Chapter 24
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, most 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.

Keywords Islands • Renewable energy • Barriers • Caribbean

Introduction

The Caribbean power generation sector depends on approximately 97 % of its energy production on imported fossil fuels (CIA 2014; IEA 2013; Byer et al. 2009). This causes not only locally harmful emissions of particular matter and nitric oxides

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but also emissions of greenhouse gases causing global warming and climate change (IPCC 2014). One of the solutions to reduce the fossil fuel based power generation is the implementation of renewable energies.

Within the Caribbean area, abundant resources exist for solar and wind based power generation with annual irradiation ranging from 1700 to 2300 kWh/m^2 year and average wind velocities from 5 to 9 m/s (Stackhouse and Whitlock 2008; Xsitaaz and Clarke 2014). These resources are available on every island, and are supplemented by a huge potential for hydro power generation on larger islands with high mountains (IRENA 2012). In addition, geothermal potential can be found on all volcanic islands of the Eastern Caribbean island belt (Joseph 2008). Biomass could also be a renewable option to substitute fossil fuels based on high agricultural yields on Caribbean islands (IRENA 2012).

Even though the Caribbean is rich in clean and sustainable natural resources for economic competitive power generation, the implementation of renewable energy technology is rather slow (Shirley and Kammen 2013). As a result, the islands experience high electricity prices, energy poverty and grid connectivity deficits. In addition, the limited amount of imported fuel poses a serious challenge to a sustainable energy production due to the region's projected increase in population and thus energy demand (Insulza 2008). Furthermore, the, severe effects of climate change on the Caribbean island states are already showing up and act as a forceful reminder of the negative side effects of fossil fuel combustion. Despite recent RE promotion efforts throughout the region, more drastic measures are required to promote renewable energy and to remove existing barriers if CARICOM's set goal of a 20 % renewable electricity capacity share by 2017 is going to be reached (CARICOM 2013). This paper sets out to explore the diverse barriers and strategies to overcome those barriers that impede the use of RE for electricity production in the Caribbean today. The paper focuses on all Caribbean island states, excluding Cuba and Haiti due to their special economic and political situations. The analysis in this paper investigates not only technical and economic, but also political and social barriers.

While different geographical and political circumstances affect overarching regional analyses, this paper uses empirical research methods to identify and categorise barriers to RE into a framework that decision makers within Caribbean islands can apply. 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. Ince has set a baseline for the scientific understanding of barriers for implementing renewables in the Caribbean and pointed out that more research is needed, especially quantitative studies. While reports of different institutions have targeted the subject, they lack clear scientific methodology (CREDP 2010, 2011; IDB 2011).

Tackling both the currently slow uptake of renewable energies (RE) in the Caribbean, as well as the lack of evidence-based strategies to overcome barriers of implementation, our work aims to deliver a comprehensive overview on the most important barriers. The empirical analysis covers the views of all important stakeholders in the Caribbean power generation sector.

For this research the four identified main categories of barriers are technical, economic, political and social constraints (Blechinger 2013; Negro et al. 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?

These research questions are examined along the following structure of the paper. First the applied methods are explained and broad literature review on the methodologies is given. This is followed by the presentation of the results which are discussed in the next section. Within the discussion recommendations to remove the identified barriers are presented. Finally, the paper ends with a summary in the conclusion section.

Methods

In order to answer the three main research questions, a three-fold analysis is performed, consisting of a literature review which is complemented by a qualitative and quantitative investigation. Firstly, a literature review of peer-reviewed papers and reports extracted the existing expertise on barriers to RE and revealed the challenges to sustainable electricity production in the Caribbean. The consulted literature consisted of primary and secondary sources, as well as intergovernmental reports.

The material reviewed in the first step has been limited to literature that concerns itself with wider barriers to renewable energy in general on the one hand, and with limitations to renewable energy implementation on small island states and remote areas in low-income countries on the other hand. The search criteria followed the clustering of barriers in categories developed by Blechinger (2013) and Negro et al. (2012). The analysis sharpened the focus on market failure, so as to decide whether to include this component as an additional main barrier to the previously identified technical, political, economic and social categories. Furthermore, the literature review has been limited to cover renewable energy use for electricity production only.

In a second step, a qualitative survey closely elicits current difficulties in the implementation of RE. To this end, semi-structured interviews were conducted with three "super experts" who have diverse and extensive professional experience within the Caribbean energy sector. Since this form of data gathering provides in-depths results of discursive and explorative nature, it results in a holistic understanding of the expert's opinions on the interrelated barriers to renewable energy (Merriam 1988; Bogdan and Biklen 2003; Guba and Lincoln 1994; Magoon 1977; Patton 1980). Therefore, while the literature provides us with the barriers per se, the

rich, deep data from the expert interviews contributes meaning to the factual developments and explores why the participants hold their respective views (Stainback and Stainback 1988; Joubish et al. 2011; Creswell 1994). Consequently, the questions are primarily attitudinal, seeking the expert's view and understanding of the topic, which clearly points out the nature of the Caribbean specific barriers and potential solutions of how to remove them. The data reflect subjective judgment, which implies that interpretation plays a major part in processing the results (Creswell 2003; Denzin 2011; Rossman and Rallis 2003).

Expert assessments were selected for an analysis of interaction and proposals for promoting renewable energy (Maxwell 2013). 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). The comprehensive process of an in-depth study allows only for a small number of interviewees. We limited the amount of interviews to three, however triangulated by a quantitative study thereafter.

The interview technique follows Witzel's conceptualisation of the problem-centred interview, but is also characterised by the methods of expert interview (Witzel 1989; Meuser and Nagel 1991). The experts have been selected based on their knowledge on RE, and represent different stakeholders, namely utilities, government and the private sector respectively. The results from the preceding literature review served as an interview guide, thereby thematically organising the insights from the literature review into a coherent and consistent approach to the analysis and comparative review of the outcomes (Witzel 1989). The previous data collection on barriers to RE via literature review thus serves as heuristic-analytical framework to generate ideas for the questions that are asked, however not dominating the talk (Witzel 2000). The previous categorisation of the barriers assisted the research team in identifying, coding and categorising patterns (Joubish et al. 2011), which resulted in an alteration of the list of barriers (Atteslander 2008). The final outcome of the interviews was thus organised as inductive/deductive mutual relationship (Witzel 2000), thereby avoiding a mere confirmation of the literature review.

The aggregation of the results of these two steps culminated in a list of 31 detailed barriers. In the third, quantitative research step, they have been subsequently weighted empirically through another round of questioning. Via email and/or telephone, over 100 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 0 to 5 (cf. Fig. 24.1). This psychometric, summated scale measures the importance of all the barriers through intensity of feelings and attitudes about each barrier (Bryman 2002; Likert 1932; McIver 1981; Spector 1992). The inclusion of a "don't know category" ensures that respondents with a non-attitude answer in a way that corresponds with another variable systematically (Paulhus and Reid 1991; Schnell et al. 2008; Schuman and Presser 1981; Converse and Presser 1986).

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

Fig. 24.1 Likert scale from highest importance (*5*) to absolutely no importance (*0*) and "don't know" category

To allow for more in-depth interpretation, the questionnaire contains a comment section for the participants to further elaborate. The analysis recognises the possible impact of the social desirability bias, whereby especially representatives of energy ministries might want to present their organisation in a favourable light, thereby distorting the answers (Paulhus 2002). However, also the private sector and utility representatives might deliberately exaggerate their basic agency and communion values such as personal agency and commonalty relating to their role in the advancement of renewable energy technologies (Paulhus 1984, 1991; Bardwell et al. 2001; Sullivan and Scandell 2003).

The methodological triangulation allows for a more holistic, complete and contextual understanding of barriers to RE, and provides a connection of different perspectives from different sectors (Banister et al. 1994; Denzin 1978; Flick 1995, 2011; Holtzhausen 2001; Jakob 2001). Through the combination with the qualitative analyses, the quantitative research step serves as confirmation and validation (Tashakkori and Teddlie 2003; cf. *Phasenmodell* p. 3 Jakob 2001), it increases the validity and credibility of findings (Patton 1990; De Vos 2002), and finally enhances the result's trustworthiness (Ralph 1999).

The summation of the weightings finally permitted a detailed clustering of the barriers, whereby the mean of the responses has been evaluated for both the separate stakeholder groups, as well as for the overall sample size. The end-product of this study has been 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.

Results

The first step of the research, the literature review, 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 each barrier and assisted the team 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 Rio 2011). Since the former found no mentioning in the interviews, it was dropped from 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." Williams highlighted two barriers: the risk aversion of commercial banks, as well as the lack of evidence-based assessments of RE potentials as barriers to their funding and implementation. Both aspects, were then 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 et al. 2012; Painuly 2001), yet this assumption could not be confirmed in the interviews, it was therefore deleted 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 and 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 2014; Williams 2014), and possibly in favour of RE if they reduced the price level. The second step of the analysis thus altered the list, e.g. by incorporating "short terms of procurement contracts" (ECLAC and GTZ 2004) into other financial barriers, while adding "strong fossil fuel lobby" as social barrier.

Table 24.1 represents the barriers as listed in the questionnaire. The questionnaire is available for download from the Reiner-Lemoine Institute's website (2014), and contains a detailed description of the individual barriers.

Within the timeframe of this research, 30 participants coming from various scientific and practical backgrounds were asked to respond to a questionnaire developed by the research team. All experts selected were identified as highly prestigious experts for renewable energies in the Caribbean in a previous analysis. The sample includes seven respondents from the private sector (excluding utilities), six from utilities, seven from international organisations and five from governmental and five from academic institutions. Figure 24.2 and Table 24.2 show the overall ranking of all barriers by the five stakeholder groups who participated.

The six most important barriers (importance higher than 3.5 equals high importance) to all five groups are "lack of regulatory framework and legislation for private investors", "gap between policy targets and implementation", "high initial investments", "lack of regulatory framework for independent power producers (IPPs) and power purchase agreements (PPAs)", "diseconomy of scale", and "utility monopoly of production, transmission and distribution of electricity", respectively. For the five most important barriers the variance is relatively low, which indicates a shared perception of the barriers' importance among the respondents. The sixth most important barrier shows a larger variance which means more extreme values

Table 24.1 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 and 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
3.3.2.	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

(continued)

Table 24.1 (continued)

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

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

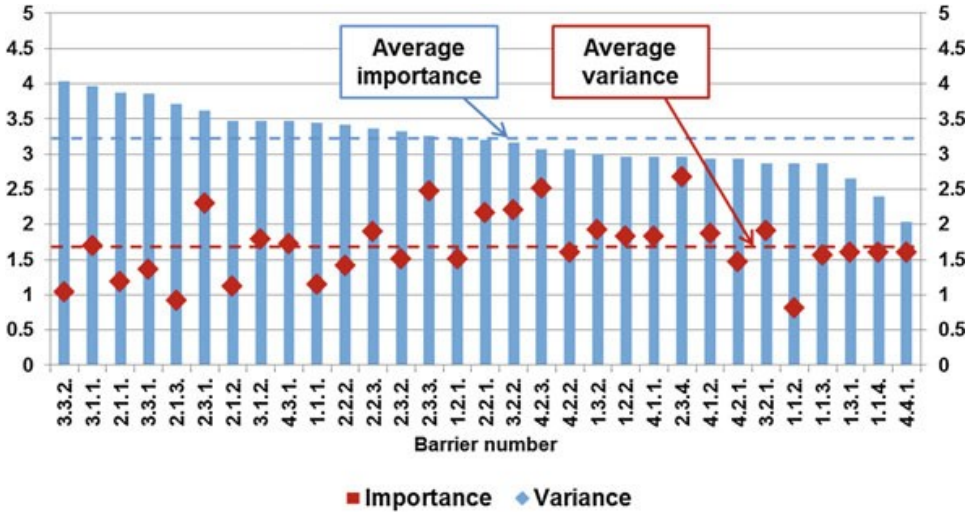

Fig. 24.2 Results of empirical weighting of barriers—overall importance and variance of each barrier

within the responses could be found. More details are explained in the discussion section.

The two barriers considered least important (importance lower than 2.5 equals to low importance) of all the groups were, beginning with the last one, "preference for status quo" and "lack of evidence-based assessments for RE potentials". Both barriers have a low variance in the importance weighting.

Overall it can be seen that the most important barriers are of economic and political nature. The most significant six items are followed by "high transaction costs" and "lack of incentives or subsidies for RE". The first social barrier is "dominance of cost over environmental issues" on rank nine with moderate to high importance. Almost the same importance is found for the item "land use competition on islands", the highest ranked technical barrier with an overall rank of ten. The remaining barriers are all ranked between importance values of 3.5 and 2.5.

Table 24.2 Results of assessment of each barrier's importance and variance by all stakeholders and importance by each single stakeholder group

Barrier no.	Barrier name	Imp. overall	Var. overall	Imp. government	Imp. organisation	Imp. private	Imp. research	Imp. utility
3.3.2.	Lack of regulatory framework and legislation for private investors	4.03	1.03	4.2	4.0	4.3	4.4	3.3
3.1.1.	Gap between policy targets and implementation	3.97	1.70	3.8	3.9	4.4	4	3.7
2.1.1.	High initial investments	3.87	1.18	4.4	3.9	3.7	4.2	3.3
3.3.1.	Lack of legal framework for IPPs and PPAs	3.86	1.36	4.2	4.3	4.0	4.2	2.7
2.1.3.	Diseconomy of scale	3.71	0.92	3.2	3.6	3.6	4.4	3.8
2.3.1.	Utility monopoly of production, transmission and distribution of electricity	3.62	2.30	3.8	4.1	4.2	4.2	1.8
3.1.2.	High transaction costs	3.47	1.12	3.4	3.7	2.9	4.2	3.3
4.3.1.	Lack of incentives or subsidies for RE	3.47	1.78	3.4	3.7	3.9	3.4	2.8
2.1.2.	Dominance of cost over environmental issues	3.47	1.72	3.6	2.9	3.7	3.4	3.8
1.1.1.	Land use competition on islands	3.45	1.14	3.4	3.1	3.2	3.8	3.8
2.2.2.	Lack of understanding of project cash flows from financial institutions	3.41	1.41	4	3.3	3.7	4	2.2
2.2.3.	Lack of private capital	3.37	1.90	3.6	3.6	3.3	4	2.5
2.3.2.	Small market sizes	3.32	1.50	3.4	3.3	3.8	3.8	2.3

(continued)

Table 24.2 (continued)

Barrier no.	Barrier name	Imp. overall	Var. overall	Imp. government	Imp. organisation	Imp. private	Imp. research	Imp. utility
2.3.3.	Lock-in dilemma (conventional energy supply structures block REs)	3.25	2.47	3	4.0	3.7	4.2	1.5
1.2.1.	Lack of technical expertise and experience	3.23	1.51	3.8	3.4	3.0	4	2.2
2.2.1.	Lack of access to low cost capital or credit	3.21	2.16	2.6	3.8	3.6	3.2	2.7
3.2.2.	Lack of RE experts on governmental level	3.17	2.21	4.4	3.7	3.1	3	1.7
4.2.3.	Strong fossil fuel lobby	3.07	2.51	2.8	4.2	3.7	3.5	1.3
4.2.2.	Lack of local/national champions/entrepreneurs	3.07	1.60	3.8	3.6	2.9	3	2.2
1.3.2.	Unsuitable transmission system and grid stability issues with decentralised RE	3.00	1.93	3.2	2.2	2.3	4.4	3.2
1.2.2.	Low availability of RE technologies	2.97	1.83	3.2	3.3	2.6	4	2.0
4.1.1.	Lack of social norms and awareness	2.97	1.83	3.8	3.6	3.3	2.4	1.7
2.3.4.	Fossil fuel subsidies and fuel surcharge	2.96	2.68	2.2	3.7	3.2	4.25	1.7
4.1.2.	Lack of educational institutions	2.93	1.86	3.6	3.7	3.1	2.4	1.7
4.2.1.	Lack of RE initiatives	2.93	1.46	3.4	3.3	3.0	2.6	2.3

(continued)

Table 24.2 (continued)

Barrier no.	Barrier name	Imp. overall	Var. overall	Imp. government	Imp. organisation	Imp. private	Imp. research	Imp. utility
3.2.1.	Lack of formal institutions	2.87	1.92	3.6	3.0	2.6	3.8	1.7
1.1.3.	RE impact on landscapes and ecosystems	2.86	0.81	2.8	2.7	3.3	2.4	3.0
1.1.2.	Natural disasters	2.86	1.57	3.2	2.4	2.8	3.2	2.8
1.3.1.	Inappropriate transport and installation facilities	2.66	1.61	3.2	2.6	1.7	3	3.0
1.1.4.	Lack of evidence-based assessment of RE potentials	2.39	1.60	2.4	2.2	2.9	2.6	1.8
4.4.1.	Preference for status quo	2.04	1.61	1.8	2.7	3.0	1.6	1.0

The variances are higher than average showing that the consensus on the ranking has been relatively low and more extreme evaluation values on both sides of the distribution curve were the rule.

Looking at the results for the five stakeholder groups, it becomes evident that there are differences in the number of barriers perceived as highly important. Researchers rank fourteen barriers with a score value of 4 or higher, thus considering these to be of high or highest importance. The participating representatives of governments and organisations ranked a total of five barriers with 4 or higher, while representatives of the private sector merely ranked four barriers within the high and highest importance. In contrast, representatives of the Caribbean utilities consider no barrier of an importance as high as 4 or above.

Another striking aspect is the discrepancy in perception of the barriers between the utilities and the rest of the stakeholders as it can be observed in Table 24.2. The items, "lack of regulatory framework and legislation for private investors" and "lack of legal framework for IPPs and PPAs" received high importance from all stakeholders with the remarkable exception of the utilities. "Lack of legal framework for IPPs and PPAs" is also seen as a highly significant barrier by the representatives of organisations. Private and academic representatives assign an importance score of four and higher to the overall second most important barrier "gap between policy targets and implementation". In comparison, political and academic representatives give an importance of four or higher to the third most important barrier "high initial investments", with the political group considering these most important. For researchers the most important barriers are "unsuitable transmission system and grid stability issues with decentralised RE" with an importance of 4.4, together with "diseconomy of scale" and "lack of regulatory framework and legislation for private investors". The first two have an overall importance of 3 (20th rank) and 3.7 (5th rank). "Land use competition on islands" is considered as most important barrier among utilities with an importance of 3.8, as well as "diseconomy of scale" and "dominance of cost over environmental issues". The first listed barrier by utility representatives is on rank 10 (importance of 3.45), the second listed is on rank 5 (importance of 3.7) and the third listed is on rank 9 (importance of 3.47) according to the overall ranking. From the governmental perspective the barriers "high initial investments" and "lack of RE experts on governmental level" are most important, with an average value of 4.4. As a comparison, overall "high initial investments" is ranked on number 3 (importance of 3.87), while "lack of RE experts on governmental level" is only ranked on 17 with an importance of 3.17.

Discussion

Three of the six most important constraints ranked alike by all stakeholder groups referred to political barriers, pointing to the leading role governments and regulatory agencies must play if they are to achieve CARICOM's 20 % renewable

electricity capacity share by 2017. While two of these refer to the lack of legal and regulatory framework for renewable energy projects, one refers to the gap between policy targets and implementation. The responsibility of overcoming these three barriers lies with the governments, who must provide clear legislation and regulatory rules to secure and attract investments. Decisive government action can fill the gap between good intent and actual implementation. Ultimately, a clear regulatory framework laid out by the respective governments will allow for the removal of three of the six major barriers for implementation.

The other three most important barriers are of economic nature. Diseconomies of scale lead to high specific investment and power generation costs. In combination with the other economic barrier "high initial investments", the need for cost or price reduction to enhance the implementation of renewables is self-evident. Means of implementation may be direct or in-direct subsidies, such as tax reduction for investments or secured feed-in tariffs. By adjusting market sizes so as to become more attractive to investors could provide a significant solution that especially targets the issues of diseconomy of scale. Alternatively, the creation of a single Caribbean-wide market would allow for a similar attraction of investors in RE. The monopolistic structure of the power generation sectors in most Caribbean island states is nominated as sixth most important barrier. On smaller islands, reaping benefits of a market liberalisation is impeded by the small overall size and a lack of capacities to create proper competition without a decrease in service quality. To overcome the negative effects of monopolies two of the aforementioned measurements can serve as solution: the creation of a Caribbean wide market would generate more competition on the one hand, while on the other hand sufficient regulation could direct utilities on smaller island states towards the implementation of renewables.

Most of the solutions for the most important barriers can be provided under governmental guidance. However, local governments need support to implement these solutions. Political representatives see the lack of renewable energy experts on governmental level as one of the most important barriers. This call for support from the inside perspective of the governments clearly shows that tasks such as the creation of a regulatory framework cannot be met by current governments alone. Support of local and national organisations may strengthen the administrative capacities and renewable energy expertise that is required.

While all stakeholders of the power generation sector should contribute to overcoming the aforementioned barriers, the results expose some discrepancies in the perception of the barriers, reflected in the variance of the results. Researchers are much more sceptical about the success of renewables and rate about three times as many barriers of high importance as the private sector, governments and organisations do. In contrast, utilities express confidence in developing renewables by rating relatively few barriers of importance, which might be a reflection of their monopolistic position in the market. Yet, the private sector seems to confirm this issue by including the utilities' monopoly market distortion in their top three barriers. For this special barrier the high variance shows the different perception of the importance indicator. By virtue of their position, the utilities have given their

monopolistic position in the market a low importance in impeding the development of RE. Indeed, utilities have rated their market position between low and very low importance and might even be seen as chance to implement renewables due to the power of a monopolistic utility, whereas private and academic stakeholders blame the monopolies for holding back renewables.

Other interesting barriers that received different ratings (highest variances) among the respondents are "fossil fuel subsidies and fuel surcharge", "strong fossil fuel lobby" and "lock-in dilemma (conventional energy supply structures block REs)". These barriers all relate to the power of the prevailing energy system and its decision makers, pointing to their unwillingness to change the power generation structure. This is mostly considered as barrier by new players in the market, as well as by renewable favouring organisations or research institutions. With utilities being representatives of the current energy system, they have ranked these barriers very low, as did the governmental representatives. This disagreement is a big hurdle for RE implementation as the more powerful players (utilities and governments) would not target these barriers, however considered highly important by all the other players. Utilities and governments must issue clear and binding statements with regards to the implementation of renewables, thereby removing suspicion that they would prefer the fossil based status quo.

Moreover this example emphasizes the need for improving the dialogue and communication between utilities, private sector, governments, researchers and international organisations in the Caribbean. Like their counterparts from the IOs, the representatives of academia have demonstrated a similar trend in rating many of the barriers as important or 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 renewable energy projects on the ground and academia. For this group, a lack of mutual understanding impedes the development of renewable energies.

Overall, the empirical results show clear trends that match the experience of the experts interviewed in the second research step and the insights from the literature. Even though the experts included in this study are regarded as high level renewable energy experts, their assessment is not necessarily valid for all Caribbean island states and their related renewable energy projects. It may be biased with respect to the location of the expert or its disciplinary background. More case studies from each island would be necessary to test the importance of the barriers along real implemented projects.

Conclusion

For this research, qualitative and quantitative empirical methods were applied in parallel. Both have been useful to provide answers to the research questions. A total of 32 barriers (8 technical, 11 economic, 6 political and 7 social) could be identified in response to the first research question. "Lack of regulatory framework and

legislation for private investors", "gap between policy targets and implementation" and "high initial investments" topped the list as the most significant barriers. They were immediately followed by the items: "Lack of legal framework for IPPs and PPAs", "diseconomy of scale" and "utility monopoly of production, transmission and distribution of electricity". To overcome these barriers the experts interviewed suggested to install a sound and effective regulatory framework for private investors and more oversight over monopolistic utilities. In addition, a Caribbean wide market was also seen as one possibility to resolve some of the economic barriers.

Apart from identifying the key barriers to the development of RE in the Caribbean, the paper addressed the systemic, overarching lack of communication and mutual understanding between the RE key players. Most of the experts were convinced that cheaper electricity prices and an environmentally sustainable and independent energy supply would be feasible if the actors were cooperating. By these recommendations, this study 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. The findings reflect the specific character of the Caribbean region, but they can also be applied to other small developing island states with similar framework conditions. In general the methodology can easily be applied to other regions for identifying and evaluating region-specific ranking of barriers. For future research it would be interesting to compare the results of the Caribbean area to barriers for implementing renewable energies on other islands states worldwide.

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