Barriers and solutions to the development of renewable energy technologies in the Caribbean

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Abstract

Despite large amounts of readily available renewable energy (RE), island states in the Caribbean are still heavily dependent on mostly imported fossil fuels for their energy production. Making use of empirical analyses, this paper explores the barriers to the development of RE for power generation in the Caribbean, and outlines a strategy of how to overcome these barriers. Semi-structured interviews with three "super-experts" serve to supplement the findings of a preceding literature review. Approximately 30 experts are consulted to confirm and rank the identified barriers to RE according to their importance. The end-product of this study is a ranking matrix that will serve as a strategy instrument for decision-makers, who are then able to prioritise barriers and initiate their removal.

Introduction

Despite large amounts of readily available renewable energy (RE) in the form of wind and solar, hydro power, geo-thermal or biomass, 97% of the Caribbean's energy production is based on largely imported fossil fuels (ECLAC & GTZ, 2004; ECLAC, 2009; CREDP, 2010; IDB, 2011). As a result, high electricity prices, energy poverty and grid connectivity issues are coupled to both the challenge of the region's projected increase in population and thus energy demand (Insulza, 2008), as well as to the challenge of mitigating the potentially severe effects of climate change on the Caribbean island states. Despite recent RE promotion efforts throughout the region, more drastic measures are required to remove existing barriers and achieve CARICOM's set goal of a 20% renewable electricity capacity share by 2017 (CARICOM, 2013). This paper sets out to explore the diverse barriers and their solutions to the use of RE for electricity production in the Caribbean today, thereby focusing on islands only, and excluding Cuba.

Research Objectives

The aim of this paper is to elicit the barriers to the development of RE for the electricity sector on Caribbean islands, and to rank them according to their importance. While different geographical and political circumstances affect overarching regional analyses, this paper uses empirical analysis to identify and categorise barriers to RE into a framework that can be applied by decision makers within Caribbean islands. Whereas much work has been done on the barriers to RE in general (Painuly, 2001, Verbruggen et al., 2010), only one academic study (Ince, 2013) has focused on this specific region. The identified four main categories of barriers are technical, economic, political and social constraints (Blechinger, 2013; Negro, Alkemade, & Hekkert, 2012). The contribution of the present paper consists of an elaboration on these barriers, and the development of a rating matrix that includes a strategy on how to prioritise and initiate their removal.

Thus the central questions pursued are the following:

- What are the barriers to the development of RE in the Caribbean?
- Which are the most important barriers?
- What measures can be implemented to overcome these barriers?

Methods

In order to answer these questions, a three-fold analysis is performed. Firstly, a literature review of peer-reviewed papers and reports leads to the extraction of existing expertise on barriers to RE and the challenges to sustainable electricity production in the Caribbean.

Secondly, a qualitative survey serves to more closely elicit current difficulties in the implementation of RE. To this end, semi-structured interviews were conducted with 3 "super experts" who have diverse and extensive professional experience within the Caribbean energy sector. The interviewees approached are associated with the Caribbean Electric Utility Services Corporation (CARILEC), the Caribbean Community Secretariat (CARICOM) and the Deutsche Gesellschaft für Zusammenarbeit (GIZ). The latter organisation looks back on more than ten years of project experience in the Caribbean, and was heavily involved in the Caribbean Renewable Energy Development Programme (CREDP). While the results from the preceding literature review serve as an interview guide, the open character of the qualitative research process ensures balancing the insights from the interviews with the outcomes of the literature review. A mere confirmation of the latter is thus avoided.

Consequently, the interviews are followed by an alteration of the list of barriers. The aggregation of the results of these two steps culminates in a list of 31 detailed barriers. They are subsequently weighted empirically through another round of questioning. Via email and/or telephone, 30 experts from the private and public sector, utilities, international organisations (IOs) and academia were presented with a questionnaire containing the list of barriers, and were asked to rank them on a Likert scale from 5 to 0 (cf. Figure 1). To allow for more in-depth interpretation, the questionnaire contains a comment section for the participants to further elaborate. The low number of samples is balanced with a careful selection of experts, thus ultimately ensuring empirical validity.

5	4	3	2	1	0	Z
Highest importance	High importance	Moderate importance	Low importance	Very low importance	Absolutely no import.	Don't know

Figure 1: Likert scale

The summation of the weightings finally permits a detailed clustering of the barriers, whereby the mean of the responses is evaluated for both the separate stakeholder groups, as well as for the overall sample size.
The end-product of this paper is a rating matrix of the identified and categorised barriers and sub-barriers. Since the ranking follows the importance and impact of the barriers, this matrix serves as a strategy instrument to allow for their removal by political and economic decision makers. In this regard, this paper will advance the implementation of RE in the Caribbean and thus contribute to the region's energy security, access and sovereignty, as well as the diversification and decarbonisation of its energy production.

Results

The first step of the research produced a list of 32 barriers to renewable energies in the Caribbean, grouped into the aforementioned four broad categories. While the bulk of the analysed literature pointed in the general direction of the single barriers and aided in the formulation of the key and supporting questions of the interviews, it was the crucial information extracted from the responses of Mr Williams (CARICOM), Mr Homscheid (GIZ/CREDP) and Mrs Jean (CARILEC) that allowed for the creation of a thorough list of Caribbean-relevant barriers to RE. Literature on barriers to renewables on small island states, for example, frequently mentioned natural barriers such as limited availability of natural resources or land as restriction to the implementation of RE (IRENA 2012, Ince 2013, del Río 2011). Since the former found no mention in the interviews, it was dropped out the list, while the latter was modified as barrier to be included as "Land use competition on islands". Homscheid (2014) illustrates this by saying "[l]and is available but it comes with certain problems. You can't put up a wind farm in the midst of a hotel development area." As Williams highlighted both the risk averseness of commercial banks, as well as the lack of evidence-based assessments of RE potentials as barriers to their funding and implementation, these two aspects were included in the list. According to Homscheid (2014), there is no "study that was looking at the complex economics comparing one vs. the other [RE], looking at the scaling effect."
In the literature, efficiency constraints of RE technologies were given high priority as a barrier to their development (Ince 2013; Timilsina, Kurdgelashvili, & Narbel 2012; Painuly 2001), yet could not be confirmed in the interviews, leading to their exclusion from the list. A significant social barrier frequently pointed to in the literature was the consumer resistance to RE, and their preference for the status quo (Reddy & Painuly 2004 Painuly 2001, Verbruggen et al 2010, Sovacool, 2009, Ince 2013). However, the interviews indicated that consumers were mostly concerned with high electricity prices (Jean, Williams 2014), and possibly in favour of RE if they lead to their reduction. The second step of the analysis thus altered the list, e.g. by incorporating ´"short terms of procurement contracts" (ECLAC/GTZ, 2004) into other financial barriers, while adding "strong fossil fuel lobby" as social barrier.

Table 1 represents the barriers as listed in the questionnaire. The questionnaire is available for download from the Reiner-Lemoine Insitute's website (2014), and contains a detailed description of the individual barriers.

Table 1: Unranked barriers to RE in the Caribbean

1. Technical Barriers
1.1. Natural Conditions
1.1.1. Land use competition on islands
1.1.2. RE impact on landscapes and ecosystems
1.1.3. Natural disasters
1.1.4. Lack of evidence-based assessment of RE potentials
1.2. Technical Constraints
1.2.1. Lack of technical expertise and experience
1.2.2. Low availability of RE technologies
1.3. Infrastructure
1.3.1. Inappropriate transport & installation facilities
1.3.2. Unsuitable transmission system and grid stability issues with decentralised RE
2. Economic Barriers
2.1. Price/cost
2.1.1. High initial investments
2.1.2. High transaction costs
2.1.3. Diseconomy of scale
2.2. Financial Aspects
2.2.1. Lack of access to low cost capital or credit
2.2.2. Lack of understanding of project cash flows from financial institutions
2.2.3. Lack of private capital
2.3. Market Failure/distortion
2.3.1. Utility monopoly of production, transmission and distribution of electricity
2.3.2. Small market sizes
2.3.3. Lock-in dilemma (conventional energy supply structures block REs)
2.3.4. Fossil fuel subsidies and fuel surcharge
3. Political Barriers
3.1. Policy
3.1.1. Gap between policy targets and implementation
3.1.2. Lack of incentives or subsidies for RE
3.2. Institutional Capacity
3.2.1. Lack of formal institutions
3.2.2. Lack of RE experts on governmental level
3.3. Regulatory
3.3.1. Lack of legal framework for IPPs and PPAs
3.3.2. Lack of regulatory framework and legislation for private investors
4. Social Barriers
4.1. Consumer Behaviour/awareness
4.1.1. Lack of social norms and awareness
4.1.2. Lack of educational institutions
4.2. Interaction Networks
4.2.1. Lack of RE initiatives
4.2.2. Lack of local/national champions/ entrepreneurs
4.2.3. Strong fossil fuel lobby
4.3. Cultural
4.3.1. Dominance of cost over environmental issues
4.4. Psychological/Moral
4.4.1. Preference for status quo

ECLAC (2009), Arenas (2013), Weisser (2004a,b),Beck & Martinot (2004), ESMAP (2009), Boyle (1994), Unruh (2000), CREDP (2010), Union of Concerned Scientists (2002), Owen (2006), Timilsina, Kurdgelashvili & Narbel (2012), Quadir et al (1995), IEA (2011), LCCC (2012)

Within the timeframe of this research, 17 participants responded, none of which were from the governmental sector. The results presented are thus comprised of the

answers of six private sector, four utility, three international organisation and four academic representatives. Figure 2 shows the overall ranking of all barriers by the four stakeholder groups who participated, in which a top four under the barriers can be identified.

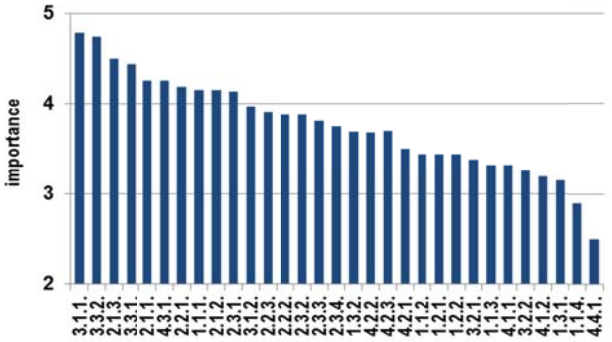

Figure 2: Importance of barriers for all stakeholder groups

The four most important barriers to all four groups are "gaps between policy targets and implementation", "lack of regulatory framework and legislation for private investors", "diseconomy of scale" and "lack of regulatory framework for independent power producers (IPPs) and power purchase agreements", respectively.

The four barriers considered least important of all the groups were, beginning with the last one, "preference for status quo", "lack of evidence-based assessments for RE potentials", "inappropriate transport and installation facilities" and "lack of educational institutions".

Analysing the results for the four stakeholder groups, it becomes evident that representatives of organisations rank 20 barriers with 4 or higher, thus considering these to be of high or highest importance. The participating researchers ranked a total of eleven barriers with 4 or higher. In contrast, representatives of the Caribbean utilities and private sector only consider five barriers to be of high importance or slightly above that.

Another striking aspect when comparing results of the different groups is that the overall top four barriers have been ranked into the top five barriers of all single stakeholders, except the organisations. Yet, the organisation's single most important barrier, unanimously ranked with 5 for highest importance is the "lack of access to low cost capital or credit". Interestingly, this barrier has been ranked tenth with an average importance of 3.25 by the utilities, fourth with an average importance of 4 by the private sector and 23rd with an average importance of 3 (of moderate importance) by the researchers. Noticeable when looking at the latter's top five ranked barriers however, is the fact that researchers have given an average importance of 4.25 and 4 to two barriers that have not been rated relatively important by the others. "Unsuitable transmission system and grid stability issues with decentralised RE" have been given an average importance of 3.5 by organisations and utilities, and a mere 2.17 by the private sector, showing second last in their ranking. "Low availability of RE technologies" is of low importance to utilities and private sector with an average ranking of 2 and 2.33 in both groups respectively.

Discussion

Three of the four most important constraints for all stakeholder groups were political barriers, pointing to the leading role governments must play if they are to achieve CARICOM's 20% renewable electricity capacity share by 2017. Linking the non-participation of the governmental representatives approached for the study with its outcome is purely speculative, yet a possible indicator of prioritisation issues for RE within Caribbean governments, despite their urgency with regards to consumer prices and climate change. The responsibility of overcoming these three barriers lies with the governments, who must provide clear incentives such as feed-in tariffs that guarantee grid access, long-term contracts, cost-based purchase prices etc. Similarly, the "diseconomy of scale" barrier can be overcome by governments making their market sizes attractive to investors, or alternatively enabling the creation of a single Caribbean-wide market.

The results expose a clear discrepancy in the perception of the barriers to RE within the different stakeholder groups. Organisations are much more sceptical about the success of RE and rate about four times as many barriers of high importance than the private sector and utilities have done. Consequently, single problems cannot be isolated, inevitably further impeding concrete action to remove these difficulties. Furthermore, the results reflect the distance of most IOs to actual RE project implementation. Crucially, it is IOs who have a mandate to enable or even fund these projects. The negative feedback from their lack of understanding of issues on the ground with regard to the lack of external support for both public and private sector RE initiatives results in delaying a higher RE share in electricity production in the Caribbean even more. The study thus highlights the clear need for engagement of public (funding) organisations with the private sector, IPPs and utilities, who ultimately implement RE projects.

This study moreover reveals the huge need for improving the dialogue and interplay between research and industry, as well as the communication between utilities, private sector and researchers in the Caribbean. Like their counterparts from the IOs, the representatives of academia have demonstrated a similar trend in rating many barriers as very important. Moreover, they have prioritised barriers that were not perceived to be important by the other groups at all, which points to severe communication problems between those who are implementing RE projects on the ground and academia. Again, a lack of mutual understanding impedes the development of RE.

Despite low actual RE shares, utilities have expressed confidence in developing RE by rating relatively few barriers of importance, which on the one hand might be a reflection of their monopolistic position in the market. On the other hand, the private sector seems to confirm this issue by including the utilities' monopoly market distortion in their top five barriers. However, both groups clearly call for a stronger legal regulatory framework in order to enable a higher RE share. By rating transaction costs and diseconomy of scale among their top five barriers, utilities furthermore indicate the need for an external actor to step in and mitigate these effects. In doing so, governments need to work with the utilities and provide incentives for private sector development.

Apart from identifying the key barriers to the development of RE in the Caribbean, the seminal contribution of this paper lies in pointing out the systemic, overarching lack of communication and mutual understanding between the RE key players. Its removal lies at the heart of a high RE share, and with that cheaper electricity prices and an environmentally sustainable and independent energy supply.

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