PROJECT DOCUMENT

Sustainable Energy in the Caribbean: Reducing the Carbon Footprint in the Caribbean through the Promotion of Energy Efficiency and the Use of Renewable Energy Technologies

Barriers to identification and implementation of energy efficiency mechanisms and enhancing renewable energy technologies in the Caribbean.

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Project Document

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Introduction

In presenting his Vision for the UN global initiative - "Sustainable Energy for All", United Nations Secretary-General Ban Ki-moon noted that the world today faces two urgent and interconnected challenges related to energy (Ki-moon, 2013). One was that of accessibility. One-fifth of the world's population lives without access to electricity and the opportunities it provides for the development and an improved quality of life. Secondly, where modern energy services are in abundance, emissions of carbon dioxide and other greenhouse gases from fossil fuel use are contributing to climate change and its myriad consequences. The small island developing states of the Caribbean are among those whose livelihoods are most threatened by climate change. The challenges to the environment and economy posed by climate change are compounded by those related to the high costs of imported petroleum fuels to meet the energy needs of the islands. Trinidad and Tobago is the only major producer and net exporter of petroleum among CARICOM members. Barbados, Belize and Suriname supplement their needs with small local production but, like all other member countries, are net importers. For most of these countries, oil imports gobble up a significant portion their foreign exchange earnings, in some cases, leaving very little to meet other needs. Notwithstanding the challenges posed by imported fuel and climate change, and in spite of their huge potential for renewable energy, these small islands are listed among the most inefficient energy users globally.

Three overarching objectives underpin the goal of achieving sustainable energy for all by 2030:

(i) Ensuring universal access to modern energy services

(ii) Doubling the rate of improvement in energy efficiency

(iii) Doubling the share of renewable energy in the global energy mix. (Ki-moon, 2013)

These objectives are of direct relevance to policy makers in the Caribbean, who have been tardy in efforts to address the issues of Climate Change adaptation and social and economic vulnerability of continued reliance on imported fuel. There have been many regional initiatives on Energy Policy and Renewable Energy and Energy Efficiency. However, the slow progress on initiatives and the limited application of Renewable Energy and Energy Efficiency give cause for concern. Have incentives been placed in the right areas? Are investors aware of the bankable opportunities in the field of renewable energy? Do Governments understand the importance of a facilitative regulatory regime?

Speaking on the sustainable energy for all initiative, United Nations Secretary General alluded to several factors constraining progress on renewable energy and energy efficiency. These included preservation of the status quo; financial obstacles such as high initial costs and limited sources financing, price and subsidies, counterintuitive regulatory policies and dated business models. To what extent are these factors at play in the Caribbean? This research paper aims to provide some answers to this important question. The paper is structured as follows. The next section describes the methodology. Section 3 provides a review of the literature of Renewable Energy and is followed by section 4 which provides a review of the literature on energy efficiency. Section 5 provides a summary and conclusions.

I. Methodology

A. Objectives

The objective of this study is to research barriers to the identification and implementation of mechanisms for enhancing energy efficiency and investment in renewable energy in the Caribbean. Specifically the study aims to provide an assessment of the region's status with respect to energy efficiency and renewable energy and to identify mechanisms for the enhancement of energy initiatives.

B. Literature review

A literature review was conducted covering a wide range of published papers and studies on the subject matter of renewable energy and energy efficiency in the Caribbean. Studies were drawn from international bodies, CARICOM and other regional institutions, specialists' institutions like the CCCCC, the University of the West Indies and its research units e.g. CERMES.

C. Web-based survey

The information from the literature review was supplemented by the findings of a web-based Survey. The survey was designed to garner any new or emerging thinking on the subject matter among the targeted respondents. The survey was circulated via email to targeted energy and energy conscious government offices, private entities and NGOs in the thirteen (13) CARICOM member countries. The survey was composed of a variety of opened ended questions, ranking type questions and multiple choice questions.

II. Renewable energy

A. Overview of renewable energy potential

Several studies and reports have concluded that the Caribbean has relatively high renewable energy (RE) resources. Most Caribbean states have enough renewable energy sources to meet their peak demand for energy (Samuel, 2013). Blechinger (2015) estimates that a US$ 35 billion investment can increase electricity generation capacity from renewable energy sources by over 16 GW and install 3.1 GWh of batteries. He estimates that such an investment would result in an average share of 62 per cent of renewable energy in total power generation in the Caribbean and an average reduction in the price of electricity of US$ 0.08/kWh. Kammen and Shirley (2013) estimate the cost and benefits of key RE projects in Barbados, Jamaica, Grenada and the Netherland Antilles and find that these projects are cost effective. However, despite the abundance of such resources, only a few islands utilize a significant amount of renewable energy. With renewables accounting for 28 per cent of electricity generation, Dominica is the CARICOM member which obtains the largest proportion of its energy from renewable sources. Over 90 per cent of the energy used in CARICOM states comes from fossil fuels even though the majority of countries do not produce any petroleum products (Ochs, Konold, Auth, Musolino, & Killeen, 2015).

Several studies have aimed to identify the barriers inhibiting the harnessing of renewable energy resources in the Caribbean. This research identifies four key studies that specifically examine the barriers to RE development in the region. The findings of each of these studies will be presented followed by a discussion of the major categories of barriers identified by these studies. Information on major barriers will be supplemented by various other studies which also examine the issue, however, in less detail. Several additional examples presented in the literature which highlight key barriers and success stories for individual countries have also been identified.

B. Barriers to renewable energy: summary of key studies

In 1998, the Caribbean Renewable Energy Development Programme (CREDP) was initiated to identify and remove barriers to RE development. Through a process of interviews with key stakeholders, CREDP identified the following as being the most significant barriers to the development of renewable energy in the Caribbean[1].

Table 1
Barriers identified by CREDP

Policy-related barriers	Barriers related to RE finance	Barriers related to human and institutional capacities	Awareness and information barriers
Lack of commitment on the part of governments	Insufficient acceptance of RE	The existing capacity-building activities and opportunities in RE are scattered and fragmented in the Caribbean region. Existing opportunities lack continuation, regional cooperation and possibly integration	Lack of awareness of and confidence in the technology
Lack of suitable human resources	Lack of project developers	There are few opportunities for RE training in the region for officers/decision-makers, technicians of ministries, utilities and local industry.	Most decision-makers would prefer to actually see functioning demonstration projects before investing in RE technologies
Lack of interest and commitment of national utilities			Insufficient availability and management of relevant energy data
Discriminating taxation of RE products and other financial disincentives for RE technologies			Lack of systematic RE resource assessment

Ince (2013) conducted seventy-five interviews across the Caribbean region to ascertain the main drivers and barriers to the deployment of RE technology. After identifying the main drivers and barriers, he categorizes them and develops a questionnaire to establish the impact those factors have on a Caribbean nation's intention to develop RE technology. Ince then utilizes a regression model to identify the key factors influencing intentions for RE development. He finds that individual champions (or lack thereof), external influences such as foreign agencies, and informal culture of government institutions are the main factors which act as drivers or barriers to RE. However, Ince admits that these results may be difficult to interpret because the sample size was small and response rates by Caribbean states to his questionnaire were disparate. The full list of drivers and barriers identified by Ince through his interviews is provided below.

[1] Barriers were listed but not ranked.

Table 2
RE drivers and barriers identified by Ince (2013)

Informal institutions	Finance and entrepreneurship	Formal institutions
Stakeholder interaction – relates to level of trust, understanding and cohesion between stakeholders	*Project funding* –availability of start-up funds	*Ownership* – relates to the challenges posed by the ownership of projects or technologies. Ince notes that the benefits of the technologies may not always be felt by the owner of the project thereby creating a disincentive to investment
Expertise and knowledge – relates to human capacity constraints	*Energy pricing*– the cost of RE vs. the cost of conventional fuels. Considers fuel subsidies.	*Policy instruments* - legislation, standards, regulations, financial mechanisms etc.
Government politics–relates to the issue of party politics in the development of RE projects	*Entrepreneurship*– relates to the attractiveness of RE development to the private sector	*Government policy (or lack thereof)*
Psychology and mindset – relates to the way of thinking or culture of individuals, organizations and communities		*Regulatory scheme* – relates to the method of regulation employed for the electricity utility or utilities in the country
		Transparency and accountability – relates to how clear the goals, deliverables and measurement of indicators are to stakeholders and the general public
		Utility structure –relates to the market, organizational and regulatory structure of the utility

Source: (Ince, 2013)

Table 3
Drivers and barriers identified by Ince (2013)

Natural factors	External influences	Other factors
Resource potential	*International organizations*	*Individual influence* – influence of champions (or lack thereof)
Natural environment – relates to the impacts on the natural environment of the energy sources	*Regional organizations*	*Technology and industry* – relates to the level of technology available in the country
Island diversity – relates to small market size and the differences between Caribbean states which inhibit interconnection		

Source: (Ince, 2013).

In the project document for the establishment of the Caribbean Centre for Renewable Energy and Energy Efficiency (CCREEE), barriers were identified through a process that involved the dissemination of questionnaires to key stakeholders across the region (United Nations Industrial Development Organization, 2014). The barriers identified by the study are listed below.

Table 4
RE barriers identified by CCREEE

General barriers	Knowledge and awareness barriers	Policy barriers	Market barriers
Inadequate project development and implementation expertise	Incomplete and decentralized regional data collection, compilation, analysis and dissemination	Lack of a clear enabling framework/strategy e.g. regulation does not allow RE interconnection, net-metering, net-billing etc.	Market structure not clearly defined
Lack of regional technical coordination, implementation and harmonisation capacities	Lack of institutional memory	Inadequately defined policy targets	Inadequate support mechanisms for expanding RE (including market distorts e.g. caps on RE addition)
Low grid stability	Lack of data on costs and benefits to the public		Inadequate energy performance standards for buildings, vehicles etc.
Fossil fuel subsidies			Small market size (diseconomy of scale)
Land use competition			Lack of industry data (energy use)
Low electrification rates (mainly Guyana, Haiti and Suriname) – besides availability of finance, the lack of regulatory framework to allow private business such as RE service companies to operate in this market is also a barrier			Utility monopoly power
			Lack of private capacity and initiatives
			Inadequate metering arrangements

Source: Caribbean Centre for Renewable Energy and Energy Efficiency(CCREEE) Project Document.

Table 5
RE barriers identified by CCREEE

Finance barriers	Capacity barriers	Technology barriers
Inadequate low-interest and innovative financing programs	Lack of technical capacity to formulate and enforce policies	Need for demonstration projects
Inadequate financial policies (lack of financial incentives)	Limited local capacity in both the public and private sector to develop and sustain RE technologies	Need for technology and knowledge transfer
Apprehension in making new investments given the vulnerability of Caribbean states to natural disasters and other external shocks	Brain drain	Presence in the market of low-quality equipment
	Limited local educational/training programmes	Grid readiness

Source: Caribbean Centre for Renewable Energy and Energy Efficiency (CCREEE) Project Document, 2014.

Through a multistep process involving a literature review, interviews and surveys, Blechinger (2015) identifies several barriers to the development of renewable energy resources in the Caribbean. Blechinger (2015) divides barriers into four categories, political, economic, technical and social. The complete list of barriers identified by Blechinger (2015) is provided below.

Table 6
Technical and economic barriers to RE identified by Blechinger

Technical barriers			Economic barriers		
Natural conditions	*Technical constraints*	*Infrastructure*	*Price/cost*	*Financial aspects*	*Market failure/distortion*
Land use competition on island	Lack of technical expertise and experience	Inappropriate transport and installation facilities	High initial investments	Lack of access to low-cost capital or credit	Utility monopoly of production transmission and distribution of electricity
RE impact on landscapes and ecosystems	Low availability of RE technologies	Unsuitable transmission system and grid stability issue with decentralised RE	High transaction costs	Lack of understanding of project cash flows from financial institutions	Small market sizes
Natural disasters			Diseconomy of scale	Lack of private capital	Lock-in dilemma (conventional energy supply structures block RE)
Lack of evidenced-based assessment of RE potential					Fossil fuel subsidies and fuel surcharge

Source: (Blechinger, 2015).

Table 7
Political and social barriers identified by Blechinger

Political barriers			Social barriers		
Policy	*Institutional capacity*	*Regulatory*	*Consumer behaviour/awareness*	*Interactive networks*	*Cultural*
Gap between policy targets and implementation	Lack of formal institutions	Lack of legal framework for IPPs and PPAs[2]	Lack of social norms and awareness	Lack of RE initiatives	Dominance of cost over environmental issues
Lack of incentives or subsidies for RE	Lack of RE experts on governmental level	Lack of regulatory framework and legislation for private investors	Lack of educational institutions	Lack of local / national champions / entrepreneurs	Psychological / moral
				Strong fossil fuel lobby	Preference for status quo

Source: (Blechinger, 2015).

Based on survey responses of regional energy experts, Blechinger (2015) then ranks the barriers in terms of their relative importance as hindrances to renewable energy development in the Caribbean. A score of 5 represents the highest importance while a score of 0 represents the lowest importance. Blechinger's full ranking of barriers is provided below.

[2] IPPs – Independent Power Producers; PPAs – Power Purchase Agreements.

Table 8
Ranking of barriers

Rank	Barrier	Category	Score[3] (0-5)
1	Lack of regulatory framework and legislation for private investors	Political	4.03
2	Gap between policy targets and implementation	Political	3.97
3	High initial investments	Economic	3.87
4	Lack of legal framework for IPPs and PPAs	Political	3.86
5	Diseconomy of scale	Economic	3.71
6	Utility monopoly of production transmission and distribution of electricity	Economic	3.62
7	High transaction costs	Economic	3.47
8	Dominance of cost over environmental issues	Social	3.47
9	Lack of incentives or subsidies for RE	Political	3.47
10	Land use competition on island	Technical	3.45
11	Lack of understanding of project cash flows from financial institutions	Economic	3.41
12	Lack of private capital	Economic	3.37
13	Small market sizes	Economic	3.32
14	Lock-in dilemma (conventional energy supply structures block RE)	Economic	3.25
15	Lack of technical expertise and experience	Technical	3.23
16	Lack of access to low-cost capital or credit	Economic	3.21
17	Lack of RE experts on governmental level	Political	3.17
18	Strong fossil fuel lobby	Social	3.07
19	Lack of local / national champions / entrepreneurs	Social	3.07
20	Unsuitable transmission system and grid stability issue with decentralised RE	Technical	3.00
21	Low availability of RE technologies	Technical	2.97
22	Lack of social norms and awareness	Social	2.97
23	Fossil fuel subsidies and fuel surcharge	Economic	2.96
24	Lack of educational institutions	Social	2.93
25	Lack of RE initiatives	Social	2.93
26	Lack of formal institutions	Political	2.87
27	RE impact on landscapes and ecosystems	Technical	2.86
28	Natural disasters	Technical	2.86
29	Inappropriate transport and installation facilities	Technical	2.66
30	Lack of evidenced-based assessment of RE potential	Technical	2.39
31	Preference for status quo	Social	2.04

Source: (Blechinger, 2015).

According to Blechinger's findings, the main barriers to the development of renewable energy in the Caribbean are political and economic barriers which significantly restrict the incentives for investing in renewable energy. Based on his results, Blechinger identifies three main clusters of barriers which are most important to the Caribbean region. These clusters are listed in order of importance below:

- Regulatory frameworks and policies
- Cost and financing
- The clout of conventional power suppliers

[3] Where barriers have the same score, the barrier with the lowest variance is ranked highest.

C. Discussion of main barriers

Based on the four key articles and many additional sources, the main barriers to the development of RE technology in the Caribbean can be categorized as:

(i) Regulatory frameworks and policies

(ii) Informal institutions

(iii) Costs and financing

(iv) Market barriers

1. Regulatory frameworks and policies

The literature suggests that this category of barriers is by far the most extensive and important as a hindrance to RE. All four of the key studies examined identified several barriers tied to policy and regulations. Several other studies/reports including Flavin (2004) and Ochs (2015) gave prominence to government regulations and policy as a barrier to RE development. Barriers in this category represent disincentives to RE development which have been created by government actions or can be directly removed by the actions of the government.

- **Regulatory and ownership structure of utility** – Most of the electrical utilities in the region are legally protected monopolies in electricity generation, transmission and distribution (Shirley & Kammen, 2013) and have not implemented net-metering or feed-in-tariffs which would encourage independent power producers (IPP) (Ochs, Konold, Auth, Musolino, & Killeen, 2015). Even where net metering is available and IPPs permitted, there are significant restrictions on their operations. For example, while several countries including Grenada, Jamaica and Barbados facilitate net-metering, upper limits exist on the number of kilowatts covered in the agreement thus limiting the incentives for IPPs (Shirley & Kammen, 2013).
- **Lack of institutional capacity** – The lack of technical expertise presents a major challenge to the development of adequate policy and regulations to enable RE development particularly in the smaller Caribbean states (Ince, 2013) (Blechinger, 2015). “Governments in the Caribbean need help in building their capacity to effectively prepare terms of references for consultants; write requests for proposals RFPs; evaluate bids; refine policies, and establish administrative procedures” (Geoghegan, Ince, Witter, Springer, Finisterre, & Leotaud, 2014).
- **Price distortions** – Fossil fuel subsidies can significantly reduce the price faced by consumers thereby limiting the incentives to switch to cleaner energy sources. Di Bella and others (2015) estimated expenditure on fuel subsidies for countries in Latin America and the Caribbean over the period 2011 to 2013. Their study estimates that several Caribbean countries provided direct or indirect fuel subsidies which ranged from 0.1 per cent of GDP for Saint Kitts to 2 per cent of GDP for Trinidad and Tobago. Such distortions can restrict the development of RE even if financial incentives exist.
- **Transaction costs** – Excessive bureaucracy is also a major impediment to the development of RE. In Jamaica, the process of obtaining clearance for an RE project can involve almost twenty steps and several different organizations (Ochs, Konold, Auth, Musolino, & Killeen, 2015). In the tourism sector, despite the benefits of RE utilization, the costs of reconfiguring hotels with conventional energy systems already in place is a major deterrent (Hintler, Archibald, Bahirwani, Becker-Birck, Chessin, & Waggoner, 2015).
- **Inconsistent and short-term policy** – Ince (2013) and Blechinger (2015) identify several inconsistencies in government policy which can generate uncertainty with respect to the objectives of the government thereby limiting long-term private sector investment in RE. Ince

(2013) also identifies the behaviour of ruling political parties who often discontinue the policies and initiatives of the previous administration.

- **Lack of regional technical cooperation** – The development of the RE sector can be impeded by the lack of coordination between the vast number of players and initiatives in the RE sector across the region (Ochs, Konold, Auth, Musolino, & Killeen, 2015). Ince (2013) notes that stakeholder interaction could either play a key role in facilitating the development of RE technology or in impeding it.

2. Informal institutions

Several studies highlight cultural and psychological barriers to RE technology. Such barriers are difficult to overcome even when other barriers may not exist. Two key barriers in this category can be identified from the literature.

(i) **Strong traditional ties to conventional energy sources** – Ince (2013) notes that the development of RE can prove difficult where there is a deep affinity with fossil fuels. Such ties to fossil fuels are strongest in petroleum producing countries like Trinidad and Tobago. However, "even in countries that are net importers of fossil fuels (i.e., the vast majority of countries in the region), interest in the status quo often remains high, whether on behalf of governments that collect taxes on imports and electricity sales, or companies and individuals that profit from the import, distribution, and burning of fossil fuels" (Flavin, Gonzalez, Majano, Ochs, da Rocha, & Tagwerker, 2014). In the context of strong organizational ties to petroleum, a champion from within the sector is usually needed to initiate the paradigm shift from non-renewable to renewable energy sources. Ince (2013) points out the role played by Dr. Raymond Wright in steering Jamaica towards greater utilization of RE technology. The Petroleum Corporation of Jamaica (PCJ) where Dr. Wright worked was able to lead the development of RE even without formal policy (Geoghegan, Ince, Witter, Springer, Finisterre, & Leotaud, 2014).

(ii) **Lack of knowledge and awareness** – Many studies consider the lack of knowledge and awareness to be a significant barrier to RE development in the Caribbean. Despite the fact that the cost of RE technology has fallen significantly and several studies reveal significant economic and environmental benefits to RE development, many individuals still harbour reservations which sometimes stem from bad experiences in the past (Ince, 2013) (United Nations Industrial Development Organization, 2014).

3. Costs and financing

All studies identified financial aspects as a key barrier to the development of RE in the region. These barriers can be divided into two main categories.

(i) High initial costs –The high cost of installing RE technology was ubiquitous as a barrier in the literature. This problem is particularly acute where conventional energy systems are already in place. This barrier exists both at the level of the utility (Ince, 2013) and at the private sector level (Hintler, Archibald, Bahirwani, Becker-Birck, Chessin, & Waggoner, 2015). In Barbados, financial incentives for the installation of solar water heaters resulted in their use in 50per cent of households even in the absence of a proper regulatory framework (Geoghegan, Ince, Witter, Springer, Finisterre, & Leotaud, 2014) (Ince, 2013).

(ii) Availability of funding –Given the high initial cost of RE technology, the availability of low-cost financing is also a major barrier. Most financial institutions in the region provide inadequate financial products for investments in RE resulting in heavy reliance on financing from international developmental agencies (Flavin, Gonzalez, Majano, Ochs, da Rocha, & Tagwerker, 2014).

4. Market barriers

These barriers are characterized by naturally occurring phenomena that create disincentives to the development of RE.

- **Small market size** – The low energy demand of most Caribbean countries does not allow economies of scale from many RE projects. The potential power generation of RE resources like geothermal power on several islands is greater than the current demand thus limiting the incentives for their development. Regional interconnection was cited as a potential solution which would significantly increase market size and the incentive for investment in RE sources such as geothermal energy which requires significant initial capital investment (Ochs, Konold, Auth, Musolino, & Killeen, 2015).
- **Land use competition** – The use of land for RE projects is controversial in many Caribbean countries particularly those dependent on tourism. There is often great reluctance by landowners to facilitate the development of RE projects (Blechinger, 2015) (Flavin, Gonzalez, Majano, Ochs, da Rocha, & Tagwerker, 2014) (United Nations Industrial Development Organization, 2014).

III. Renewable energy status in selected countries

A. Antigua and Barbuda

Current state of RE utilization

Despite significant potential from the wind and solar power, Antigua uses RE (solar and wind) to generate less than 1per cent of its electricity. It is estimated that Antigua has the potential to generate almost four times its current capacity from wind alone (Ochs, et al. 2015). Antigua allows IPPs to interconnect private RE technology with the grid but only if they have implemented net metering and are approved by the utility. Antigua's electric utility is a state run monopoly.

Main barriers

The category of barriers identified by respondents as presenting the greatest challenge was that of the regulatory framework and policy[4]. Ince (2013) notes that the old electrical infrastructure and the reluctance of the utility to utilize unfamiliar technology are major barriers to RE development. Also highlighted by respondents was the lack of information on available technical and financial resources to inform decision-making on the high cost of the technology.

Current strategies

Antigua has implemented tax credits and exemptions in order to promote RE. In 2015 the Renewable Energy Act was established which seeks to set an economic and legislative platform for the development of RE by:

- Creating a legal framework for a feed-in-tariff and net metering system
- Establishing an RE fund
- Granting fiscal incentives (tax breaks and exemptions import duties) on approved projects

[4] One regional stakeholder and one private sector representative responded for Antigua and Barbuda.

B. Barbados

Current state of RE utilization

Barbados has grid tied RE capacity (mostly solar) of 2.3per cent of total installed capacity. However, Barbados has a high rate of solar water heater usage with the technology installed in 50 per cent of households in addition to significant commercial usage particularly in the tourism sector (Geoghegan, et al. 2014). The country has the potential to generate 103 MWs of electricity (roughly 40 per cent of current installed power capacity) from wind, solar and biomass. The electric utility is a privately owned monopoly which, with limitations, allows IPPs and net metering (Ochs, et al. 2015).

Main barriers

Respondents identified costs and financing issues as the main barrier to RE development in Barbados. This seems to indicate that current financial incentives are not sufficient to move RE forward. Regulatory and policy barriers were also identified along with the conventional energy structures (Table 9).

Current strategies

Barbados facilitates IPPs, net metering and has implemented a range of fiscal incentives. These measures have resulted in a significant utilization of solar water heaters. Barbados' success in expanding solar water heater usage took place without significant legislation and clear policy. Unfortunately, such success has not spilled over into the utilization of other RE technologies. Attempts are being made to address this situation with the development of a National Sustainable Energy Policy.

C. Jamaica

Current state of RE utilization

Jamaica generates about 8 per cent of its electricity from RE (mostly wind and hydro). While this rate is modest when compared to most Caribbean countries, Jamaica's use of RE only represents about 15 per cent of current potential (hydro, wind, solar and biomass). Jamaica liberalized power generation in 2004 and as such the electric utility is privately owned. The liberalized market means that IPPs are allowed to operate although the utility still has a monopoly in the transmission, distribution and retail supply of electricity. Net metering is also permitted but limitations on capacity and the price paid by the utility to IPPs only allow relatively small scale RE producers to benefit.

Main barriers

The two most important barriers identified by the respondent represents regulatory and policy limitations[5]. The monopoly power of the utility was identified as the main barrier with inconsistencies in the legal framework for IPPs identified as the next most important barrier. The high cost of initial investment was also identified as a significant barrier.

Current strategies

Jamaica is one of the most favourable locations for RE. Financial incentives are granted for the utilization of RE technology and IPPs are allowed to operate (see table12).

[5] One private (energy) sector respondent.

D. Trinidad and Tobago

Current state of RE utilization

Trinidad and Tobago has the potential to generate electricity from wind (50 MW) and solar power (308 MW). However, given its significant reserves of oil and natural gas, the country generates 99.9per cent of its electricity from fossil fuels. Moreover, government subsidises electricity rates particularly to households, resulting in Trinidad and Tobago having the lowest energy prices in the region. Trinidad and Tobago's electric utility is state owned and operates as a vertically integrated utility with a monopoly in transmission and distribution of electricity. There are three independent power producers. Trinity Power, Trinidad Generation Unlimited (TGU) and Powergen, that supply power to the Trinidad and Tobago Electricity Commission (T&TEC) under power purchase agreements. However, the state has a majority interest in the both TGU and Powergen. Currently, the utility does not facilitate net metering.(Ochs, et al. 2015).

Main barriers

Based on responses to the survey, the biggest barrier to RE development has to do with the regulatory framework and policy[6]. All respondents highlighted some aspect of this category as the main barrier to RE although respondents differed on the specifics. The elements pertaining to regulations and policy highlighted were:

- Subsidies on fossil fuels
- Lack of a proper regulatory framework for private investors
- Lack of a regulatory framework for IPPs
- Utility monopoly power along with the utilities reluctance to pursue RE
- Inconsistent policy and gaps between policy and implementation

Given the dominance of the petroleum industry, respondents also identified the supply structures of conventional energy as a significant barrier to RE development. The high cost of RE technology and difficulties in accessing financing were also unanimously identified as barriers. One public sector stakeholder noted that the lack of engagement by the population, the small size of the local market and difficulties involved in acquiring land for RE projects were also significant barriers.

Current strategies

Feed-in tariffs which would provide a guaranteed price for an IPP to sell power to the grid are currently being developed. In 2011, the Framework for the Development of a Renewable Energy Policy contained several policy recommendations for the development of RE. Coming out of this exercise the government instituted a number of incentives for the manufacture and utilization of RE technology:

- Import duty exemptions for equipment and machinery used in the manufacture of solar water heaters
- Tax credits of 25 per cent on the cost (TT$ 10,000 and less) of solar water heaters purchased for household use
- 0-Rated VAT granted for solar water heaters, solar PV panels and wind turbines

[6] Three private sector stakeholders and two public sector stakeholders responded to the survey.

- Wear and Tear Allowance on 150 per cent of expenditure incurred in the acquisition of wind turbines, solar photovoltaic systems, and solar water heaters. The incentive also applies to equipment purchased for the manufacture of solar water heaters.

Tables 9 – 13 summarize key elements of the energy and RE development for selected countries in the Caribbean.

Table 9
Main RE barriers in selected countries

Country	Regulatory framework and policy	Informal institutions	Costs and financing	Market barriers
Antigua and Barbuda	- Lack of framework for private investors	- Lack of knowledge and awareness	- High initial costs	- Small market size
	-Utility monopoly power	-Strong ties to conventional energy sources (utility infrastructure and personnel)	- Difficulties in obtaining capital	
	-Gap between policy and implementation			
Barbados	-Utility monopoly power	- Conventional energy structures	- High initial costs	- Small market size
	-Gap between policy and implementation		- Limited access to capital	
Jamaica	-Utility monopoly power		- High initial costs	
	- Inconsistencies in the legal framework for IPPs			
Saint Lucia	-Utility monopoly power	- Current low cost of fossil fuels	- High initial costs	- Small market size
	-Gap between policy and implementation		- Difficulties in obtaining capital	- Difficulties in obtaining land
Trinidad and Tobago	- Lack of framework for private investors	- Traditional ties to fossil fuels	- High initial costs	- Small market size
	- Utility reluctance to develop RE		- Difficulties in obtaining capital	- Difficulties in obtaining land
	- Fuel subsidies			
	-Gap between policy and implementation			

Table 10
Installed power

Country	Installed power capacity (MW)	Installed RE capacity (MW)	RE share of installed capacity (%)
Antigua and Barbuda	113	0.8	0.7
The Bahamas	536	0	0
Barbados	240	5.5	2.3
Belize	141.8	82.5	58.2
Dominica	27.7	7.6	28.6

Table 10 (concluded)

Country	Installed power capacity (MW)	Installed RE capacity (MW)	RE share of installed capacity (%)
Grenada	48.6	0.7	1.4
Guyana	383	55.1	14.4
Haiti	390	62.4	16
Jamaica	926.4	72	7.8
Montserrat	5.5	0	0
Saint Lucia	88.6	0.2	0.2
Saint Kitts and Nevis	56.4	3.2	5.7
Saint Vincent and the Grenadines	52.3	6.4	12.2
Suriname	410	189	46.1
Trinidad and Tobago	2,368	0.01	0.005

Source: C-SERMS Baseline Report (Ochs, et al. 2015).

Table 11
Regulatory support for RE

Country	Feed-in-tariff	Net metering	IPPs permitted
Antigua and Barbuda	Suggested	Implemented	Implemented
The Bahamas	In development	In development	Suggested
Barbados	In development	Implemented	Implemented
Belize	Suggested	Suggested	None
Dominica	None	Implemented	Implemented
Grenada	Suggested	Implemented	Implemented
Guyana	None	Suggested	Implemented
Haiti	Suggested	Suggested	Implemented
Jamaica	None	Implemented	Implemented
Montserrat	None	None	None
Saint Lucia	Suggested	Implemented	Implemented
Saint Kitts and Nevis	None	None	Implemented
Saint Vincent and the Grenadines	Suggested	Implemented	Implemented
Suriname	In development	Suggested	Implemented
Trinidad and Tobago	In development	None	Suggested

Source: C-SERMS Baseline Report (Ochs, et al. 2015).

Table 12
Fiscal incentives for RE

Country	Tax credits	Tax reduction and exemption	Public loans/grants
Antigua and Barbuda	Implemented	Implemented	Suggested
The Bahamas	None	Implemented	None
Barbados	Implemented	Implemented	Implemented
Belize	Suggested	None	None
Dominica	None	Implemented	None
Grenada	In development	Implemented	In development
Guyana	None	Implemented	None
Haiti	Suggested	Suggested	In development
Jamaica	Implemented	Implemented	Implemented
Montserrat	Suggested	Suggested	None
Saint Lucia	Suggested	Implemented	None
Saint Kitts and Nevis	None	Implemented	Implemented
Saint Vincent and the Grenadines	Suggested	Suggested	None
Suriname	None	Suggested	None
Trinidad and Tobago	Implemented	Implemented	None

Source: C-SERMS Baseline Report (Ochs, et al. 2015).

Table 13
RE and electricity targets

Country	RE target	Renewable electricity target
Antigua and Barbuda	15% by 2030	20% by 2020
The Bahamas	30% by 2030	15% by 2020, 30% by 2030
Barbados	20% by 2026	29% by 2029
Belize	50% reduction in fossil fuel dependence by 2020	89% by 2033
Dominica	100% by 2020	100% by 2020
Grenada	20% by 2020	100% by 2030
Guyana	None	90% (hydro)
Haiti	None	46% by 2027
Jamaica	20% by 2030	12.5% by 2015
Montserrat	None	100% by 2020 (geothermal)
Saint Lucia	35% by 2020	35% by 2020
Saint Kitts and Nevis	None	20% by 2015
Saint Vincent and the Grenadines	None	60% by 2020
Suriname	None	None
Trinidad and Tobago	None	5% of peak demand by 2020

Source: C-SERMS Baseline Report (Ochs, et al. 2015).

IV. Energy efficiency

A. Overview of energy efficiency in the Caribbean

The threat of climate change and the economic hardship that usually accompanies high oil prices have helped to awaken awareness of the need for energy efficiency among most Caribbean citizens and policy makers. According to UNECLAC, there have been clear improvements in the focus on, and diligence in efforts to improve energy efficiency in most countries (ECLAC 2014). This is evident at the regional, national and sectoral levels.

There is no doubt that the Caribbean region understands the need for a coordinated approach to addressing regional energy challenges. In 2013, this was demonstrated with the passage of the CARICOM Energy Policy. While individual CARICOM member states can have a significant impact on expanding the efficient use of energy and renewable energy technologies, a more cohesive and coordinated regional approach was deemed necessary to facilitate a broader, more durable transition and help achieve sustainable energy goals most cost-effectively. In March 2014, the Government of Austria, United Nations Industrial Development Organization (UNIDO) and Small Island Developing States Dock*ing* (SIDS DOCK) signed a Memorandum of Understanding (MOU) on support for the establishment of a SIDS network of regional sustainable centres. In July 2014, the project document for the Caribbean Centre for Renewable Energy and Energy Efficiency (CCREEE) was validated. This CCREEE has acknowledged the considerable progress of CARICOM member states in creating enabling environments for energy efficiency interventions. Within the Caribbean, countries (including Trinidad and Tobago) are seeing the need for increasing efficiency, especially within the energy sector. For example, Barbados has been promoting the use of smart grids which allow a more intelligent control of electricity and the use of sustainable resources. Recently Trinidad and Tobago has launched and is in the process of executing a nationwide 3-year Public Awareness campaign on Energy Efficiency and Renewable Energy.

The CARICOM Energy Programme, CARICOM Regional Oganization for Standards and Quality (CROSQ) Secretariat and the GIZ-REETA Project have been undertaking work related to the development of energy efficiency codes and standards for buildings and appliances in the region and have recently concluded in December 2015 a Regional Validation Workshop - Development of Minimum Energy Performance Standards for Public and Commercial Buildings in CARICOM countries.

B. Barriers to energy efficiency: summary of key studies

Energy efficiency has also been growing over the last few years in the region as a beneficial by-product of the adoption and use of renewable energy technologies and as a result of the need for energy conservation given the rising cost of petroleum fuel.

A review of the literature in this field has shown that within the Caribbean, the drivers for active support for the implementation of renewable energy and energy efficiency initiatives have remained fairly constant over time. Initially, it was the fluctuating price of oil which led to a policy priority for alternative energy sources for energy security. Today, it is also the increasing environmental awareness and concern about the sustainability of conventional energy use, as well as climate change. In addition, renewable sources of energy provide benefits that are not reflected in energy policies and market conditions, including increased employment, reduced import dependence, and reduced burdens on foreign exchange.

Previous studies have identified initial barriers to implementation of energy efficiency mechanisms in the Caribbean to include: subsidies for conventional forms of energy, high initial capital costs, imperfect capital markets, lack of skills and information, financing risks and uncertainties, and a variety of regulatory and institutional factors. Additional factors include information and knowledge barriers due to a lack of customer information on recommended products and sales places, lack of trained and technical personnel to actively promote energy efficiency, unsupportive legislature and policy development and high transaction costs associated with the market development and the development of demand-side programmes. Some of the barriers and the measures to overcome them identified by the Energy Efficiency and Renewable Energy in the Caribbean Outreach magazine article put forward by the Economic Commission for Latin America and the Caribbean (ECLAC) are presented in the table below.

Table 14
Barriers and mitigating measures

Barrier to implementing energy conservation and efficiency strategies	Measures to remove barriers
Lack of information	Information centres and services; appliance labelling and consumer information
Lack of trained personnel or technical or managerial expertise	Development and delivery of training programmes
Below long-run marginal cost pricing and other price distortions	Instituting supportive legal, regulatory and policy changes
Regulatory biases or absence of regulations to support energy development	Development of relevant policies and standards
High transaction costs	Market development and commercialisation; development of demand- side management programmes, support for the introduction of energy service companies
High initial costs of energy efficiency technologies coupled with lack of access to credit	Develop innovative financing mechanisms
Higher perceived risks of the more- efficient technology	Technology research, adaptation, and demonstration; and/ or performance contracting
High user discounts rates	Support for the introduction of energy service companies

As part of the previous programme, ECLAC granted technical assistance to the governments of Belize, Guyana and Curaçao in order to identify the regulatory and fiscal barriers that hindered the use of energy efficiency technologies and renewable energy technologies, and developed recommendations for their removal. As a result, the countries planned to remove the identified barriers, in particular in the transport area. Furthermore, ECLAC´s activities led to the development of Curacao's first national energy plan, which includes the promotion of energy efficiency and renewable energy. Moreover, the governments of Bahamas, Suriname and Aruba have accepted national energy policies that had been

prepared by ECLAC for the promotion of energy efficiency measures and renewable energy technologies. In this regard, The Bahamas will be presenting the policy before their Cabinet for approval, followed by the development of an action plan for implementation. The Aruban Prime Minister has already formed a team for the implementation of the policy, and their "Nos Aruba Vision" seeks to have 100per cent renewable energy sources by the year 2020.

The preliminary assessment was undertaken during the preparatory phase of the Caribbean Centre for Renewable Energy and Energy Efficiency (CCREEE), alluded to earlier, and highlighted several current energy efficiency barriers facing the region today. These are reiterated below in no particular order:

- General barriers- the inadequacy of project development and implementation expertise, lack of regional coordination and harmonization efforts and poor Energy Efficiency policy support by the private sector
- Knowledge and awareness barriers- the lack of target specific data collection and analysis
- Policy barriers – the gaps between the policy framework and the defined policy targets and the strategic plans to achieve such defined goals
- Market barriers – the various setbacks in the business areas, for example, exploring the sustainable linkages between industries/sectors
- Finance barriers – in adequate low interest and innovative financing programs. Lack of financial incentives risks aversion.
- Capacity barriers – the gaps between creating enabling environments for the formulation of efficiency policies and implementation processes
- Technical barriers – the need for knowledge transfer from imported expertise to build local markets in the areas of implementation and maintenance.

In 2014, UNECLAC completed a report analysing the progress of national programmes and activities associated with the promotion and development of energy efficiency between 2008 and 2013, within the LAC region. The report noted that the energy saving potential from energy efficiency measures requiring little or no investment remains high. It further concluded that "there have been clear improvements in the focus on, and diligence in efforts to enhance energy efficiency in most countries. This has been due mainly to the conviction that climate change is a reality and that one of the most efficient ways of mitigating its impacts is by implementing cost-effective energy efficiency policies." (UN ECLAC, 2014) The report highlighted the following as areas where significant progress was made:

- Institutions: several countries have now mandated designated institutions with the task of designing implementing and operating energy efficiency programmes. But the lack of continuity of institutions remains a problem.
- Policy signals: public Policy guidelines on energy efficiency have been published in several countries.
- Technology: new energy efficient technologies e.g. combined cycle plants for power generation are in expanded use.
- Training and information: each country has to a greater or lesser extent specific policies with regard to capacity building training and public information
- Regulations: countries have made significant improvements in the implementation of regulations and standards of efficiency.

Further work is seen to be required in the following areas;

- Institutional capacity: limited evidence of major state-run organizations involved in energy efficiency
- Regulatory frameworks: weaknesses in the regulatory framework endure
- Energy service companies: the market for nurturing energy service companies remains underdeveloped. The implementation of performance type contracts, financed by the investments of ESCOs is almost non-existent throughout the region.
- Financing: there continues to be a shortage of specific financing for national energy efficiency programmes.
- Public knowledge: there continues to be insufficient knowledge – at all social levels- about the activities that can be carried out, the economic benefits that can be obtained, and the technology that can be used to reduce energy consumption especially in the residential sector.

Arguably, the most important regional programme to improve energy efficiency was undertaken with the Caribbean hotels. The Caribbean Hotel Energy Efficiency Action Program- Energy Efficiency and Micro-Generation in Caribbean Hotels – sought to assess the potential for energy efficiency in the Caribbean hotel sector (Tetra Tech, 2012). Using Barbados as an example Caribbean Hotel Energy Action Programme (CHENACT) concluded inter alia that:

- Hotels are generally not aware of the opportunities for energy savings in their hotels.
- Hotel owners are not convinced of the claims of the equipment and service providers
- Owners were unwilling to make EE/RE investments
- While commercial bank loans are available they do not target energy efficiency

Although the barriers identified have been validated through several reports highlighted above, this study also sought to take a fresh look at the problem by a executing a sample survey on energy efficiency and renewable energy.

C. Survey type and methodology

This assessment incorporated the use of a questionnaire-type survey. It attempted to identify major barriers and gaps across a cross section of the Caribbean region. Thirteen (13) countries were targeted for responses, of which only five (5) responded. These are Antigua and Barbuda, Barbados, Jamaica, Saint Lucia, and Trinidad andTobago. The survey was circulated via email to targeted energy and energy conscious government officials, private entities and NGOs in the various countries. The survey comprised of a variety of structured questions including opened ended, ranking, rating and multiple choice. While the number of respondents to the survey was relatively small (percentage), the information provided was useful in assessing the current state of EE/RE barriers within the region. The responses to the Energy Efficiency portion of the questionnaire is analysed and summarized below.

D. Summary and analysis of survey result

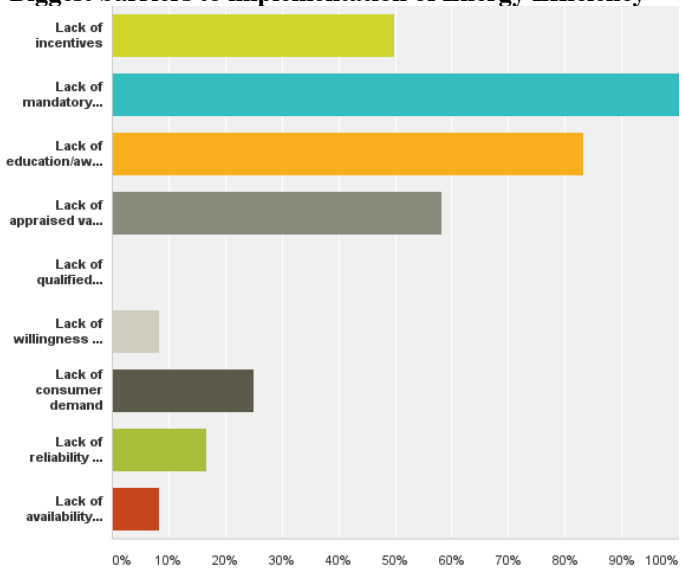
The word energy efficiency has been subject to various definitions globally. Still, its definition remains somewhat unclear to many. Respondents indicated that energy efficiency strategies can also be mistaken for sustainability, energy productivity and energy conservation. There is, therefore, need in the Caribbean region for a clear, identifiable definition of energy efficiency when moving forward.

Seventy-five percent of the respondents indicated that their countries have established energy efficiency strategies within the last five years. Some of these national strategies are based on a broader CARICOM goal whilst others reflect a national push towards awareness and energy improvement. Although the strategies have been implemented, there is overall a very low rate at which the goals are being effectively achieved.

Respondents identified a lack of mandatory legislation, lack of education/awareness and a lack of appraised value for energy efficiency to be the top three (3) barriers to the implementation of energy efficiency (figure 1)

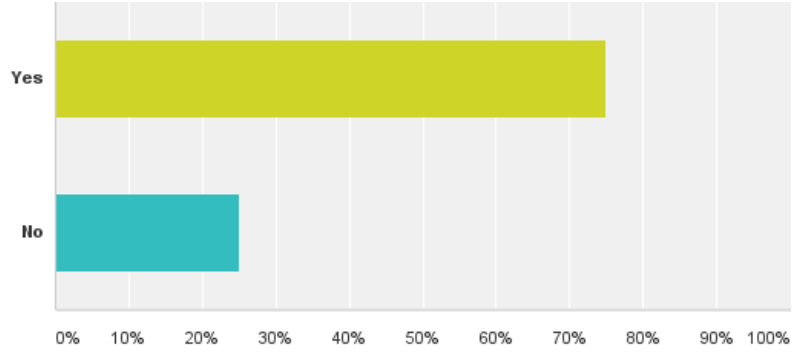
Q14: From your experience in the field, what do you think are the biggest barriers to the implementation of energy efficiency (please select all that apply)

Figure 1
Biggest barriers to implementation of Energy Efficiency



Q16. Do you think that financial barriers inhibit the implementation of energy efficiency strategies more than policy interventions?

Figure 2
Financial barriers vs policy barriers to EE



The overall consensus as can been seen above is the great need for governments to push the development, implementation and enforcement of legislation to actively stimulate the growth of energy efficiency regionally. It is evident that the current voluntary approach is not enough, and to better reap the benefits that can come from a holistic energy efficient switch, a mandatory policy to govern and strategically provide for an energy efficient vision for Caribbean countries is necessary

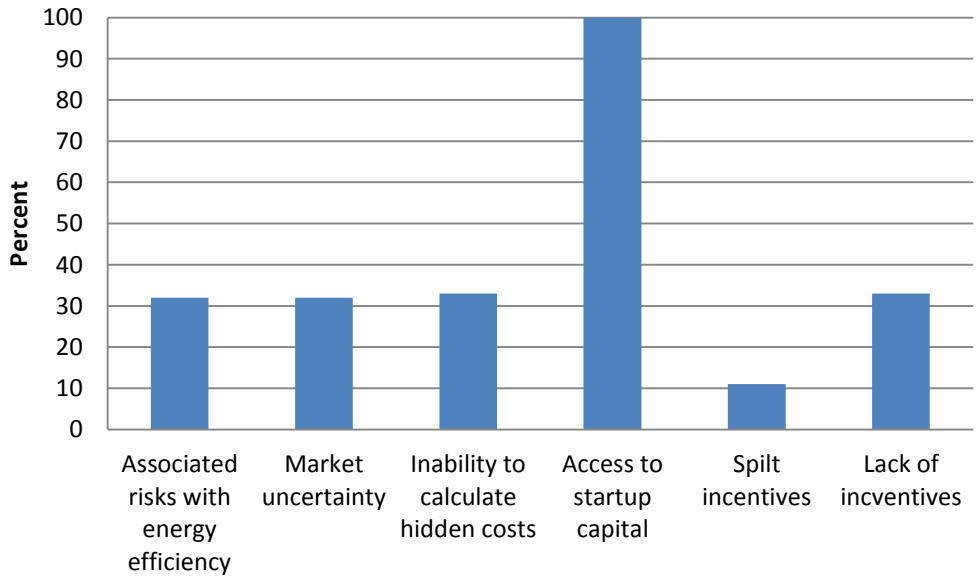
Although respondents noted the need for government legislation to encourage the widespread uptake of energy efficiency, three-quarters of respondents also indicated that financial barriers are bigger inhibiting factors relative to policy barriers (figure 2).

The respondents who indicated that financial barriers inhibit the implementation of energy efficiency strategies more than policy intervention also suggested that the main financial barrier was access to start-up capital (figure 3).

The 25 per cent of respondents who indicated that policy barriers were greater inhibiting factors than financial barriers also selected the following as the main policy barriers: Lack of guiding policy; Policy measures that are voluntary rather than mandatory; the need for policy reform across associated sectors to reflect energy efficiency; lack of incentives for the uptake of energy efficiency; and a lack of incentives for the creation of a demand market for energy efficiency.

Q17: If yes to Q16, which of the following are the main financial barriers? (Select all that apply)

Figure 3
Main financial barriers



Besides financial and policy barriers, respondents were asked to indicate the main technical barriers impacting upon the successful implementation of energy efficiency (see table 15). Those most commonly mentioned were insufficiency or inadequacy of data on energy efficiency products and projects; insufficient appropriately skilled personnel; difficulty in obtaining financing; and technical and legal challenges, with respect to tying into the grid.

Table 15
Four technical barriers to EE

Technical barrier 1	Technical barrier 2	Technical barrier 3	Technical barrier 4
Product standards	Product quality	Skilled installation and maintenance	
Low investment opportunities, no credit	Need for greater dissemination of policy, legislation and incentives	Financing options for investment limited e.g. green bond	Information about Government project is not made available to general public.
Lack of trained/qualified energy practitioners	Difficulty of assessing relative effectiveness of different products and services	Poor techno-economic forecasting methods/tools/models	Some products incompatible with local power supply/codes/regulations etc.
Training	Good value products	Lack of monitoring protocols	Deterrent strategies
Grid tie renewable energy system as only policy	Unstable grid source	Inferior grid source	No proper voltage standard
High fossil fuel subsidies	Lack of Legislation for EE across all sectors	Lack of Green Building Codes	High costs
Certification of ESCOs	Lack of experts to certify projects for financing	lack of regulatory drive	appropriate standards
Lack of reliable data with regards to certain products.	Lack of a firm understanding of how to apply certain initiatives for a specific project.	Lack of dedicated. Research and Development facility	Lack of data from pilot projects
Lack of trained personnel to identify major energy efficiency opportunities within various organisations	Lack of baseline data and poor data collection with respect to measuring the impact of energy efficiency measures	Ease of access to energy efficient equipment on the market	

In order to better understand the technology gap, respondents were asked to recommend a solution to rectify the main technical barrier that they would have identified. All respondents pointed to the need for public education and awareness building methods.

Table 16
Recommendations to rectify main technical barriers

Responses
Include local communities in the process-e.g. churches, NGOs that are actively demonstrating these technologies
Improve awareness and education in the field
Engage legislative change and empower awareness on the country
Include off grid system in the energy policy
Address subsidy reform.
Unsure
Create an easy, clear regional ESCO certification system
Establish a research and development facility within the Caribbean that would allow the opportunity to receive data and statistics on energy efficient products and or pilot projects
Undertake a targeted capacity building a programme to train professionals in energy management/etc.

V. Summary and conclusions

The objective of this study was to examine the barriers to the identification and implementation of mechanisms for enhancing energy efficiency and investment in renewable energy in the Caribbean. The study was based mainly on secondary research from published books, journals, reports and papers. These were supplemented by an online survey of energy stakeholders.

The review of literature found broad consensus regarding the common barriers impacting renewable energy and energy efficiency. Four main barriers were identified:

(i) Regulatory frameworks and policies: In some countries private monopoly ownership structure of most utilities and the tardiness with respect to implementing policy governing net metering and feed-in tariffs has slowed the growth of IPP and the deployment of renewable technologies. In Trinidad and Tobago, massive fuel subsidies practically wipe out any economic incentive for renewable energy and or energy efficiency development. Bureaucratic delays and inconsistent policies are cited as major deterrents.

(ii) Conservatism: The studies highlighted certain cultural barriers to renewable energy development. One is that strong vested interests are reluctant to let go of the conventional energy sources. This is compounded by the fact that there is still widespread lack of knowledge and awareness about the functioning, costs and benefits of renewable energy technology and or energy efficiency.

(iii) Costs and financing: The studies identified two aspects of this problem. The high initial cost of capital and the availability of funding. While the funding requirements for renewable energy technology are indeed relatively high with long payback periods, the same cannot be said about energy efficiency. There are many low hanging fruits for energy efficiency improvements. Typically these are backed by Energy Service Companies who guarantee energy savings to pay for improvements. However, such companies and arrangements are yet to have a major impact in the region.

(iv) Market Barriers: Investment in and deployment of renewable energy technologies are adversely affected by market size and land use. The small market size and consequent low energy demand in most Caribbean countries do not allow for economies of scale from many renewable energy projects. In the limited land space of these islands, renewable technology

often finds itself in competition with tourism for land use. State intervention and a well thought out land use policy can be useful in this regard.

The quality of the survey was hampered by the low response rate. Nevertheless, respondents corroborated the evidence in the literature with respect to the main barriers. The low response may be attributed to "survey fatigue" among potential respondents. Several individuals and institutions complained that this work has already been done. They suggested that the UNECLAC should focus instead on funding more micro level projects aimed at eradicating known barriers.

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