classified by respondents as economic, technical and natural disasters. The economic risks mentioned were mainly external to the development of the project that neither developers nor investors could control. Investments in renewable energy have high initial costs (upfront costs), but once the infrastructure is in place, fixed costs are low (operational costs, maintenance, and employment). In addition, variable costs are predictable because the wind and solar energy are free. The electricity generation is variable because it depends on renewable sources but there are predictable measurements and projections. Furthermore, in accordance with Sadorsky (2010), who mentioned that the balance between profitability and risk for RE is precarious, interviewees said that the profit margin is not very high, as indicated by the respondents, so variations in predicted costs threaten profit margins. Minimum Technical Requirements, referred to as a major barrier was identified also as the greatest risk for many respondents. Within the PPA, the KWh price is also a concern. One respondent said he was concerned that the fixed price contract with the PREPA for the

next 20 years is not high enough to cover expenses and provide the expected return on capital. It is important to highlight the fact that MTRs was identified as an important barrier and risk. This avoidable situation emphasizes the importance of agreements with investors in order to nurture this market.

Another element in the equation that could affect profit is the reduction or elimination of federal financial incentives. There is uncertainty regarding continuity, which depends on decisions made at the White House and the United States Congress. This research proved that the instability of the economic instruments for the promotion of RE (EIPRE) represents a risk to consider, since these are outside of Puerto Rico's control. Without this suitable control, (i.e. decisions concerning EIPRE) or a plan B, (i.e. a support system as Dinica suggested), in the case of EIPRE being discontinued, Puerto Rico fails to provide a sense of security to diminish this risk. Another political point raised, was the speed with which government agencies manage project permits, which can delay the completion of engineering work. This not only hinders the sales of energy but in some cases also threatens the financial arrangements that require the completion of the project by a specific date.

On the technical issue, one respondent expressed concern that the PPA includes clauses which state that PREPA has the discretion to disconnect RE projects for security reasons, but do not provide clarification of such situations. Natural disasters were mentioned as a risk to consider, in particular, storms, hurricanes, and earthquakes, which could paralyze operations. All respondents mentioned this point and the insurance premium which is considerable, although they have been assured that the purchased equipment has been designed to withstand the climate of Puerto Rico and that projects have insurance for them.

We asked about the possibility of investing without federal incentives, and respondents indicated that this is almost impossible. The concept of dual sustainability (Welch & Venkateswaran, 2009) where the high cost of conventional energy could become financially self-sustaining, without extensive government support, is not a reality for renewable energy in Puerto Rico. In this sense, government incentives seem to be a condition for investment.

When asked about the economic incentives available to promote RE outside of Puerto Rico, respondents mentioned: green certificates, PPA regularized[7], Kyoto Protocol[8], Renewable Energy Certificates (RECs)[9], and Feed in Tariff[10]. The latter was the best known through the experience in Spain and, its effectiveness is seen as a way to start

the market. Even though the most important economic incentives to promote RE in Puerto Rico are not controlled by the country, respondents indicated that there is no need to change them beyond ensuring their continuity. However they suggested the following changes to existing public policies, such as: (1) a plan agreed between PREPA and the Government for Puerto Rico which clearly states where energy is needed and the exact criteria of the PPA, (2) the use of two contracts: one technical and one for buying and selling energy in order to separate the two processes, (3) consider establishing a RE machinery manufacture industry because all companies currently need to import RE equipment, which is not only expensive but requires machinery such as cranes and trailers that do not exist locally and have to be imported.

The last question is deliberately similar to the second, because after encouraging interviewees to review failures, barriers, and risks in a way that they probably had not previously, it was expected that new reasons to invest in this industry in Puerto Rico may arise. The reasons given for investing in renewable energy in Puerto Rico were as follows: (1) as elsewhere in the world, operating costs of RE are primarily fixed, (2) free fuel contributes to low variable costs, (3) contracts are awarded to purchase the energy produced for 20 years at a fixed price, so earnings are predictable, and investment risk is low, (4) Puerto Rico does not have what some call "sovereing risk" as it nestles under the rules and currency of the United States, so there is financial stability.

7. Conclusions

There are several aspects of Puerto Rico that make the development of industrial-scale RE unique. Among them are; an isolated electrical system, high energy consumption with a downward trend, an energy mix dominated almost entirely by fossil fuels, an electricity system dominated by an auto-regulated public corporation, no endogenous fossil fuel reserve, economic instruments to promote RE which is controlled by another nation, (namely the United States), and a state government in bankrupcy with an economic crisis lasting nearly a decade. In this scenario, Puerto Rico should manage the development of RE giving special attention to the sustainable, environmental, social and economic aspect.

This article provides key points for governments in countries that aspire to create baselines for the creation of a renewable energy market. At the same time, this research presents the first impressions that the pioneers of the industry have had on failures, barriers and

market risks that is only now beginning to be articulated. From these impressions, we can conclude that political conditions and conditions in international markets have made possible the emergence of this industry. The country has managed to take advantage of incentives provided by the United States at a time of technological maturity that has allowed sufficient power generation for these projects to be profitable in Puerto Rico's expensive electricity market. This was identified by the respondents as a competitive advantage compared with a) the saturated markets in Europe, b) the United States' difficult entry into RE, and c) Latin American countries that do not offer the currency and regulatory security that Puerto Rico has. We can also conclude that reliance on mature technologies such as solar and wind, and the creation of a legal framework conducive to such investment outweighs the uncertainty of an unarticulated market.

An important issue included in this case is that all the suitable conditions in international and local markets for investors to venture into this type of project may be present, but even if one component that integrates this kind of operation, such as interconnection (minimum technical requirements), is unfavorable for investors or poorly managed, it is likely to be detrimental to market growth. This could endanger or eliminate existing projects and dissuade future investors. If this happens, existing agreements, such as the PPAs, may be negated, and may render established targets for renewable energy development proposed by the government entirely unachievable.

Endnotes

[1] This article is a portion of a doctoral dissertation submitted to the Law Faculty of Complutense University of Madrid in October 2015. References' pages number missing due to original citation format.

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[3] If the market have limited information about the effectiveness and benefits of the technology, there may be information market failure (Gillingham & Sweeney, 2010).

[4] Principal-agent relations occur when the interest of one party (the principal) depend on the actions of another (the agent) (Sorrell et. al, 2000).

[5] Power Purchase Agreement: agreement between power plants and public utility.

[6] Toolling agreement can be interpreted as leasing contracts on a plant wherein the "toller", the buyer of the call option, has the right to the plant output at his or her discretion (Eydeland & Wolyniec, 2003)

[7] Power Purchase Agreement supervised by an external regulatory body.

[8] The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change, which commits its Parties by setting internationally binding emission reduction targets (UN, 2016).

[9] A renewable energy certificate, or REC is a market-based instrument that represents the property rights to the environmental, social and other non-power attributes of renewable electricity generation. RECs are issued when one megawatt-hour (MWh) of electricity is generated and delivered to the electricity grid from a renewable energy resource (EPA, 2016).

[10] A feed-in tariff (FIT) is an energy supply policy that promotes the rapid deployment of renewable energy resources. A FIT offers a guarantee of payments to renewable energy developers for the electricity they produce (NREL, 2016).

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Table

Table 1. *Semi-structured interview questions*
1. What does your renewable energy project consist of? (type of technology, capacity, location, investment amount, type of funding and electricity sales contract).
2. Why has the company invested in renewable energy in Puerto Rico?
3. What electricity sector market failures in Puerto Rico have limited investment in renewable energy? Market failures are understood as defects in the local energy market that do not allow fair competition for investment resources between renewable and fossil fuels.
4. What are the barriers that the project had to overcome? Market barriers are understood as obstacles that could impede the expected success and could be, for example: (1) economic and financial, (2) institutional and political, (3) technical (4) awareness and information.
6. What are the major risks considered when making the decision to invest in a renewable energy project?
7. Would you invest in Puerto Rico if there were no federal incentives?
8. Are you aware of any policy to promote renewable energies abroad?
9. Which policy do you think is the best for use in Puerto Rico?
10. In short, what is the biggest benefit of investing in a renewable energy project on an industrial scale in Puerto Rico?