Strengthen Research Development and Uptake Capacity in Urban, Land and Municipal Management in the Caribbean

[NSUS Network for the application of STI to the urban sector]

FINAL REPORT
FOR THE USE, ADAPTATION AND MANAGEMENT OF TECHNOLOGY FOR THE URBAN SECTOR

Submitted by

Development Policy and Management Consultants

May 23, 2012

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ACRONYM

LUCLEC  Saint Lucia Electricity Services Limited
EM      Energy Management
BLP     Barbados Light and Power
ACP-ST  Africa, Caribbean and Pacific – Science and Technology
EU      European Union
STI     Science, Technology and Innovation
CARICOM Caribbean Community
LCDS    Low Carbon Development Strategy
SPACC   Special Pilot Adaptation for Climate Change
IADB    Inter-American Development Bank
GEF     Global Environment Facility
PPCR    Pilot Project for Climate Resilience
AusAID  Australian Agency for International Development
UNFPA   United Nations Population Fund
LDCs    Least Developing Countries
GDP     Gross Domestic Product
UNECLAC United Nations Economic Commission for Latin America and the Caribbean
WRM     Water Resources Management
GWI     Guyana Water Incorporated
NDIB    National Drainage and Irrigation Board
NGOs    Non-Governmental Organizations
GIS     Geographic Information System
CDM     Comprehensive Disaster Management
NCSA    National Capacity Self Assessment
CREDP   Caribbean Renewable Energy Development Programme
REEEP   Renewable Energy and Energy Efficiency Partnership
PUC     Public Utility Commission
PPA     Power Purchase Agreement
CWASA   Central Water and Sewerage Authority
GHGs    Greenhouse Gases
UNFCCC  United Nations Framework Convention on Climate Change
UNCBD  United Nations Convention on Biodiversity
UNCCD  United Nations Convention to Combat Deforestation and Forest Degradation
1. **INTRODUCTION**

1.1 **Overview**

This report is one of three (3) commissioned under the European Union (EU)-sponsored African Caribbean and Pacific – Science and Technology (ACP-ST) project: *Strengthen research development and uptake capacity in Urban, Land and Municipal Management in the Caribbean* which focuses on the application of science and technology to the urban sector. The project is concerned with the uptake of research into policy making in the Caribbean, and is intended to contribute to better urban planning and by extension, poverty alleviation in the urban areas of the Caribbean, through placing emphasis on socially and economically feasible relevant science, technology and innovation (STI) at the heart of applied research and policy making. This paper complements work being done on the other two papers, i.e., B3 which focuses on the Dutch perspective on STI development in the field of urban energy and water management, and C2 that focuses on the best practices in STI policy. This research pays particular attention to Caribbean innovation trends in the urban energy and water management and factors impeding technology use, adoption and adaptation.

This research is organized in four sections. This first section sets out, *inter alia*, the objectives of the study and the methodology followed in its execution.

Section two of the study provides an overview of the urban and energy sectors of the five countries selected for study mainly to establish a contextual framework for the discussions later in the study. In this regard therefore, in an effort to be succinct, it outlines a brief overview of the structure of the Caribbean economies under review that provides a framework and context for the discussions that follow. This section does not seek to be exhaustive. In this regard, it outlines the current use of technologies in the Caribbean in the urban energy and water sectors, and the challenges and opportunities in adoption and adaptation of further technologies in these sectors. Emphasis was also placed on natural hazards and growth threats posed by climate variability and change and challenges to adaptation such as technical capacity issues, insufficient information or sharing of information and data, insufficient public awareness and the channels through which information flow, financial limitations, and issues surrounding municipal governance. All of these can compromise the adoption of technological innovations in energy and water sectors within Caribbean states.

Sections three provides a detailed analysis of the use and adoption of technological innovations in the energy and water sectors in the Caribbean, as represented by the sample countries selected for the study. This detailed analysis is undertaken with the use of both the primary and...
secondary data collected by the researchers. The final section of the study, section four, summarizes the overall findings of the research and posits some recommendations.

### 1.2 Objective of the Research

The primary aim of this research is to identify the current technologies in and for the Caribbean in the areas of urban planning and management. In order to do this, the study collected and analysed data on the use, adoption, and adaptation and validation of technologies in the energy and water sectors to provide an understanding of challenges to the decision-making processes with respect to urban governance, use of information management systems and the factors which allow/and or inhibit the occurrence of technological innovation in support of competitiveness of Caribbean economies.

The objectives of the study, therefore, are:

- **a)** to identify and discuss the policy and action frameworks and/or development programmes provided by the urban sector in the Caribbean;
- **b)** to examine the current technologies (both indigenous and foreign) available in and for the Caribbean for urban planning and management in the energy and water sectors;
- **c)** to identify the major constraints to technological up-take in the Caribbean in order to assess the potential impacts on urban planning and management generally and the energy and water sectors specifically and to develop strategies to overcome these challenges; and
- **d)** to analyse the non-technical and cultural impediments that need to be understood and addressed to facilitate the adoption of local technology and the adaptation of best practices from outside of the region with a view towards stimulating discussion on the decision-making process in urban governance and competitiveness and innovation.

It is however critical to recognize at this early stage, that the distinction between urban and rural in the small islands can sometimes appear blurred. As such, in many instances, the policies adumbrated are not unique to the urban sector, but tends to focus on the national economy as a whole.
1.3 Justification for Selection of Territories

This research involved five (5) independent Caribbean Community (CARICOM) member states. These are the mainland states of Guyana and Suriname and three (3) island states of Barbados, Saint Lucia and Saint Vincent and the Grenadines. The criteria used for the selection of the countries was based on the need to recognise the diversity of the region with respect to geographic, demographic, socio-economic, cultural and historical characteristics.

Firstly, the larger territories have much larger urban populations than the smaller ones and therefore present greater challenges in addressing the issues of planning, management and technological innovation.¹ Secondly, in addition to differences in geographic area and population between the larger and smaller countries, the inclusion of Suriname as one of the countries to be studied provides an opportunity to bring a different cultural perspective to urban planning, management and technology adoption to the wider region. While the English-speaking Caribbean has had a planning tradition based on what pertains in Britain, Suriname as a former Dutch colony takes an approach that is linked to that planning tradition and is fundamentally different in many respects. Thirdly, the choice of countries with different levels of urban development was based on the comparable experience in innovation in energy and water management. For example, Barbados has a history of moves towards innovation in the energy sector, with moves more recently towards a Green Economy, while Guyana² and Suriname, sharing a common freshwater zone and being faced with similar challenges, will point to the need for joint efforts in this area in the face of climatic variability and change. More recently, Saint Lucia and Saint Vincent and the Grenadines have been conducting pilot studies aimed at both conserving water and making more available in the dry season through innovations in the water and energy sectors in the face of more projected extreme weather events and climate variability and change.³ All of these have the benefit of illustrating potential best practices that could be adopted and pitfalls to be avoided for the future development of Caribbean urban economies as they seek to enhance their competitiveness.

¹ This must be taken with the caveat that the rural-urban divide in many of the smaller islands can become blurred in places.
² Guyana has also developed a bold plan in its Low Carbon Development Strategy (LCDS).
³ These countries have been pursuing projects under a programme financed by the Global Environment Facility (GEF), the World Bank and the Australian Agency for International Development (AusAID) termed Special Pilot Adaptation to Climate Change (SPACC), and more recently, a World Bank/Inter-American Development Bank (IADB) financed programme termed Pilot Programme for Climate Resilience (PPCR).
1.4 Methodology

The researchers utilised a plurality of research methodologies to elicit the necessary information and data that informed the findings in this paper. These methods included a review of secondary information that are publicly available, designed and administered a questionnaire survey using a block design in the sampled countries, conducted structured interviews with key government and private sector personnel, utilised visual observation and applied professional knowledge to the data and information acquired. These methods allowed the researchers to ask the following questions in fulfilling the objectives of the study. The research questions were therefore set as:

a) What policy and action frameworks and/or development programmes are present in the Caribbean that promote urban development?

b) What technologies (both indigenous and foreign) are available in and for the Caribbean for urban planning and management in the energy and water sectors?

c) What are the major constraints to technological uptake in the Caribbean?

d) What are the major non-technical and cultural impediments that need to be understood and addressed to facilitate the adoption of local technology and the adaptation of best practices from outside of the region?

In answering the above questions, the research was able to specifically provide the following outputs:

- Identifying existing technologies in the areas of water management and urban energy issues in the five Caribbean states.\(^4\) This is being guided by a typology developed from a study: *Best Practices in Urban Planning and Management Technologies*, running concurrently, framed by priorities established under the “Caribbean Urban Agenda” as set out in the draft policy working paper: Verrest H, Mohammed A, Moorcroft S. *Towards a Caribbean Urban Agenda*. The Caribbean Network for Urban and Land Management.

- Analysing urban governance systems in the five Caribbean states with respect to the use and adaptation of urban technologies.

- Appraising techniques to identify relevant technologies, determine usefulness in the required context and ensuring appropriate adaptation and validation for use.

\(^4\) For justification in selecting these five (5) states, please refer to the consultant’s research proposal.
Examining the technical and non-technical impediments to the implementation of local and introduced technologies in the five Caribbean states. This was guided by appropriate existing literature on use and adaptation of technology internationally (e.g. the typology established by the Global Competitiveness Report 2011-2012). This aspect will inform the study: Best Practices in Urban Planning and Management Technologies, to allow for determination of requirements for adaptation of technologies to the Caribbean region.

The research does not aim to provide new findings, but rather to focus attention on the urban phenomenon in the face of changing natural phenomena and how these increasing challenges can be addressed from a technological perspective.
2. BACKGROUND TO THE STUDY

2.1 General Overview

Globally the world’s population has been increasing at an alarming rate of 1.17% per annum since the turn of the century (UNFPA, 2010). However, this growth is uneven as the developing countries of Asia, Africa and Latin America have witnessed rates in excess of those in the developed world. Of primary concern to environmentalists, developmental specialists, planners and decision-makers is the phenomenon of urbanization, especially in the Least Developed Countries (LDCs), where rural-urban migration has fuelled the significant rise of the urban population over the past decades and has posed major challenges (UNFPA, 2010). The immense growth of LDC cities has led to a multiplicity of socio-economic and environmental problems that include slum development and the related issues of crime and social deprivation, poor health and sanitation resulting from over-crowded living conditions, traffic congestion and general environmental degradation linked to air, land and water pollution.

In many countries of Asia and the Pacific the urban sector plays a vital role in economic growth and development. The survival of large segments of the population depends on effective urban planning and access to affordable public services. While cities dominate the economies of these countries, grave disparities have emerged giving rise to poverty for over two billion people. With about 1.1 billion people projected to be added to Asian cities in another twenty years, it is conceivable that the situation is likely to get worse if drastic actions are not taken.

In order to address the emerging urban developmental problems confronting developing countries, strategic cutting edge, cost-effective and clean technologies need to be promoted and adopted over conventional or traditional approaches and investments must include the poor to allow for their participation in and benefit from the development process. The idea of promoting sustainable, resilient and climate compatible urban environments is relevant in this context and requires environmentally-friendly technologies, with specific emphasis on climate resilient technologies, the adoption of environmental safeguard measures, and the building and strengthening of institutions capable of enforcing these measures.

For millions of urban dwellers in developing countries and especially some in the small island developing states (SIDS) of the Pacific and Caribbean energy and water security have become growing challenges due in part to high urban population growth rates, the effects of climate change and ineffective urban planning and management (Bynoe, 2012). The slow up-take of new and emerging technologies in the energy and water sectors for instance\(^5\) have contributed

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\(^5\) These are due to a multiplicity of problems associated with insufficient information to plan going forward and to fully derive the benefits from those technologies, the need for transformational change in mindset and attitudes at
to insecurity problems in both sectors that have compounded inefficiencies, shortages and high and rising consumption costs which in turn have exacerbated widespread poverty and degraded urban environments. Furthermore, the sloth in adopting to more efficient energy technologies comes at a time when many LDCs are expending between 20% and 50% of their gross domestic product (GDP) on meeting their energy requirements (Binger, 2011). At the same time, global climatic models are indicating a more severe warming and drier periods by 2100 (IPCC, 2007), thus aggravating the freshwater situation in water stressed States, for example, in the Caribbean.

Over the past decades Caribbean countries, and in particular their urban settings, have been severely affected by natural hazards such as tropical storms, hurricanes, earthquakes, extreme weather events associated with the El Nino and La Nina Southern Oscillations, landslides and volcanic eruptions giving rise to severe loss in lives and damage to property and infrastructure. Between 1960 and 1989, for example, hurricane deaths in the Greater Caribbean Basin was about 28,000, disruption to lives 6 million and property destroyed estimated at $16.0 billion (UNECLAC, 2010). The urban areas in the Caribbean are particularly vulnerable to natural events as was demonstrated in the widespread destruction of Port-au-Prince, Haiti in the 2010 earthquake, the effects of the 2010 El Nino effects on Caribbean States and the Guyana floods of 2005/2006 and 2007. These natural events also impacted upon the quality of life of the Caribbean urban population (UNECLAC, 2010).

In the Caribbean, many of the countries exhibit problems similar to those of their counterparts in other areas of the developing world although on a much smaller scale. Their small physical size and scare resources, limited technological development, technical human capacity and financial capabilities have not only restricted their abilities to develop, adopt and effectively utilize technological innovations and best practices in the energy and water sectors to transform their urban economies, but also considerably reduced their response mechanisms to the challenges that confront the effective integration of these sectors into the planning and management of the urban environment for the betterment of their populations. In addition, this problem has exacerbated their levels of vulnerability and abilities to respond to a variety of environmental hazards to which many of them are susceptible. As a result, the urban populations of the Caribbean continue to be severely impacted upon by a variety of natural and anthropogenic factors that contribute to flooding and droughts which influence, *inter alia*, the quality and quantity of potable water, inadequate sewage disposal systems, traffic congestion, poor mobility and air pollution.

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all levels, and a general revision of policies and enforcement of regulations to allow the adoption of appropriate technologies in these sectors.
In a number of Caribbean territories access to cheap and efficient energy have been elusive for the proper functioning of the urban system for several decades. High energy costs that is estimated at US$0.31/KWh\(^6\) and frequent power outages in Georgetown, for example, have not only negatively affected the urban economy but also the quality of life of population, especially the lower income groups that are unable to pay the bills of the utility company and have generally resorted to various illegal means to access energy for regular household use. This has sometimes led to the destruction of property by fire and deaths of residents from electrocution. It seems obvious, therefore that in some of the urban areas the authorities have been unable to find innovative means of delivering services in the energy sector in a manner that takes into consideration the social inequity among the urban populations. There is no doubt that in the urban areas, the water providing utilities also confront similar problems, with leakages from the system estimated at approximately 60% (IDB, 2011). Furthermore, poor planning and changing land use patterns have often resulted in the dual problem of flooding during periods of heavy rainfall and water shortages, leading to rationing in some instances, during the dry season. This situation is projected to get worse with climate variability and change, unless better adaptation technologies can be found and adapted to the Caribbean realities and the policy environment reformed.

In the sampled countries the urban areas are confronted with a number of socio-economic, environmental and management issues which have negatively impacted the overall living conditions of the populations. Within the urban areas there are widespread social and economic disparities among the population with squatting being a prominent feature in some sections of the urban environment. In Georgetown, Guyana the slum development is severe. Despite government interventions the problem has persisted with the embankments along major waterways being illegally occupied and solid waste dumped into canals contributing to flooding during periods of heavy rainfall. The living conditions of the urban poor in the countries are exacerbated by their lack of sufficient access to affordable energy and water supply.

The two mainland countries of Guyana and Suriname by virtue of their numerous river systems have the potential to meet urban demand for cheap and clean water while island water-stressed states of Barbados, Saint Lucia and Saint Vincent and the Grenadines with limited freshwater ecosystems, and faced with the prospect of climate change, are in a somewhat more precarious situation. With respect to energy, Suriname is the only country that produces significant enough fossil fuel to satisfy some of its domestic energy needs and supplements this

\(^6\) This is due to a combination of inefficiencies leading to nearly 40% line losses and the cost of imported fossil fuel that reached US$147 per barrel of Brent crude in 2008.
with energy from hydro–power generation. The country is said to produce nearly 94% of its national energy requirements. Guyana has the potential to exploit her extensive river systems and along with the smaller island states, to pursue other sources of energy, such as solar, wind, biogas and thermal which in combination could make energy more affordable to the urban poor and alleviate poverty. Nevertheless, innovative approaches with the use of available technology have not received the much needed attention they deserve, nor has the proper policy environment been created to incentivize technological innovation in these sectors, i.e., water and energy.

It can be argued therefore, that energy and water are two critical sectors which, if not appropriately managed have the potential to inhibit the proper functioning of the urban system. Both sectors, if effectively integrated into the management of cities have the potential to fuel growth and expansion of the urban economy and improve the livelihood of the population. For this to occur, however, municipal authorities, governments, the private sector, civil society and the utility companies must have a clear vision of the roles and functions of the sectors as well as their inter-relationships, with available technologies serving as a driver of this process to enhance the performance of the water and energy sectors. In the Caribbean decades of planning and management of urban areas seem to have either neglected to include water and energy as principal elements of their urban development plans, undervalued their importance, or treated them as discrete sectors rather than focusing on the interplay between the two. It is now urgent, therefore, that decision-makers, planners and other urban administrators give priority to the energy and water sectors as part of their strategy to improve municipal management, build green and climate resilient cities, and alleviate poverty.

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7 The Brokopondo Dam is the main hydro-electric dam. Further, the country subsidises energy to a significant degree that costs Surinamese on average US$0.10/kwh.
3. **OVERVIEW OF THE COUNTRIES, THEIR URBAN SETTING, ENERGY AND WATER SECTORS**

3.1 General

The primary purpose of this aspect of the study is to provide an overview of the countries generally, and the urban environment in particular. Furthermore, particular attention is focused on the energy and water sectors in these countries. The countries under study range in size from 215,000 km$^2$ in the case of Guyana (the largest country with regards to physical size in the study) to 389 km$^2$ in the case of Saint Vincent and the Grenadines (Table 1). All of the countries fall within the rubric of small island developing and low-lying coastal states, meaning that they tend to have some general characteristic features. For example, the Caribbean region is viewed as one of the most uncompetitive places to conduct business with fuel prices varying in some instances to 400 times what it is in Japan (Binger, 2011). This is compounded by other administrative barriers which saw all of the countries in this study scoring below 50 out of a total of 183 countries in the World Bank’s most recent *Doing Business Survey* (World Bank, 2012). Interestingly, all countries in this study saw their ranking decline over that for 2011, with the sharpest decline being Saint Vincent and the Grenadines that fell by 9 places. Also, countries in the study are seen as being particularly vulnerable to climate variability and change with insufficient capacity to adapt, inadequate institutional and political arrangements to implement programmes to reduce their energy dependence and for more effective urban and land use planning, and insufficient emphasis on a risk management ethic to address the challenges posed by natural hazards and climate change.

Rising sea levels, together with the coastal erosion, salt water intrusion, escalation in the frequency of tropical storms and intensity of hurricanes, and disruptions in rainfall and freshwater supply represent a considerable threat to Caribbean countries. Approximately 60% of the Caribbean’s population lives within 1.5 km of the coast at risk of submergence, flooding and storm surges (Simpson et al, 2010). These climate and extreme weather challenges are compounded by the fact that states are small, have an exceptionally high level of debt, and heavy dependence on expensive imported fuel (21% of GDP in 2007 - four times the cost of

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8 In the World Competitiveness Index for 2011-2012, out of 142 countries evaluated, Barbados, Guyana and Suriname were ranked 42$^{nd}$, 109$^{th}$, and 112$^{th}$ respectively. Neither Saint Lucian nor Saint Vincent and the Grenadines were assessed (World Economic Forum, 2012).

9 Saint Lucia, Saint Vincent and the Grenadines, Guyana and Suriname ranked 52$^{nd}$, 75$^{th}$, 114$^{th}$, and 158$^{th}$ respectively out of a total of 183 countries surveyed. Barbados was not part of the sampled countries.

10 Observational data for the Caribbean already indicates a level above the global mean temperature increase of approximately 0.6°C during the 20th century. Mean sea level rose during the period between 2 and 6 mm/yr and rainfall variability. Disaster losses in recent years have also been extensive: For example, a single category 2 tropical cyclone in 2005 wiped out 200% of Grenada’s estimated GDP in that year (UNECLAC, 2006).
food imports,\textsuperscript{11} which means they do not have the necessary resources to implement climate adaptation and disaster risk reduction programmes. Failure to adapt to climate change could cost an estimated average of 5\% of 2004 GDP across the Caribbean by 2025. Predicted costs rise to as much as 75\% by 2100 for smaller nations.\textsuperscript{12} Business as usual, given the scale of these costs, will mean that the economies of the CARICOM member states are in perpetual recession.

Table 1: Principal Statistics on Countries in the Study

<table>
<thead>
<tr>
<th>Country</th>
<th>Physical Size (in km(^2))</th>
<th>Urban Land Area (km(^2))</th>
<th>Population Size</th>
<th>Urban Population</th>
<th>Urban population density (persons/km)</th>
<th>Urban population as a % of Total Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barbados</td>
<td>430</td>
<td>273,331***</td>
<td>111,519</td>
<td>41</td>
<td>111,519</td>
<td>41</td>
</tr>
<tr>
<td>Guyana</td>
<td>215,000</td>
<td>70</td>
<td>751,223*</td>
<td>217,855</td>
<td>1,700</td>
<td>29</td>
</tr>
<tr>
<td>Saint Lucia</td>
<td>616</td>
<td>170,000 **</td>
<td>47,600</td>
<td>28</td>
<td>47,600</td>
<td>28</td>
</tr>
<tr>
<td>Saint Vincent and the Grenadines</td>
<td>389</td>
<td>120,000 ***</td>
<td>52,261</td>
<td>69</td>
<td>52,261</td>
<td>69</td>
</tr>
<tr>
<td>Suriname</td>
<td>163,270</td>
<td>78</td>
<td>491,989 *****</td>
<td>339,472</td>
<td>3,100</td>
<td>69</td>
</tr>
</tbody>
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But these challenges also impact the urban sub-regions as it would imply that: (i) urban development in areas such as the capital cities of Paramaribo, Bridgetown, Castries, Kingston, or Georgetown, is largely limited to coastal areas, and (ii) the vulnerability and susceptibility of the urban conurbations cannot be divorced from those of the national economies.

The sample countries are heavily natural resources-based, with the Islands of Barbados, Saint Lucia and Saint Vincent and the Grenadines depending heavily on tourism, with agriculture and industries being of lesser importance with regards to their contribution to the Islands’ gross domestic product (GDP). In general, the main land-use categories are productive – for instance industrial uses; consumptive- as seen in the provision of housing, and conservational as with forestry and protected areas. In addition, the cities are the focal point for various commercial, industrial and service-oriented activities making them a magnet for persons searching for ‘bright light’ opportunities that are associated with the urban area. As a result, these urban areas in these states, like many other such areas in other developing countries, experience high rates of population density due to this influx of people usually from the rural areas.

\textsuperscript{11} Bynoe, M (2011) The Cost of Climate Change in the Caribbean, presented at Conference of Parties (CoP) 16 in Cancun, Mexico.

3.2 The Urban Setting

The main issues to be addressed include the urban demographic, socio-economic and environmental conditions as well as the legal and institutional management framework.

These issues will be examined in the overall context of the energy and water sectors focusing on the extent to which they impact the performance of the two sectors and their potential to adapt technological innovations to improve the living conditions of the urban populations within the countries.

3.2.1 Urban Demographics

Data show that the Caribbean region is considerably more highly urbanized than the world taken as a whole (Potter, 1993). This is so despite the fact that urban centres in the region were originally established and maintained as points of administrative and commercial control, and thereby had more to do with plantation agriculture than manufacturing. Summarizing the development of highly polarized patterns of urban settlement during the mercantile and colonial eras, it is demonstrated that contemporary Caribbean urbanization can only be understood in terms of the joint processes of global convergence-divergence. Convergence represents the universal adoption of Western norms of consumption, whilst divergence connotes increasingly varied production possibilities between nations owing to the international division of labour. These are important distinctions that need to be understood, if a better appreciation of urban governance and the process of urbanization is to be understood within the Caribbean context.

According to Table 1 the two mainland countries of Guyana and Suriname have the largest populations of 751,223 (2002) and 491,989 (2011) respectively. However, Suriname and Saint Vincent and the Grenadines are the most urbanized countries with approximately 69% and 43% of their populations residing in urban areas. While the proportion of urban populations for Guyana, Barbados and Saint Lucia are much lower than those of Suriname and Saint Vincent and the Grenadines representing 29%, 41% and 28% of their total national populations respectively, they can be considered significant enough to provide a meaningful understanding of the energy and water demands in the urban sector of the countries under investigation.

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3.2.2 The Energy and Water Sectors

While across the Caribbean region there is an unequal distribution of energy resources such as petroleum, coal, natural gas and hydro potential, there are substantial sources of renewable energy which if properly harnessed could play a vital role in meeting energy demands. Available data provided by the Caribbean Renewable Energy Development Project (CREDP) indicated that in 1997 electricity generation across 16 countries was 23,000 GWh of which 93% came from fossil fuels. The CREDP report noted that between 1993 and 2002 energy consumption grew by over 36% with a projected growth rate of 4% per annum. These statistics undoubtedly revealed the nature of the urban energy sector where demand in being fuelled by rapid population growth and urban industrial expansion. In 2009 with an allocation of about US$1.5 million from CREDP/UNDP, a number of renewable energy projects were undertaken across the Caribbean in an attempt to explore new technologies to meet the region’s growing energy demands.

According to the consultancy firm Renewable Energy and Energy Efficiency Partnership (REEEP) in 2010 only 60% of the population of Guyana was serviced with electricity despite the availability of several sources of renewable alternatives. About 98% of the electricity came from petroleum and the remaining 2% from biomass. Petroleum imports came mainly from Venezuela and Trinidad and Tobago. In 2008 imported petroleum products amounted to US$410.1 million which was approximately 25.8% above the imported value of US$320.9 in 2007 due in large part to the significant rise in the oil prices that reached US$147 per barrel of Brent Crude in 2008.

Available data from the REEEP Report also revealed that Guyana’s economic growth is constrained due to its heavy reliance on costly imported petroleum products. Imported petroleum represented 31.3% of the value of Guyana’s merchandise imports in 2008 compared to 30.2% in 2007. But this is a similar case for Saint Lucia and Saint Vincent and the Grenadines. However, despite increasing expenditure on petroleum products these countries total installed capacity did not cover the demand for electricity. Electricity demand from residential, commercial and industrial consumers continued to rise while supply capacity has remained almost constant. As a result, the REEEP report posited that in the case of Guyana, consumers experienced frequent and long outages, load discharges and voltage variations. Distribution losses were estimated at roughly 40% emanating from corrupt billing transactions, faulty meters, and illegal connections and thefts by consumers, especially in the urban areas and squatter settlements occupied by low income groups.

As posited in the REEEP (2010) report there was a need for effective regulation and while most Caribbean countries achieved progress in the regulation of their electricity sector by establishing a regulatory agency empowered to set service standards and tariffs, the same was
not the case in Guyana. The sector in that country was plagued with legal personnel and financial constraints which invariably restricted the regulatory agency from fulfilling its role. The report also pointed to the datedness of the country’s energy policy taking into consideration advancements of modern technology in renewable technology and the status of the Guyana economy.

Against the background outlined above, it is not surprising that the urban energy sector experienced a variety of problems for several decades and appeared to be far from being close to a solution. In the urban environment businesses, households and the service sectors had all been impacted upon by the inadequate supply of electricity and many had resorted to individual measures to address the problems. The difficulties encountered included erratic electricity supplies contributing to damages to equipment and fires to buildings.

In an attempt to address the problem of electricity theft, the Guyana Power and Light Inc. (GPL) has embarked on a pilot project to install pre-paid meters in homes in a number of areas in the urban area of Georgetown. To date about 1,400 meters have been installed and it was reported that that while these are aimed at energy efficiency and reduction in theft, it is too early to assess the impact of this programme.

Similarly, the IDB (2007) report on “Support for Sustainable Energy Framework for Barbados” identified that the economic hardships that the country was experiencing could be alleviated if action to promote sustainable energy and improved efficiency in the sector could be attained. It was felt that Barbados’ high dependence on imported fossil fuel to meet domestic demand was negatively impacting on its competitiveness and also the social and economic development prospects of the country.

Available data indicated that Barbados’ installed electricity capacity of 239.1 megawatts was 100% fossil-fuel based and that power generation represented 50% of fuel use in the country followed by transportation (33%). While Barbados’ daily domestic demand for fossil fuel approximated to about 10,000 barrels, the country produced only 1,000 barrels daily, resulting in imports of 9,000 barrels per day.

In its draft energy policy document, the Government of Barbados major focus was on developing and implementing a national energy policy to address the negative effects oil prices and capitalize on national renewable and non-renewable resources. In this regard, the government was looking to increase energy efficiency by promoting and utilizing energy efficient technologies country-wide and also focusing on energy conservation and efficiency in various sectors of the economy. These included efforts to minimize solid waste, promote recycling and construction of green buildings among others.
There is no doubt that Guyana and Suriname have the potential to meet their energy demands through the use of their vast renewable resources. This, however, is hinged on investment and the utilization of available technology. These prerequisites are largely lacking in the sector making it highly inefficient, impacting negatively on the urban economy and municipal management.

With regards to the water sector, according to the Caribbean Water Network (Caribbean WaterNet), there is a lack of Integrated Water Resources Management (IWRM) across the Caribbean region and thus an urgent need to improve the current water management systems to ensure a better balance between competing demands for the long-term planning and sustainable use of the resource. The mainland countries of Guyana and Suriname are better endowed with water resources than their counterparts across the Caribbean. However, across the region the countries are all confronted with the same challenges of providing the commodity in adequate quantities and good quality, particularly in the urban areas where populations are rapidly expanding and squatter development and poverty is becoming widespread. In addition, Caribbean countries are confronted with the prospect of declining supplies of potable water due to changing weather patterns as a result of climate change.

Unlike many of the Caribbean island states, Guyana and Suriname are rich in hydrologic resources and has abundant surface and ground water supplies near all population centres. Heavy rainfall provides high amounts of surface run-off but also ground water recharge. However, on the low-lying coastal plain where the bulk of the population, economic activities and urban centres are located, inadequate sewerage and drainage systems, constant flooding and poorly maintained and unreliable water systems have impacted on the quantity and quality of water supply.

In Guyana, altogether, there are about 170,000 customers linked to the water supply systems in Guyana but not all receive the same quality of service. In Linden, Guyana’s second largest urban centre, water provision is plagued by the unsuitable system design which has contributed to discontinuity in water supply of an average service time of 12 hours daily, low water pressure of about 1 meter in many areas, poor water quality and high water losses of about 85% in the network in some areas, leading to inefficient water supply due to waste in energy and water resources.

As in the case of electricity, efforts have been made in the water sector to address the issue of inefficient use of the resource by installing water meters in both urban and rural areas. However, the continuation of the application of a flat rate defeats the purpose of the installed meters.
Barbados is widely perceived as a water-scarce country and for this reason has given water resources management priority. Almost of the country’s water resources are provided from rainfall and underground sources, including two springs which are dependent on rainfall. There is some concern about the supply of water from rainfall recently as annual average rainfall has declined from 60 inches to 56 inches. Also, water supply on the island has been plagued with losses from the distribution system estimated to be around 35% - 40%. With respect to access to water, 98% of the homes are directly supplied from the system while the remaining 2% are within easy reach to standpipes.

3.2.3 Resource Endowment for Water and Energy Utilization

The selection of countries was based on the desire to have countries with varying energy and water resources and the possibilities for their development. Both Guyana and Suriname are more endowed with respect to their potential for harnessing energy and water resources than the other territories. Their vast land areas, mountains and large numbers of rivers, streams and lake endowed with fresh water and potential for hydro development (Suriname already exploits hydro power resources and Guyana is currently investing in this form of energy). Their extensive coastlines also have potential for the development of wind and wave energy. Although they may be technologically and financially constrained, their inclusion into the study make for useful comparison and hence their selection.

In contrast to Guyana and Suriname, St. Lucia and St. Vincent have limited land areas with few rivers that provide scope for micro hydro power energy and water supply, much smaller urbanized population than the other Caribbean countries and therefore at a disadvantage to initiate some new types technologies in energy and water sectors. However, in these two countries potential also exists for solar and wave energy due to climatic conditions and proximity to the sea and as such warrants their inclusion in the study

3.2.4 Potential for Technological Innovation

Barbados while much smaller geographically that the mainland countries of Guyana and Suriname and like the other smaller islands has limited with natural resources endowment with respect to the type of innovations it can explore in the energy and water sectors does have some special characteristics that could make it and interesting case study. The country has no large fast-flowing rivers or lakes and no mountains to support the development of hydro-power or freshwater reservois. However, its compact urban development and semi-urban development along with abundant sunshine, strong winds and relatively large coastal water resources are available to support cost effective and innovative technology in solar energy and water sectors.
3.2.5 Environmental Conditions

The urban areas across the five countries under study vary significantly in terms of size, density and environmental conditions. For the two larger mainland countries of Guyana and Suriname the centres of focus were Georgetown, Linden, New Amsterdam, Rose Hall and Corriverton on the one hand and Paramaribo, Lileydorp and Nickerie on the other respectively. In the case of the smaller territories of Barbados, Saint Lucia and Saint Vincent and the Grenadines, the urban centres investigated were Bridgetown, Castries and Kingstown respectively. A critical element of the environmental conditions across all Caribbean territories is the high incidence of urban poverty, which limits technology use and adoption. Urban poverty is one of the main drivers of urban degradation. Many Caribbean municipalities are already overwhelmed by their traditional roles of providing urban infrastructure, health and education services, land use planning and control, garbage collection and housing. The number and complexity of services provided by municipalities are also growing due to the movement to decentralize urban functions (World Bank, 2003).

In most of the territories, such as Guyana, Suriname and Saint Vincent and the Grenadines, the environmental conditions of the urban areas have been of major concerns for several decades due to issues of squatting and poor housing and living conditions (in Guyana and Saint Vincent and the Grenadines), solid waste management and deteriorating infrastructure (in all three countries). For several decades the shortage and high cost of urban land for housing development14 along with widespread poverty and high building construction costs have forced many low income groups in Guyana and Saint Vincent and the Grenadines to resort to squatting as a means of providing shelter. Squatting however in Barbados was restricted by the very small Crown estate, with less than 1% of the land being State-owned (Mycoo, 2010).

The illegal occupation of land on state reserves and along embankments of the main drainage canals and the dumping of solid wastes into canals have contributed to making many of the drainage canals in the low-lying urban areas in these states inoperable or serving only limited functions and contributing to severe flooding during periods of heavy rainfall, thus worsening the water/flood management issue in urban areas. Additionally, poor planning and governance have been two of the principal issues confronting the management of urban environment in Guyana and Saint Vincent and the Grenadines. These issues have undoubtedly contributed to the degraded state of Georgetown and the other towns across Guyana.

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14 This has been largely occasioned by a skewed distribution in land ownership and dysfunctional land markets.
Further, with growing urban populations in the Caribbean, there are a number of other intended consequences for the coverage and provision of social services. In many cases, services are of poor quality due to increasing numbers, shanty towns are expanding, and pollution associated with transportation expansion has increased (Torres, 2011).

3.2.6 Urban Planning and Management Framework

One of the key elements in the development and implementation of a STI strategy and action plan for urban development will be the need to develop a clear spatial plan for the urban conurbations in the region. In most of the Caribbean building activities and land use changes, which impact the use and adoption of technology, and the transferability of such technology, are still taking place more or less randomly. This has already resulted in the degradation of large areas and uncontrolled building activities in areas vulnerable to flooding and sea level rise, such as the estuarine zone north of Paramaribo.

Management of the utilities, energy and water are managed in all the territory by public or quasi-public institutions. The governments, through the line ministries, departments and agencies are the agencies through which many of the national level actions are executed. However, in the case of electricity rates in Guyana, these have to be approved by the Public Utilities Commission (PUC). This regulatory body, while not seeking to stymie technology development, is there to ensure that the entity also pursues efficiency criteria. Furthermore, it is the government that determines how liberalized the sectors will be, such as the legal provisions that allow power purchase agreements (PPA) in the energy sector.

For example, in Suriname, the Ministry of Agriculture, Animal Husbandry and Fisheries is in charge of the irrigation and drainage management, but water supply systems in urban areas are operated under the supervision of the Suriname Water Company. The Water Supply Service of the Ministry of Natural Resources and Energy is responsible for water supply systems in rural areas. A number of urban and rural water systems are operated by private bodies or other government institutions. The establishment of a Water Supply Administration to protect sources of drinking water supply is under way. In Guyana, the management of urban potable water falls under the Guyana Water Incorporated (GWI), the East Demerara Water Conservancy and the National Drainage and Irrigation Board (NDIB). In The Central Water and Sewerage Authority (CWASA) is empowered by Act No. 17 of 1991 to "investigate the water resources of Saint Vincent and the Grenadines and advise the Minister relating to the improvement, preservation, conservation, utilization and apportionment of those resources". This gives the CWASA, subject to the Minister's approval, the responsibility for management of the resources. It also indicates that the Authority will control the use of the resource for all other applications, including for irrigation, agriculture, industrial, and commercial purposes.
Apart from the CWASA, the other agencies involved in exercising some responsibility for water resources management are the St. Vincent Electricity Company, the Forestry Division, and the Ministry of Agriculture and Labour.

What is evident from the issue of water management in most of the territories, is the multiple number of agencies involved in management. This often leads to, *inter alia*, insufficient inter-agency collaboration and fragmentation of functions that can also impede technological transformation. A lack of an adequate framework to actualize interagency collaboration has presented challenges the water sector that needs to be overcome. In light of the fact that water management depends on a multi-agency approach to water quality, availability, removal/drainage and supply, close cooperation between the actors is vital to the for transformational change and technology uptake. Interagency collaboration involves the maintenance of cooperative relationships between Ministries, government agencies, and statutory authorities at all levels. It is also essential that these relationships take into account local, regional, and national interests simultaneously.

Water management is typically one of the responsibilities of a government as it aims to protect the environment for the good of the general public. Governments undertake to do this by establishing an appropriate set of organisations and launching specific programmes. These interventions aim at achieving national, or even regional, objectives that include, for example, enhanced economic productivity, public health and well-being (all of which should, ideally, form part of a sustainable development strategy). Water is an environmental resource with a profound impact on public health, economic activity and environmental (and ecosystem) quality. Therefore, the prerequisite for any urban development scenario is that the organisations that are assigned with water management actually possess the capability to carry out this task. A well-balanced arrangement of flexible, dynamic organisations and other related institutions is the best assurance that unpolluted water resources remain available in the future, that the right quantity and quality of water are delivered to the water users (including the ecosystems), and that people can live in a healthy environment. These organisations, however, can only execute these functions if they have access to an appropriate financial base to expand and maintain the infrastructure, to attract qualified professionals, and to prepare well for the future.

In the case of the energy sector in Barbados, the Barbados Light and Power (BLP) is the main power company, while in Saint Lucia the Saint Lucia Electricity Services Limited (LUCLEC) are the main entities responsible for energy management (EM). The EM in this scenario is a programme involving personnel at all levels with knowledge and management skills capable of promoting energy conservation and consciousness, leading to a better quality of life for all. EM can be executed by individuals, companies or countries. The Electric Utility Company of Suriname
under the Ministry of Natural Resources and Energy is responsible for the generation and distribution of electricity. There is substantial self-generation of electricity among the industries in both Guyana and Suriname. In the case of Guyana, this was occasioned by the unreliable power supply and cost of energy from the national grid. The largest self-producer, the Suriname Aluminium Company sells electricity to the Government under a long-term power purchase agreement signed in 1957 which expires in 2045. The Government resells the energy to the Electric Utility Company.

For technology adoption to become integral in the urban development programme of the countries, responding to the scale and nature of the challenges that the urban areas confront, a transformational change is required. Building resilience and delivering low-carbon economies cannot be achieved without sustainable development and climate change being embedded into all urban development programmes.
4. **Research Analysis on the Use, Adoption and Adaptation of Technology in the Urban Environment in the Caribbean**

This section of the report addresses directly the research questions posed, inclusive of the types of technologies that are available in and for the Caribbean, as it relates to the energy and water sectors. It is important to note that while the research is interested in technology use and adoption in the urban areas, because the policies pursued in the region, as previously mentioned do not focus exclusively on the urban sector, the researchers tended to discuss these generally.

*What technologies (both indigenous and foreign) are available in and for the Caribbean for urban planning and management in the energy and water sectors?*

This question allows us to provide a summary of technologies being used in or available to the Caribbean for possible application. A short description is provided for each technology, with technical feasibility and cost effectiveness analysis. It focuses on both the energy and water sectors, with the former concentrating on both the accommodation and transportation sub-sectors; in the latter, emphasis is placed on water management, looking at both water supply and water control, i.e., flood response. The research paper uses the following criteria:

**Technical feasibility:**

- Availability of technology: This assesses whether the technology is in operation or has been proven to be commercially viable, or is within the developmental stage.
- Efficiency: The ability of the technology to reduce emissions.
- Transferability of technology: This criterion identifies whether there are any technological limitations to the transfer of the technology to the Caribbean urban sector.

**Cost effectiveness:**

- Capital costs: Where possible, capital costs of technology deployment are presented. However, it is recognized that costs vary significantly across the Caribbean region for any single technology based on market demand and various local duties/taxation policies. Each technology option was presented a qualitative capital cost rating.
- Operating and maintenance costs: Where proposed technology options represent improvements to existing technologies, qualitative discussions will be put forward on the relative changes in operating and maintenance costs.
# 1. Energy Efficiency

<table>
<thead>
<tr>
<th><strong>Electrical Appliances</strong></th>
<th><strong>Technical Feasibility</strong></th>
<th><strong>Cost Effectiveness</strong></th>
<th><strong>Locations</strong></th>
<th><strong>Scale</strong></th>
<th><strong>Time Horizon for Deployment</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>i. Air conditioning efficiency</td>
<td>High</td>
<td>High</td>
<td>All countries</td>
<td>Local</td>
<td>Short-term</td>
</tr>
<tr>
<td>ii. Urban building and room designs</td>
<td>High</td>
<td>High</td>
<td>All countries</td>
<td>Local</td>
<td>Medium-term</td>
</tr>
<tr>
<td>iii. Implementing public policy on improving building designs</td>
<td>High</td>
<td>High</td>
<td>All countries</td>
<td>National</td>
<td>Medium-term</td>
</tr>
<tr>
<td>iv. Public area lighting controls</td>
<td>High</td>
<td>High</td>
<td>All countries</td>
<td>Local and national</td>
<td>Medium-term</td>
</tr>
<tr>
<td>v. Compact fluorescent light (CFL)</td>
<td>High</td>
<td>Medium</td>
<td>All countries</td>
<td>National</td>
<td>Short-term</td>
</tr>
<tr>
<td>vi. Light emitting diode (LED)</td>
<td>High</td>
<td>Medium</td>
<td>All countries</td>
<td>National</td>
<td>Short-term</td>
</tr>
<tr>
<td>vii. Energy efficiency cooling systems (refrigerators, chillers)</td>
<td>High</td>
<td>High</td>
<td>All countries</td>
<td>National</td>
<td>Medium-term</td>
</tr>
<tr>
<td>viii. Energy management systems</td>
<td>Medium</td>
<td>Medium</td>
<td>All countries</td>
<td>National</td>
<td>Medium-term</td>
</tr>
<tr>
<td>ix. Photo-sensors and timers for outdoor lighting</td>
<td>High</td>
<td>High</td>
<td>All countries</td>
<td>National</td>
<td>Medium-term</td>
</tr>
<tr>
<td>x. Solar water heaters</td>
<td>High</td>
<td>High</td>
<td>Mainly in Barbados, St. Lucia and St. Vincent and the Grenadines</td>
<td>Local and national</td>
<td>Short-term</td>
</tr>
<tr>
<td>xi. Tax concessions on solar panels and other energy technology</td>
<td>High</td>
<td>High</td>
<td>Mainly in Barbados</td>
<td>National</td>
<td>Short-term</td>
</tr>
<tr>
<td>xii. Pre-paid Meters</td>
<td>Medium</td>
<td>Medium</td>
<td>Guyana</td>
<td>Local</td>
<td>Short-term</td>
</tr>
<tr>
<td>xiii. Hotel switching from a switch to a card system</td>
<td>High</td>
<td>High</td>
<td>All countries</td>
<td>Local</td>
<td>Long-term</td>
</tr>
<tr>
<td>xiv. Improved appliances</td>
<td>Medium</td>
<td>Medium</td>
<td>All countries</td>
<td>National</td>
<td>Long-term</td>
</tr>
<tr>
<td>xv. Conversion of waste to energy</td>
<td>Medium</td>
<td>High</td>
<td>All countries</td>
<td>Local and National</td>
<td>Medium- to Long-Term</td>
</tr>
</tbody>
</table>
## 2. Transportation

<table>
<thead>
<tr>
<th>Fuel Saving Measures</th>
<th>Technical Feasibility</th>
<th>Cost Effectiveness</th>
<th>Locations</th>
<th>Scale</th>
<th>Time Horizon for Deployment</th>
</tr>
</thead>
<tbody>
<tr>
<td>i. Resource Pooling</td>
<td>High</td>
<td>Medium</td>
<td>All countries</td>
<td>Local</td>
<td>Short-term</td>
</tr>
<tr>
<td>ii. Fuel efficient vehicles (smaller engines and hybrids)</td>
<td>High</td>
<td>Medium</td>
<td>All countries</td>
<td>National</td>
<td>Short-term</td>
</tr>
<tr>
<td>iii. Less carbon intense fuels: liquefied petroleum gas</td>
<td>Medium</td>
<td>Medium</td>
<td>All countries</td>
<td>National</td>
<td>Long-term</td>
</tr>
<tr>
<td>iv. Electric vehicles</td>
<td>High</td>
<td>Medium</td>
<td>All countries</td>
<td>National</td>
<td>Short- to medium-term</td>
</tr>
<tr>
<td>v. Less Carbon intense fuels: Natural gas</td>
<td>Medium</td>
<td>Medium</td>
<td>All countries</td>
<td>National</td>
<td>Medium- to Long-Term</td>
</tr>
<tr>
<td>vi. Less Carbon Intense Fuels: Biofuels</td>
<td>Medium</td>
<td>Medium</td>
<td>Guyana and Suriname</td>
<td>National</td>
<td>Long-term</td>
</tr>
<tr>
<td>vii. Operational practices and fuel monitoring</td>
<td>Medium</td>
<td>Medium</td>
<td>All countries</td>
<td>National</td>
<td>Short-term</td>
</tr>
<tr>
<td>viii. Retrofitting/upgrade of newer engines</td>
<td>Medium</td>
<td>Medium</td>
<td>All countries</td>
<td>National</td>
<td>Short- to medium-term</td>
</tr>
<tr>
<td>ix. Alternative/renewable Electric Power (solar technology and fuels cells)</td>
<td>Medium</td>
<td>Medium</td>
<td>All countries</td>
<td>National</td>
<td>Short- to medium-term</td>
</tr>
<tr>
<td>x. Alternative energy: Hydro-power</td>
<td>High</td>
<td>High</td>
<td>Guyana and Suriname</td>
<td>National</td>
<td>Long-term</td>
</tr>
<tr>
<td>xi. Fleet Renewal</td>
<td>Medium</td>
<td>Medium</td>
<td>All countries</td>
<td>National</td>
<td>Long-term</td>
</tr>
<tr>
<td>xii. Speed management</td>
<td>Medium</td>
<td>Low</td>
<td>All countries</td>
<td>National</td>
<td>Short-term</td>
</tr>
<tr>
<td>xiii. Transportation pooling</td>
<td>Medium</td>
<td>Medium</td>
<td>All countries</td>
<td>National</td>
<td>Short-term</td>
</tr>
</tbody>
</table>

## 3. Water Supply

<table>
<thead>
<tr>
<th>Technology</th>
<th>Technical Feasibility</th>
<th>Cost Effectiveness</th>
<th>Locations</th>
<th>Scale</th>
<th>Time Horizon for Deployment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saltwater reverse osmosis system using renewable energy</td>
<td>High</td>
<td>High</td>
<td>St. Vincent and the Grenadines</td>
<td>Local</td>
<td>Short-term</td>
</tr>
<tr>
<td>Waste water treatment plants</td>
<td>High</td>
<td>High</td>
<td>All countries</td>
<td>Local</td>
<td>Short-term</td>
</tr>
<tr>
<td>Technology</td>
<td>Technical Feasibility</td>
<td>Cost Effectiveness</td>
<td>Locations</td>
<td>Scale</td>
<td>Time Horizon for Deployment</td>
</tr>
<tr>
<td>-------------------------------------------</td>
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</tr>
<tr>
<td>Water harvesting</td>
<td>High</td>
<td>Medium</td>
<td>All countries</td>
<td>Local</td>
<td>Short-term</td>
</tr>
<tr>
<td>Water metering</td>
<td>High</td>
<td>High</td>
<td>All countries</td>
<td>Local and National</td>
<td>Short- to medium term</td>
</tr>
<tr>
<td>Removal of subsidies on water</td>
<td>High</td>
<td>Medium</td>
<td>Guyana, Suriname and Saint Vincent and the Grenadines</td>
<td>National</td>
<td>Short-term</td>
</tr>
<tr>
<td>Potable water purification units</td>
<td>High</td>
<td>Medium</td>
<td>All countries</td>
<td>Local</td>
<td>Short-term</td>
</tr>
<tr>
<td>Reforest degraded watershed areas</td>
<td>High</td>
<td>High</td>
<td>Guyana, Suriname and Saint Lucia</td>
<td>Local and National</td>
<td>Medium- to Long-term</td>
</tr>
<tr>
<td>Protection of watersheds</td>
<td>High</td>
<td>High</td>
<td>Guyana, Suriname and Saint Lucia</td>
<td>Local and National</td>
<td>Medium- to Long-term</td>
</tr>
<tr>
<td>Conservancy expansion</td>
<td>High</td>
<td>High</td>
<td>Guyana and Suriname</td>
<td>Regional and national</td>
<td>Long-term</td>
</tr>
</tbody>
</table>

4. **Flood Water Management**

<table>
<thead>
<tr>
<th>Technology</th>
<th>Technical Feasibility</th>
<th>Cost Effectiveness</th>
<th>Locations</th>
<th>Scale</th>
<th>Time Horizon for Deployment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conservancy rehabilitation</td>
<td>High</td>
<td>High</td>
<td>Guyana and Suriname</td>
<td>Regional</td>
<td>Short- to medium term</td>
</tr>
<tr>
<td>Groyne design and re-enforcement</td>
<td>High</td>
<td>Medium</td>
<td>All countries</td>
<td>Local</td>
<td>Medium- to Long-term</td>
</tr>
<tr>
<td>Dyke rehabilitation</td>
<td>High</td>
<td>High</td>
<td>All countries</td>
<td>Local</td>
<td>Long-term</td>
</tr>
<tr>
<td>Sea defence revetment construction</td>
<td>High</td>
<td>High</td>
<td>All countries</td>
<td>Regional</td>
<td>Long-term</td>
</tr>
<tr>
<td>Mangrove reforestation</td>
<td>High</td>
<td>High</td>
<td>Guyana, Suriname and Barbados</td>
<td>Local and National</td>
<td>Medium-term</td>
</tr>
<tr>
<td>Enhanced land use planning</td>
<td>High</td>
<td>High</td>
<td>All countries</td>
<td>Local, regional and national</td>
<td>Medium- to Long-term</td>
</tr>
<tr>
<td>Early warning flood systems</td>
<td>High</td>
<td>Medium</td>
<td>Guyana and Suriname</td>
<td>National</td>
<td>Short- to medium-term</td>
</tr>
<tr>
<td>Comprehensive coastal zone management</td>
<td>High</td>
<td>High</td>
<td>All countries</td>
<td>Regional</td>
<td></td>
</tr>
<tr>
<td>Maintain drainage canals</td>
<td>High</td>
<td>High</td>
<td>All countries</td>
<td>Local</td>
<td>Short-term</td>
</tr>
<tr>
<td>Hydraulic pumping</td>
<td>High</td>
<td>Low</td>
<td>All countries</td>
<td>Local</td>
<td>Short-term</td>
</tr>
</tbody>
</table>
What are the major impediments that need to be understood and addressed to facilitate the adoption of local technology and the adaptation of best practices from outside of the region?

4.1 Capacity Building

From the fieldwork and consultations held as part of this project, it can be concluded that one of the main constraints in the uptake of technology in the Caribbean, and by extension the urban sector, is a knowledge gap on the principles of low carbon economies and the path to be followed in implementing this concept, even as two of the sampled countries are pursuing low carbon and green economy strategies. Conducting capacity building in the region on topics related to low carbon economies, climate compatible development and the green economy to allow for greater technological uptake and transformational change will require candid discussions, behavioral change and a modified policy environment.

Knowledge of the principles of low carbon operations and the successes being realized by countries/regions/operators should help stakeholders understand and buy into the region’s emphasis on STI. Additionally, the packaging of existing regional initiatives, inclusive of the activities undertaken under the Regional Implementation Plan to address climate change 2011-2021, Special Pilot for Adaptation to Climate Change (SPACC), the Carbon Neutral Tourism Project and the Pilot Project for Climate Resilience (PPCR) and the Comprehensive Disaster Management (CDM) Projects are but a few, will allow for an understanding of how varying projects are being coordinated to benefit the region and also work collaboratively with stakeholders in assessing and understanding current operations.

Capacity building across a range of stakeholders would be of significant benefit to the region. Policymakers and operators have vocalized the need for an understanding of low carbon planning and approaches to develop and implement these plans locally.

One of the most important elements of capacity building is the local knowledge held by operators which is invaluable in identifying and assessing feasible technological options. Many private sector stakeholders have identified that once they have an understanding of low carbon and water management planning, they would be able to assess their operations to identify appropriate technological adoption measures.

Further, the United Nations Development Programme’s (UNDP) National Capacity Self Assessment (NCSA) reports for the Caribbean were accessed to explore what capacities exist or is lacking at the systemic, institutional and individual levels. These studies were conducted for the three UN Multilateral Conventions, i.e., UNFCCC, UNCCD, and UNCBD. In this case, capacity refers to the ability of entities and individuals operating within a system to define specific
objectives and work effectively and efficiently to attain those objectives, inclusive of technological uptake.

Three (3) levels of capacity are highlighted: (i) systemic (inter-agency coordinating arrangements, policy gaps and overlaps, political commitment, public service incentives and accountability and legal and regulatory frameworks), (ii) institutional (clarity of mandates and strategies, management systems, information, human and financial infrastructure,) and (iii) individual (technical skills, work motivation and personal facilities).

The main capacity themes that have been largely responsible for a lack of technological uptake are a need for appropriate legislation, adequate funding, additional training and heightening public awareness. Furthermore, technological transformation in both the water and energy sectors must be treated as a shared responsibility amongst governmental, non-governmental agencies, community groups and individuals. National, local and regional governments, NGOs, civil society and local communities all require support to improve their systemic, institutional and individual capacities.

4.2 Data and Information are Public Goods

Attitudes and protocols regarding data collection, management, sharing and ownership of data and information will need to change. Building resilience and using risk management to aid technology transformation where there is uncertainty requires access to the best available data and information. An ‘open-source’ and ‘open-access’ attitude should be encouraged thereby providing the means by which all potential investors/individuals can share and make use of best available information. Institutional cultures which restrict access are not in the long-term interests of the Caribbean. In some instances these restrictions are imposed for entirely understandable budgetary reasons; information can be a revenue earner. In these situations alternative and more viable funding mechanisms are required.

4.3 Building on existing knowledge and expertise

A great deal of time, effort and resources has been invested into various technology reports, and impact and vulnerability assessments, and research that can inform STI in the Caribbean for urban development and management. In some cases, many of the recommendations and guidance have not been acted upon. Reports sit on shelves through lack of resources, baseline data sets are often difficult to access, technical knowledge is lost as staff retire or move out of the Caribbean. Retaining and growing technical, professional, managerial and academic research expertise and capacity is vital.
It is critical for the region to enhance research into natural disasters, extreme weather events, climate variability and change, and impact modeling to provide data and support for non-natural scientists engaged in urban planning and the preparation of adaptation and mitigation strategies.

4.4 Policy convergence

All Caribbean countries, inclusive of local governments and municipalities, will have to institutionalize technology enhancement to address climate change and disaster mitigation into their various urban development plans and programmes. Building low carbon climate resilience within the wider contexts of sustainable development and urban planning have to become an integral feature of all policy setting and decision making for the urban sector. However, addressing climate change and natural disasters without addressing the underlying urban development challenges faced by the sampled countries will not deliver resilience.

A twin-track approach to technology adoption is required which ensures that building resilience and creating low carbon urban economies become part of the wider urban planning, development and growth agenda.

4.5 Policy and Investment Roadmaps

A recent report published by the UNDP (Glenmarec, 2011) provides guidance on the financing options available for developing countries to support low-emission and climate resilient development. The range of climate finance sources is complex and includes ODA, new climate funds, private sector and capital market investment, and domestic government budgets.

The UNDP guidance sets out a roadmap approach for project developers and countries to follow to secure finance. Key to this approach is securing an optimal national policy mix for the promotion of investment. It should be noted that the policy mix, for example to develop renewable energy generation, will not be the same in each country. The existing regulatory and legislative controls vary from country to country across the Caribbean, countries have different resources, challenges, needs and priorities. New regulatory instruments will be required; some existing policies (e.g. fossil fuel subsidies) will need to be changed before investment-support policies for renewable energy can be effectively implemented.

The selection of the most appropriate mix of public policies to catalyse investment for either low carbon urban sectors or climate resilience building actions will be influenced by:
Technology maturity (low carbon) and impact uncertainties (adaptation)
Global market conditions for investment
Country conditions
Specific national barriers and challenges

4.6 Adaptation, mitigation and urban development

Low carbon and mitigation actions are often considered as separate and distinct from those concerned with adaptation and resilience building to a changing climate and indeed to wider urban development objectives. However, this can create potential problems if proposed actions are not assessed against a composite range of adaptation, mitigation and urban development goals.

An example of the relationship between creating a mitigation/low-carbon development action and an adaptation/resilience building action can be seen in energy and water resource management, where the mutual benefits are likely to be missed if actions in both areas are developed in isolation. Energy and water are inextricably linked as can be seen, for example, in hydro-power schemes and bio-fuel production.

It is clearly important that the investment in any project delivers wider benefits beyond the initial adaptation or low-carbon or development objectives that the project was originally designed to achieve. Failure to consider the linkages to other objectives may lead to missed opportunities, maladaptation and a requirement for additional investment at a later date. For example:

- Improving the energy efficiency of buildings also provides an opportunity to increase the resilience of communities to extreme weather events because the improvements required in building design and construction to improve their thermal efficiency can be similar to those needed to increase their resilience to extreme events.
- The cost of increasing the resilience of buildings of extreme events can be more compelling investment case if the additional energy savings are taken into account.
- Investment in energy efficient buildings might also enable additional finance to be secured from the carbon markets.

4.7 Developing a Risk Management Ethic

In a region already characterized by high variability in the current climate, a changing climate represents an additional stress for society, economic sectors and natural environments. This
changing risk profile will have an effect on the outcome of a wide range of decisions affecting individual, societal and economic well-being. In order to plan effectively for future, decision-makers must assess and be aware of these changing risks.

As our understanding of climate change improves it is becoming possible to gain an increasing confidence about some of the expected changes, for example, regard to increasing temperatures. However, our knowledge of climate system is not perfect, resulting in uncertainty around the precise extent of future climate change. Furthermore, we cannot know how future emissions of GHGs will change. Uncertainty also stems from our incomplete understanding of the impacts of future climate on society, the environment and economies.

Despite these uncertainties and regardless of the effectiveness of emissions reductions efforts worldwide, Caribbean governments must continue to make decisions to plan for the future. It is therefore becoming increasingly necessary that risk management processes and tools to aid urban planning be applied.
5. Conclusions

This section seeks to present some concluding remarks based on the findings of the research. For example, where possible, optimization of resources in urban development planning can assist with enhanced technology uptake and reduced vulnerabilities. Optimized planning can include:

- Integrated land use planning;
- Integrated coastal zone management;
- Transportation planning; and
- Standards, policies and code of practice development.

Planning of this nature would be conducted by central planning agencies with the Caribbean, and/or appropriate government ministries responsible for urban development. In the context of urban development and technology transfer, optimized planning may include:

- Integrated land use planning would involve the consideration of urban development and other economic drivers in land use development. In other words, planning will not be done in isolation, and will consider overall development for the urban sector. This would include:
  - consideration of protection of watersheds and sustainable energy policy
  - consideration of local community opinions in land use planning, to draw from local knowledge in defining appropriate mechanisms for development; and
  - consideration for protection of natural resources.

- Integrated coastal zone planning is critical given the threats posed by climate change and the fact that most of the region’s population is concentrated along the coast. This will include:
  - greater inter-agency collaboration;
  - reduce costs of doing business in the coastal zone; and
  - using geographic information system (GIS) to aid in the planning process.

- Transportation planning ought to be conducted in collaboration with land use planning, to allow for development to be appropriately serviced by transportation infrastructure. This would include:
  - development of formalized mass transit systems to allow for the efficient movement of tourists and locals;
  - scheduled and an efficient public transportation system; and
  - development of roads and transportation systems that allow for more efficient traffic management.
- Standards, policies and code of practice development would set guidelines that new builders, operators and technology developers may wish to pursue. Such standards include:
  - Building standards for new development related to energy efficiency, water efficiency and waste management; and
  - Designing policies that would encourage climate compatible development.

An important aspect of optimized planning would be the facilitation of collaboration between government, the private sector, academia and NGOs to identify areas for technology adoption and adaptation. The macro level planning requires significant effort and coordination, but has the potential to generate, amongst others, environmental benefits and cost reductions.

In compiling this paper, efforts were made to incorporate findings of a literature survey, feedback from stakeholders within the government, private and NGO sectors, and a household survey.

Our methodology helped us to identify capacity building as one of the major impediments to technology uptake in the energy and water sectors in urban areas. Furthermore, the potential for energy efficiency and better water management are immense. However, optimization of resources in urban development planning can assist with reducing climate and hazard vulnerability and enhance technology uptake.
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United Nations Economic Commission for Latin America and the Caribbean (2010) Damage Assessment Reports (various years), ECLAC, Port of Spain.


### Annex 1

#### Listing of Territorial Data Sources

<table>
<thead>
<tr>
<th>Country</th>
<th>Sector Interviews</th>
<th>Private Energy Producers</th>
<th>Petroleum Companies</th>
<th>Policy Documents</th>
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<td>Barbados</td>
<td>- Barbados Power and Light Co. Ltd</td>
<td>Solar Solutions Co.</td>
<td>All request for interviews were denied</td>
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<td>Guyana</td>
<td>- Guyana Power and Light Inc.</td>
<td></td>
<td>All request for interviews were denied</td>
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<tr>
<td></td>
<td>- Guyana Water Authority</td>
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<tr>
<td></td>
<td>- Linden Electricity Company Inc.</td>
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<td></td>
<td>Financial Sector</td>
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<td></td>
<td>- Bank of Guyana</td>
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<td></td>
<td>- Telecommunication</td>
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<tr>
<td></td>
<td>- Guyana Telephone and Telegraph Company</td>
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<td>- Digicel Guyana</td>
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<td></td>
<td>- Manufacturing (Hardware)</td>
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<td></td>
<td>- Toolsie Persaud Ltd.</td>
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<td>- Gafoors Company Limited</td>
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<td>- Manufacturing (Beverage/Food)</td>
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<td>- Demerara Distillers Limited</td>
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<td>- Hospitality (Hardware)</td>
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<td>- Camex Restaurants Inc.</td>
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