GOVERNMENT OF BELIZE

Ministry of Energy, Science & Technology and Public Utilities

Strategic Plan 2012-2017:

"Integrating energy, science and technology into national development planning and decision making to catalyze sustainable development"

September 26, 2012

CONTENTS

ABBREVIATIONS & ACRONYMS

AOSIS	Alliance of Small Island States
ATM	Automated Teller Machine
Bbls	Barrels
BEL	Belize Electricity Limited
BWS	Belize Water Services
BIG-GT	Biomass Integrated Gasifier - Gas Turbine
BIG-GTCC	Biomass Integrated Gasifier - Gas Turbine Combined Cycle
BNE	Belize National Energy
BOD	Biological Oxygen Demand
BoE	Barrels of Oil Equivalent
BOO	Build Own Operate
BOLT	Build Own Lease Transfer
BPOA	Barbados Program of Action
BTU	British Thermal Units
CARDI	Caribbean Agricultural Research and Development Institute
CARICOM	Caribbean Community
CARILEC	Caribbean Electric Utility Services Corporation
CCS	CARICOM Secretariat
CDB	Caribbean Development Bank
CDM	Clean Development Mechanism
CIA	Central Intelligence Agency
CO_2	Carbon Dioxide
CPV	Concentrating Photovoltaic (PV)
CREDP	Caribbean Renewable Energy Development Program
CSME	Caribbean Single Market and Economy
DFID	United Kingdom Department for International Development
EC	European Commission
ECLAC	United Nations Economic Commission for Latin America and the Caribbean
EE&C	Energy Efficiency and Conservation
EIA	Energy Information Administration (US)
ESCOS	Energy Service Companies
EU	European Union
EU-ETS	European Union Emissions Trading Scheme
FAO	Food and Agriculture Organization
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GoB	Government of Belize
GWh	Gigawatts per hour
HFO	Heavy Fuel Oil

ICT	Information and Communication Technologies
IDB	Inter-American Development Bank
IEA	International Energy Agency
IICA	Inter-American Institute for Cooperation on Agriculture
IMF	International Monetary Fund
IPPC	Intergovernmental Panel on Climate Change
ISDN	Integrated Service Digital Networks
Kwh	Kilowatts per hour
LDCs	Least Developed Countries
LPG	Liquid Petroleum Gas
MCTs	Multi-purpose Community Telecentres
MDGs	Millennium Development Goals
MESTPU	Ministry of Energy, Science and Technology and Public Utilities
MSI	Mauritius Strategy for its Further Implementation of the BPOA
MSW	Municipal Solid Waste
MW	Megawatt
NEPAD	New Partnership for Africa's Development
NGO	Non-Governmental Organization
OAS	Organization of American States
ODA	Overseas Development Assistance
OECD	Organization for Economic Co-operation and Development
OECS	Organization of Eastern Caribbean States
OPEC	Organization of the Petroleum Exporting Countries
OTEC	Ocean Thermal Energy Conversion
PAHO	Pan-American Health Organization
PPA	Power Purchase Agreements
PPP	Public-Private Partnerships
PV	Photovoltaic
R&D	Research and Development
SEFA	Sustainable Energy for All Initiative
SIDS	Small Island Developing States
SIDS DOCK	Small Island Developing States Sustainable Energy Initiative
SMEs	Small and Medium Enterprises
S&T	Science and Technology
STEM	Science, Technology, Engineering and Mathematics Education
STI	Science, Technology and Innovation
TVA	Tennessee Valley Authority
UN	United Nations
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change

US	United States of America
USD	United States Dollars
USP	University of the South Pacific
UWI	University of the West Indies
WEO	World Energy Outlook
World Bank	International Bank for Reconstruction and Development

FIGURES

PART I

BELIZE NATIONAL SUSTAINABLE ENERGY STRATEGY (2012-2033)

PART II

SCIENCE, TECHNOLOGY & INNOVATION (STI) STRATEGIC OPTIONS FOR IMPLEMENTATION (2012-2017)

EXECUTIVE SUMMARY

Background

This 2012-2017 Strategic Plan provides a summary of the strategies the newly established Ministry of Energy, Science and Technology and Public Utilities (MESTPU) plans to implement in order to streamline, manage and integrate related activities and programmes. To achieve this, the MESTPU intends to develop a framework that will result in transitioning the energy sector and economy toward low carbon development, as well as development of a plan that provides for the coordination and implementation of a comprehensive, integrated and transparent approach that develops a longer-range culture of investment and support for Science, Technology and Innovation (STI). This will position Belize to be globally competitive in key markets, to overcome barriers to accessing global markets, and to understand and respond to unpredictable markets, external shocks, and hazardous events.

The document provides an outline for the Sustainable Energy Strategy in the development of a low carbon economy by 2033. The STI Strategic Options lays out the technology needs to support the provision of energy-related services such as electricity, water supply, sewage systems, and telecommunications that are sustainable and which provide the foundation for sustainable development. Biofuels technology are slated to play a key role in the development of a low carbon economy; the STI focuses on a number of water-related technologies that are intended to significantly improve the integrated management of water resource.

This document is a work in progress, and due to uneven data coverage there are varying degrees of specificity. The implementation of the MESTPU Strategy will give priority to filling in data gaps. This strategy document integrates two of the three major areas of MESTPU's responsibilities - the energy and STI sectors. The third major area of responsibility which addresses a strategy for management and increased performance of Public Utilities will be completed in close coordination with all the public utilities soon.

Integrated Responsibilities of the MESTPU

The MESTPU is expected to execute a mandate that is aimed at strategically integrating energy and science and technology into national development planning and decision-making to catalyse sustainable development. As of March 2012, the new Ministry assumed responsibility for the Geology and Petroleum Department (GPD). The MESTPU also assumed oversight responsibility for the following areas:

- Electricity
- Energy
- Solar Energy
- Gas

- Geology and Petroleum
- Research and Development
- Public Utilities
- Public Utilities Commission
- Science Education
- Telecommunications
- Water Supply and Services (except rural water supply).

Integrating energy, science and technology into national development planning and decision making to catalyze sustainable development

These various departments, agencies and divisions will engage in unique partner relationships due to the integrated approach to research and development, from basic science to applied research, engineering to testing, and scale-up to demonstration. The MESTPU's focus is on the role that energy and science and technology (S&T) can play in accelerating sustainable development, thereby reducing poverty and increasing employment. Important in its mandate also are its regulatory and oversight roles that are intended to ensure that public utilities continue to deliver the requisite services to Belizeans in a safe, efficient and cost-effective way that are consistent with the principles of sustainable development.

This document is in two parts – *Part I, Belize National Sustainable Energy Strategy (2012-2033)*, recommends a set of programmes and action plans to achieve a low carbon economy by 2033, through improved energy efficiency and conservation, and developing Belize's domestic energy resources to facilitate private sector participation and investment in the new low carbon energy sector; to empower rural communities to participate in income-generating activities, particularly women and young people; and to encourage and advise the public and private sectors and the general public to become more aware of the critical energy issues and to take appropriate actions and response measures.

The sustainable energy strategy includes a number of programmes and activities to support the development of the country's non-renewable and renewable energy resources and improve energy efficiency and conservation in order to transform to a low carbon economy by 2033. Core strategies recommended for the development of a successful and sustainable energy sector include:

1. Improve energy efficiency and conservation across all sectors: Transport, Industry, Commercial and Residential Buildings. The goal is to achieve a minimum reduction in per capita energy intensity of at least 30 per cent by 2033, using energy utilization and GDP generated in 2011 as the baseline.

2. Reduce the country's dependence on imported fuels by 50 per cent by 2020, from one million barrels to one-half million barrels by increasing the production of modern energy carriers from domestic renewable energy

resources, coupled with improving energy efficiency and conservation. The ultimate goal is for Belize to become a net exporter of bio-fuels well before 2033.

3. To at least triple the amount of modern energy carriers derived from waste material. It is estimated that Belize's potential for sustainable harvesting of Agricultural, Forestry and Municipal Solid Waste (MSW) is as much as 717,500 tonnes. [1]Depending on the technology choices, various amounts of electricity, liquid fuels and gaseous fuels can be produced. If the bias is towards transportation fuels, the authors calculate that by 2033, next generation biomass technologies can potentially produce 1.4 million barrels of transportation fuels from these waste streams. The immediate priority of the waste-to-energy component of the strategy is to adequately treat all effluent wastes: whether from industries, livestock or human excrement sources by 2020, because of the potential harm it can cause to Belize's sensitive marine ecosystem.

4. Belize becomes a net electricity exporter by 2020. Institutionalizing a countrywide infrastructure to collect data and assess the potential for converting Solar, Wind and Hydro to electricity is an immediate priority. At the same time, Belize must obtain market access for any excess electricity produced. Work towards deepening electricity integration with Mexico and neighbouring Central American countries to nurture a market for the excess electricity. The goal is have the critical pieces for building the necessary electricity infrastructure in place no later than 2014.

5. Build the Ministry of Energy, Science and Technology and Public Utilities institutional capacity to accomplish its mandate by strengthening the Energy Portfolio through increase in professional staff, training and human resource development, acquisition of office supplies, materials and equipment, and funding to undertake institutional studies and audits, public awareness and education, and for participation in international fora.

These five (5) strategic elements integrate policies for building resilience of the national economy to climate change, consistent with the principles of sustainable development of integrating sectors to maximize synergies and make the economy and livelihoods more resilient. The Strategy positions the energy sector as the catalyst for sustainable rural development by providing improved energy services for cooking and lighting, and with that, increased options for increasing household income and promoting improved environmental practices to better protect and conserve the terrestrial and marine ecosystems.

[1] Organization of American States (OAS), Department of Sustainable Development, Energy and Climate Change Division (2009), *Feasibility Study on the Cellulosic Ethanol Market Potential in Belize*, March 2009. Available at: < http://www.sepa-americas.net/estadisticas_detalle.php?ID=11 >

Part II - Science, Technology and Innovation (STI) Strategic Options for Implementation recommends a number of options for implementation in the short-term in the next five (5) years, and is intended to accomplish two goals: (1) to accelerate the promotion of innovation through the development and utilization of modern scientific and technological capabilities to provide the basic needs of the population and to be competitive in the global market, and (2) to restructure the entire science and technology machinery, infrastructure, and programmes in order to make them more responsive to national needs and priorities in all sectors of the economy. To achieve these goals, at least five (5) strategic options will be addressed through the development of a number of components, including sector-specific projects recommended for implementation over the 5-year period.

The selection of STI Strategic Options are based on the prevailing socio-economic situation facing the country, and against the background that Belize and its people face the prospect of lagging even further in its development goals and aspirations for a *One Belize*. The following strategic options are being recommended for implementation over the next 2-5 years. These five strategic options optimally fit the needs of *One Belize*, the needs of the MESTPU, and aspirations of the stakeholders.

1. Introduce a STI Capacity Building and Institutional Strengthening Programme to strengthen the skills, competencies, abilities, and operations and services of the MESTPU to guide the development of a national culture of investment and support for STI over the next 5 years, and to respond to Belize's development goals.

2. Promote STI as important powerful ingredients to foster economic growth and competitiveness of Belize in the global market;

3. Promote Microenterprise Development for Rural and Vulnerable Populations to support entrepreneurial activities;

4. Promote Information and Communication Technologies (ICT) to support development of a culture of investment and support for STI with a focus on the information and knowledge economy and ICTs in the socio-economic sectors;

5. Build the sustainability of the MESTPU to accomplish its mission.

STI Strategic Options for Reaping the Benefits of S&T

STI Strategic Options include the implementation of a number of sector-specific projects that target the energy and water sectors in an integrated manner, and will therefore have policy implication for the public utilities and, in particular,

electricity generation and utilization. These projects introduce technologies that promote energy and food security and improved access to potable water. The MESTPU will be utilizing STI to promote food security, energy security, environmental protection and economic growth, targeting the energy and water sectors. The recommended sector-specific projects for implementation in the short- to medium-term are expected to improve the livelihoods of several disadvantaged communities, preserve and protect significant portions of the River Valley environment, increase sanitation and hygiene in several rural schools, and increase the competitiveness of the local rice, beans and corn producers. The objective is to show that Belize can, in the short- and long-term, implement strategies and projects that could lead to sustained improvements in food and energy security, reduced pressure on the environment and improved access to safe water across the country.

The MESTPU Strategic Plan 2012 -2017: Energy, Science and Technology and Public Utilities focuses on the role that energy and science and technology can play in accelerating sustainable development, thereby reducing poverty and increasing employment. Important in the Ministry's mandate also are its regulatory and oversight roles that are intended to ensure that public utilities continue to deliver the requisite services to Belizeans in a safe, efficient and cost-effective way that are consistent with the principles of sustainable development.

Part I of this Strategic Plan, Belize National Sustainable Energy Strategy (2012-2033), recommends a set of programmes and action plans to achieve a low carbon economy by 2033 through improved energy efficiency and conservation, and developing the country's domestic energy resources to facilitate private sector participation and investment in the new low carbon energy sector; to empower rural communities to participate in income-generating activities, particularly women and young people; and to encourage and advise the public and private sectors and the general public to become more aware of the critical energy issues and to take appropriate actions and response measures.

Part II , Science, Technology and Innovation (STI) Strategic Options for Implementation, recommends a number of options for implementation in the next five years and is intended to accomplish two goals: to accelerate the promotion of innovation through the development and utilization of modern scientific and technological capabilities to provide the basic needs of the population and to be competitive in the global market, and; to restructure the entire science and technology machinery, infrastructure and programmes in order to make them more responsive to national needs and priorities in all sectors of the economy.

This Strategic Plan for the newly created Ministry of Energy, Science and Technology and Public Utilities (MESTPU) presents a blueprint for addressing the challenges embodied in its recommended programmes, action plans and goals on a short and long-term basis. It is iterative and dynamic and its success requires

collaboration and partnership with other government ministries, the private sector, business entities, educational institutions, social partners and other stakeholders. But there is urgency in implementation and the work has begun as MESTPU moves forward to realize its vision of "Integrating energy, science and technology into national development planning and decision making to catalyze sustainable development".

The MESTPU Strategic Plan 2012 -2017: Energy, Science and Technology and Public Utilities focuses on the role that energy and science and technology can play in accelerating sustainable development, thereby reducing poverty and increasing employment. The MESTPU Strategic Plan provides direction and a planned pursuit of the vision and mission of the MESTPU for the next few years. It provides the Ministry with the ability to channel resources in a direction that yields the greatest benefit to the country. The Strategic Plan will enable the Ministry to plan and execute continuous organizational improvements and to achieve competitive advantage in order to generate sufficient revenue to support the projects and programmes. Important in the Ministry's mandate also are its regulatory and oversight roles that are intended to ensure that public utilities continue to deliver the requisite services to Belizeans in a safe, efficient and cost-effective way that are consistent with the principles of sustainable development.

Finally, this Strategic Plan presents a blueprint for addressing the challenges embodied in its recommended programmes, action plans and goals on a short and long-term basis. It is iterative and dynamic and its success requires collaboration and partnership with other government ministries, the private sector, business entities, educational institutions, social partners and other stakeholders. But there is urgency in implementation and the work has begun as MESTPU moves forward to realize its vision of "Integrating energy, science and technology into national development planning and decision making to catalyze sustainable development."

PART I

BELIZE NATIONAL SUSTAINABLE ENERGY STRATEGY 2012-2033

1.0 INTRODUCTION

The Ministry of Energy, Science and Technology and Public Utilities has embarked on articulating its strategic plan to enhance its planning for a ***Sustainable Energy Sector for Belize***.

The purpose of this Sustainable Energy Strategy 2012-2033 is to establish a framework that will result in transitioning the energy sector and economy toward low carbon development. The document recommends a set of programmes and action plans to achieve a low carbon economy by 2033 through improved energy efficiency and conservation, and developing Belize's domestic energy resources to facilitate private sector participation and investment in the new low carbon energy sector; to empower rural communities to participate in income-generating activities, particularly women and young people; and to encourage and advise the public and private sectors and the general public to become more aware of the critical energy issues and to take appropriate actions and response measures.

The newly established Ministry of Energy, Science and Technology and Public Utilities (MESTPU) is expected to execute a mandate that is aimed at strategically integrating energy and science and technology into national development planning and decision-making to catalyse sustainable development. The Ministry's focus is on the role that energy and science and technology (S&T) can play in accelerating sustainable development, thereby reducing poverty and increasing employment. Important in its mandate also are its regulatory and oversight roles that are intended to ensure that public utilities continue to deliver the requisite services to Belizeans in a safe, efficient and cost-effective way that are consistent with the principles of sustainable development.

The principles of sustainable development are embodied in Belize's national development plan, Horizon 2030, which embodies the vision for Belize in the year 2030 and the core values that are to guide citizen behaviour and inform the strategies to achieve a common vision for the future. One of the strategic priorities of Horizon 2030 is the promotion of green energy and energy efficiency and conservation, including creation of an institutional framework for producing a viable energy policy. In February of 2012, the Government of Belize endorsed the National Energy Policy and Planning Framework. The Horizon 2030 framework also seeks to focus on the community by anchoring development planning in the communities to promote relevance, ownership by beneficiaries and long-term sustainability of results. It also promotes collaboration within and across sectors to

increase programme efficiency and effectiveness and builds in an implementation process including a monitoring and evaluation framework.

Belize is abundant in energy resources particularly biomass (e.g., waste from forestry, sugarcane, citrus, and rice industries), hydro-electricity, solar, and some locations with good wind potential still to be assessed. Although these resources could play a central role in contributing to sustainable development, the nation remains highly dependent on imported energy sources. Furthermore, access to energy in rural areas is inadequate and public awareness regarding renewable energy, energy efficiency and conservation is low. In recent times, oil production in Belize has become a significant contributor to the country's gross domestic product (GDP) and export earnings. This natural resource endowment yields 2,800 barrels of crude oil per day[2]; however, this source is not renewable, as proven reserves are estimated at 6.7 million barrels[3]. Therefore, the country will have to create a sustainable energy policy that maximizes the development of its renewable energy resources, using to the maximum extent possible the resources generated by this fossil fuel resource to develop a sustainable energy sector.

As a founding member of the Small Island Developing States Sustainable Energy Initiative – SIDS DOCK, in December 2009, Belize committed to the collective SIDS DOCK goal of increasing energy efficiency by 25 per cent (2005 baseline) and to generate a minimum of 50 per cent of electric power from renewable sources and a 20-30 per cent decrease in conventional transportation fuel use by 2033. SIDS DOCK is a mechanism developed by its Member States[4] to provide assistance to its members with transformation to a low carbon economy by 2033, in order to generate financial resources to support adaptation to climate change. The development of a sustainable energy policy in Belize will reflect the overall SIDS DOCK goal of achieving a low carbon economy in Belize by 2033. Of significance, in February 2012, Belize was selected by the 30-Member States of SIDS DOCK to be the Host Country for the SIDS DOCK institution, providing critical start-up and long-term support, while positioning the country to derive significant early benefits from the organization's presence.

Belize is also committed to the UN Secretary-General's Sustainable Energy for All Initiative (SEFA), signed on 8 May 2012 at the Alliance of Small Island States

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[2] Belize Natural Energy Limited, At May 2012, production from eleven (11) wells in the Spanish Lookout Field and five (5) wells in the Never Delay Field averaged a total of 3,300 barrels of crude oil per day. Available at: <http://www.belizenaturalenergy.bz/bneteam/production.html>

[3] U.S. Energy Information Administration (EIA), *Belize Overview/Data*. EIA Website accessed June 13, 2012. Available at: <http://205.254.135.7/countries/country-data.cfm?fips=BH#pet>

[4] **The 30 Member States of SIDS DOCK** include, in the **Pacific Ocean**: Cook Islands, Federated States of Micronesia, Republic of Kiribati, Republic of the Marshall Islands, Republic of Fiji, Republic of Nauru, Republic of Palau, Independent State of Samoa, Solomon Islands, Kingdom of Tonga, Tuvalu, and Republic of Vanuatu; in the **Caribbean**: Antigua and Barbuda, Barbados, Commonwealth of the Bahamas, Belize, Commonwealth of Dominica, Dominican Republic, Grenada, Jamaica, St. Christopher (St. Kitts) and Nevis, St. Lucia, St. Vincent and the Grenadines, Republic of Suriname, and the Republic of Trinidad and Tobago; in the **Atlantic Ocean**: Republic of Cape Verde, Democratic Republic of Sao Tome and Principe; in the **Indian Ocean**: Republic of the Maldives, Republic of Mauritius, and Republic of the Seychelles.

(AOSIS) Ministerial Conference on "Achieving Sustainable Energy for All (SEFA) in SIDS – Challenges, Opportunities, Commitments," in Bridgetown, Barbados 7-8 May 2012. The Declaration emphasizes that achieving sustainable energy for all in SIDS includes providing all households with access to modern and affordable renewable energy services, while eradicating poverty, safeguarding the environment and providing new opportunities for sustainable development and economic growth. The SEFA initiative has identified three interlinked objectives which underpin the goal of achieving sustainable energy for all by 2030:

- Ensuring universal access to modern energy services;
- Doubling the global rate of improvement in energy efficiency;
- Doubling the share of renewable energy in the global energy mix.

1.1 Objectives of the Strategy

The sustainable energy strategy includes a number of programmes and activities to support the development of the country's non-renewable and renewable energy resources and improve energy efficiency and conservation in order to transform to a low carbon economy by 2033. Core strategies recommended for the development of a successful and sustainable energy sector include:

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[5] Organization of American States (OAS), Department of Sustainable Development, Energy and Climate Change Division (2009), *Feasibility Study on the Cellulosic Ethanol Market Potential in Belize*, March 2009. Available at: < http://www.sepa-americas.net/estadisticas_detalle.php?ID=11>

2020, because of the potential harm it can cause to Belize's sensitive marine ecosystem.

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5. Build the Ministry of Energy, Science and Technology and Public Utilities institutional capacity to accomplish its mandate by strengthening the Energy Portfolio through increase in professional staff, training and human resource development, acquisition of office supplies, materials and equipment, and funding to undertake institutional studies and audits, public awareness and education, and for traveling.

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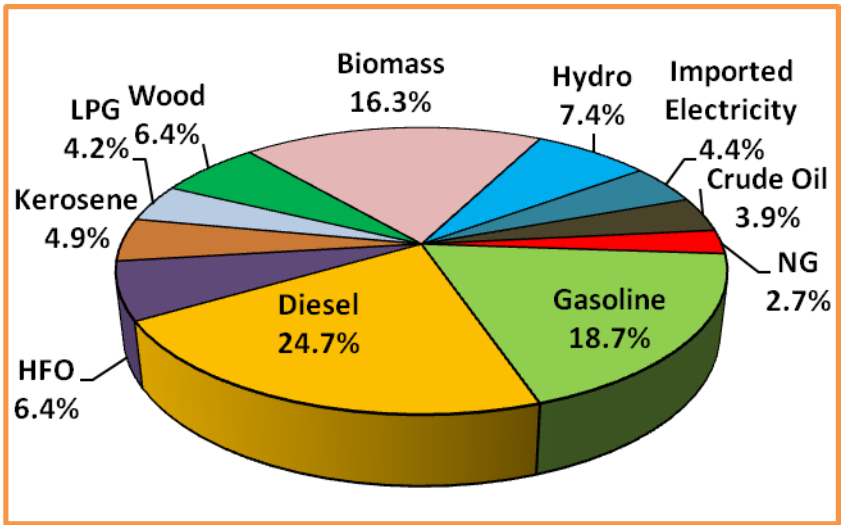
1.2 Energy Situation in Belize

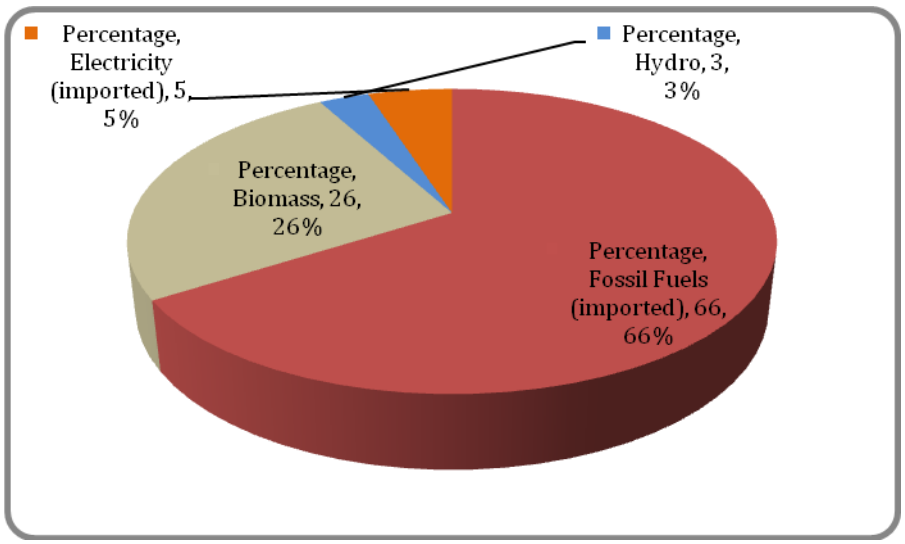
Belize acquires its energy from four main sources, specifically, fossil fuels (75.5 per cent), biomass – traditional biomass and bagasse (22.7 per cent), hydro (7.4 per cent) and imported electricity (4.4 per cent); Belize currently imports 100 per cent of refined fossil fuels used (Figure 1). Oil was recently discovered in commercial quantities; and presently Belize National Energy (BNE) produces around 2,800 barrels per day.

Figure 1: Belize Primary Energy Supply (2010)



Source: NEP (2011)

Figure 2: Belize energy supply matrix



Source: NEP (2011)

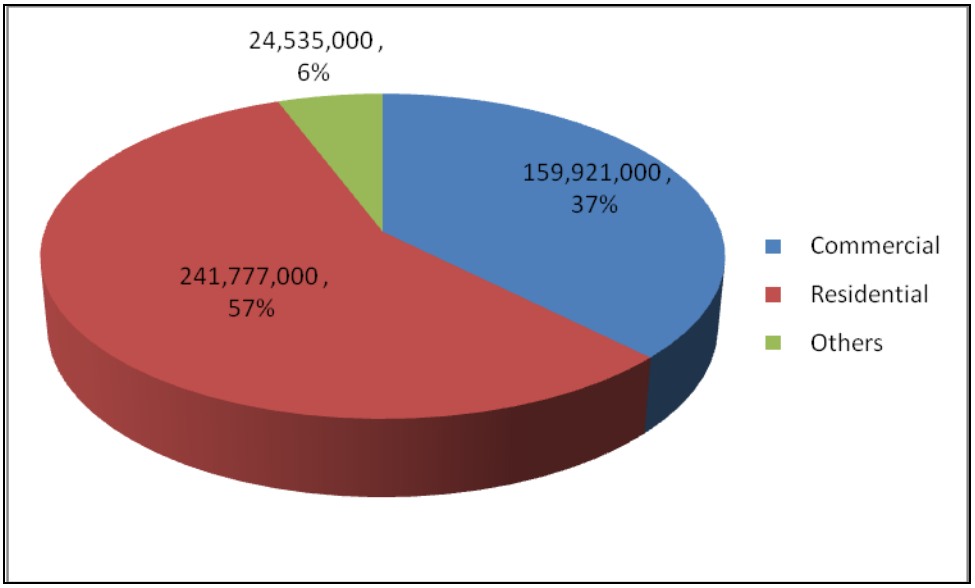
As much as 27.6 per cent of the electricity which is used in Belize is imported from Mexico. Belize produces the majority of its electricity from a mix of hydro (45.9 per cent), biomass (14.1 per cent), and fossil fuels (12.1 per cent. In 2010, total net generation on BEL'Grid was 483.3 GWh – peak demand was just over 80 MW. Electricity sales of 426.2 GWh, on the BEL's Grid may be disaggregated as follows: 56.7 per cent for residential households; 37.7 per cent for industrial and commercial

establishments; and 5.8 per cent for street lights. In 2010, the weighted average electricity rate to consumers was 22.3 US cents per KWh. As a part of its socioeconomic package, government created a "social tariff" as a part of their formal electricity pricing structure whereby profits from mid and high-end electricity consumers were used to *cross-subsidise* costs associated with the social tariff.

The Electricity Sector

Belize Electricity Limited (BEL) is Belize's main commercial, transmitter, seller, supplier and distributor of electric current. It is a Limited Corporation recently re-nationalized by the Government of Belize (67 per cent), Social Security Board (25 per cent) and various small shareholders (8 per cent). Current licensing agreement extends to 2015 and under the terms of the license, the Company has the right of first refusal on any subsequent license grant. Residential and commercial uses of electricity account for the majority of the electricity demand in Belize (Figure 3).

Figure 3: Belize electricity end-use



Source: NEP (2011)

Residential (Household) Sector

Unemployment in Belize is high (14.5 per cent) and about 43 per cent of households are considered poor. In many poor rural households, the main source of energy is fuel wood and charcoal. Kerosene lamps and candles are a significant source of lighting; these sources used to provide energy cooking and lighting put households at high risk of indoor pollution, particularly women and children who suffer the most from serious illnesses as a result, thus limiting chances for productive lives. This situation has to be addressed as part of the national rural sustainable development strategy. Furthermore, low-income households tend to purchase cheap, inefficient appliances with high energy consumption and which are typically unsafe

for use. These items not only have higher operating costs, but also pose a threat to the health and safety of citizens. The numerous problems associated with inefficient appliances require a combination of policies that would tackle efficiency of energy use, energy conservation and a change to more energy efficient appliances.

In rural areas, not only is there a need for wider access to electricity, many of these communities will require off-grid communal facilities; even so, greater access to potable water and ICT services are also essential to rural development.

Industrial & Commercial Sectors

The industrial sector in Belize is characterized by inadequate technical capacity. The lack of energy management expertise in the industry has been identified as one of the key barriers to increased energy efficiency. Most industries in Belize consume large quantities of electricity inefficiently and the implementation of energy efficiency and conservation (EE&C) programmes will reduce consumption and operating expenses.

The commercial sector includes, among others, wholesale and retail shops, hospitals, hotels, restaurants and recreation centres. Overall, the demand for energy in the sector is mainly met by commercial electricity and in off-grid locations, diesel generators.

Mining Sector

Within the mining sector, demand is met through self-generation and, in a few cases, from the electricity grid. There are opportunities for mining companies to participate in the electricity supply side through, for instance, the production of surplus power which can either be sold to the grid or to neighbouring off-grid communities. Mining in Belize has largely been limited to minerals (such as dolomite) and, more recently, oil explorations. There is also limited amount of gold mining in some areas.

Transport Sector

The transport sector is a major user of petroleum products, accounting for just over 6,000 barrels of oil per day or 85 per cent of the fossil fuel use. This represents around 57 per cent of overall energy use. Although road transportation is dominant, various forms of transportation play vital roles in the lives of the rural populace. Though some regulations are in place, inefficient practices characterize the sector and there is much scope for integrating sustainable energy practices therein.

In Belize, there are three main multinational oil companies in the petroleum products industry, namely, Puma Energy, Sol Belize, and UNO. The Government of Belize, through the Ministry of Finance, regulates retail service station prices which are devised to include a high proportion of taxes used to buffer against the international fluctuations in the oil market. Although the wholesale and retail

markets are open to multiple importers, currently, Puma Energy has the authority and the facility to import oil for commercial consumption into the country, suggesting a monopolistic structure in the wholesale portion and an oligopolistic structure in the retail portion of the petroleum distribution chain. The GoB in 2012 has licensed BNE to import limited quantities of diesel fuel.

2.0 NEED FOR A NATIONAL SUSTAINABLE ENERGY STRATEGY

The Sustainable Energy Strategy is needed to maximize the provision of energy services from domestic resources, to provide the needed energy services for the building of a highly resilient economy, foster improved livelihoods for the rural population, and improved quality of the environment that makes ecosystems more resilient to the impacts of climate change. Replacement of imported fossil fuels with secure, cost-effective indigenous renewable sources will generate economic savings which can be invested into climate change adaptation. Improved energy security will reduce the Belizean economy's exposure to the devastating economic consequences of unpredictable changes in the price of petroleum fuels resulting from market forces intervention for the primary purpose of profits without production.

Belize has vast endowment of renewable energy resources given its estimated 350,000 population. Energy and water are two of the most essential needs of a functioning society; the scale of its use is closely associated with the capabilities and the quality of life that is experienced by society's members. In fact, the quality of life of any society is directly proportional to the availability of energy services and the efficiency of use in producing goods and services. Populations mainly require energy services for heating, lighting, communications and transport. We use energy in our homes, in public and commercial buildings, in industry, and in the land, sea and air transport sectors. The natural resource endowment of Belize consists of vast areas of land marginal for food production but suited to biomass feedstock production for fuel, fibres, fertilizers, and feed. If proven feasible, development of this resource, as well as:

(a) Hydro, which has already seen significant development and future plans for expansion;
(b) Development of wind energy in feasible locations;
(c) Significantly increased use of solar for providing energy services in remote areas and for cooling services for buildings, and;
(d) Increased production from oil wells which could significantly reduce Belize's energy-related trade deficit and improve energy security. Dependence on imported liquid fuels for transportation continues to make Belize extremely vulnerable to international oil-price shocks which can significantly disrupt economic planning and deter foreign direct investment within the industrial sector. At the same time, the country is already feeling the effects of climate change and will require significant investment for adaptation.

The continued increase in global energy consumption and the associated resources used throughout the world, including in Belize, is unsustainable. Continuous increase in demand for reliable and cost-effective electricity supplies is a major challenge for the country and failure to provide same may hinder future economic development. So too is the rising and unpredictable cost of fuel imports. The high cost of oil prices has been negatively impacting the Caribbean economies, including Belize. On the macroeconomic level, Balance of Payments has been significantly impacted by the global oil economy and the significant foreign exchange demand that results has acted as a constraint to public investment in all areas, including the social services. Government's ability to find capital for economic stimulation and social investment in areas such as health and education is significantly reduced.

On the microeconomic side, many citizens simply cannot afford to pay for adequate supply of energy services for their homes. This is frequently to the detriment of their health, comfort, and well-being. The problem is not uncommon in Belize, with many among the population resorting to traditional biomass heating for cooking, hot water and other domestic services. The cost of fuel does not only affect people's health, but can also impact transportation costs and citizens' ability to travel and earn a livelihood.

Energy prices are a significant factor in the general economic prosperity of a society, with high energy prices impacting the manufacturing, commercial and transport sectors, potentially causing inflation and a slowdown of the economy. But there is significant different macro-economic impact from high energy prices based on imported and volatile energy resource versus comparative high energy cost but based on reliable domestic resources. Quite apart from the very real likelihood of the future restrictions on availability of fossil fuels such as oil and gas, there is the even more critical issue of the consequences of global warming caused by burning fossil fuels. Climate change is an energy-related issue as an estimated 80 per cent of greenhouse gases is generated by the energy sector, primarily from combustion of fossil fuels; climate change is really "the dark side of fossil fuel" and Caribbean territories, including Belize, are facing very serious threats as a result. According to the Inter-governmental Panel on Climate Change (IPCC) Fourth Assessment Report, Belize and other Caribbean states are among the group of developing countries that have contributed the least to the global emission of greenhouse gases (GHG) but are the most vulnerable countries to the effects of climate change.

3.0 STRATEGIES & PROGRAMMES

SIDS and low lying countries such as Belize, share a number of challenges and disadvantages in their sustainable development quest: vulnerable economies; dependence upon limited land based natural resources and on the vagaries of international trade; lack of economies of scale; high transportation and communication costs; susceptibility to natural disasters; vulnerability to the

adverse effects of global climate change; inordinate pressures on coastal and marine ecosystems; and a limited availability of the means to implement comprehensive sustainable development goals. The international community recognized the special constraints to sustainable development that these countries faced economically, environmentally, and socially by virtue of their small size. Access to affordable energy services thus becomes a major component in how SIDS and low lying states address sustainable development. Climate change is listed as the major challenge to the sustainable development of developing countries, thus, transformation of the energy sector will help in addressing energy and climate change challenges, as well as the promotion of economic development in an uncertain and unpredictable global economic environment.

Importation of millions of barrels of fuels is a major source of economic vulnerability for many remote and rural communities that have little or no access to modern and affordable energy services. At the same time, difficulties in expanding electricity generation to meet the growing demand are likely to remain the single most important constraining factor in the economic development in Belize. The dependence on imported petroleum for commercial energy needs continues to cause severe imbalances in trade and the rising costs of petroleum imports have put a serious drain on limited national financial resources. The recent food, fuel and financial crises, with added economic devastation wrought by tropical hurricanes and cyclones, have worsened existing fiscal stresses for many developing countries, including Belize.

High energy prices and high inefficiencies in the use of energy resources make Belize less competitive than other countries and therefore, opportunities for job creation are limited to a few industries. Development of the country's renewable energy resources and increasing the efficiency of use will provide Belize with a reliable source of energy at predictable prices and provide the foundation to generate employment and put Belize on the path to transitioning from a primarily fossil fuel-based economy to a low carbon economy. The availability of a reliable supply and predictable priced energy is a necessary foundation to develop and market new products and services which is the basis of employment, the end impact of which would be reduced levels of poverty. A sustainable energy sector is the foundation of sustainable development in Belize.

To embark on a path for sustainable economic development, Belize needs to develop an energy strategy that reduces the nation's economic vulnerability and builds resilience to climate change, protects the environment, and provide a catalyst for improving the quality of the population particularly those located in rural areas.

3.1 Strategic Element #1: Improve energy efficiency and conservation by at least 30 per cent by 2033, using energy utilization and GDP generated in 2011 as the baseline.

The CARICOM countries are very inefficient users of energy. On average, the Caribbean uses at a minimum 200 per cent more energy per unit of Gross Domestic Product (GDP) compared to best practices. Consequently, there are numerous investment opportunities in energy efficiency, particularly in the areas of lighting, cooling, transportation and industrial production.

Goal #1: Develop an Energy Efficiency and Conservation Policy 2012-2033

- Collect end-use data from key sectors: Transport, Industry, Commercial and Residential Buildings; and Develop White Paper - Draft Energy Efficiency & Conservation Policy.
- Conduct consultations with key public and private sector stakeholders in the energy sector, civil society organizations and the general public;
- Introduce legislation and regulations aimed at improving energy efficiency and conservation and to meet the 2033 energy strategy goals, including introduction of legislation that creates a framework for the establishment and proper functioning of Energy Service Companies (ESCOs).

Goal #2: Reduce consumption of electricity by 50 per cent, from USD 6.8 million to USD 3.4 million, for the provision of cooling and lighting services to public sector buildings

- Data collection from all government departments for all occupied buildings;
- Conduction of energy audits of buildings identified with the highest usage per unit of building floor area;
- Develop new procurement rules for acquisition of appliances and equipment in the public sector and new tariffs system based on degree of energy efficiency;
- Development of revised building code to maximize internal lighting from the sun but also minimize the need for cooling — green designs to be introduced; banks and other financial institutions to become part of the planning and implementation.

Goal #3: Increase electricity consumption efficiency by 30 per cent in commercial buildings

- To conduct energy audits in commercial buildings to identify potential savings;
- To establish an energy efficiency revolving fund for commercial entities;
- Revise tariffs on the importation of energy efficiency appliances and lighting through policy adjustments and changes that provide incentives to owners and occupants of commercial buildings;

- Revise building codes to promote the use of more energy efficient structures that minimize the use of electricity for lighting and cooling;

Goal #4: Increase Energy Efficiency and conservation in the Hotel & Tourism Industry by 30 per cent

- To conduct energy audits in hotels to identify potential savings;
- To establish an energy efficiency revolving fund for hotel and tourism stakeholders;
- To assist the hotel and tourism stakeholders to develop and implement energy management plans;
- To develop and implement training programmes for hotel and tourism staff in energy utilization.

Goal #5: Improve household energy efficiency and conservation by more than 25 per cent through improvement in lighting, cooling and water heating efficiency and conservation

- Establish a Pilot Voluntary Exchange Lighting Programme with the Belize Electricity Limited where consumers can opt to have the electric utility provide consumers with energy efficient lighting and the cost applied to their monthly utility bill;
- Consumer public education and awareness programme in energy efficiency and conservation in communities;
- Establish a Pilot Household Water Heater Programme to increase the availability and affordability of solar water heaters for householders through a partnership with the national electric utility and ESCO's.

3.2 Strategic Element #2: Reduce the country's dependence on fossil fuels consumption by 50 per cent by 2020, from one million barrels to one-half million barrels by increasing the provision of modern energy carriers utilizing domestic energy resources, coupled with improving energy efficiency and conservation

Goal #1: Enhance the regulatory framework for the petroleum sector and build the capacity of the Geology and Petroleum Department (GPD) to better administrate and manage the exploration and production of the hydrocarbon resources of Belize and increase production to oil.

- Carry out comprehensive revision of the petroleum legal regime and fiscal regime;
- Carry out capacity building and training to strengthen the Department's capability to administer the petroleum industry and to build National capacity in the area of petroleum;
- Establish a work station for seismic processing and interpretation, well log analysis and interpretation and data management;
- Establish basic geological lab.

- Produce proper geological maps and formalized stratigraphic sections of Belize;
- Establish saleable data packages for competitive bidding rounds;
- Carryout basin study of the Corozal Basin and Belize Basin to advance knowledge of the geology and petroleum systems;
- Increase production of crude oil from onshore deposits to a minimum of 10,000 barrels per day;

Goal #2: Fast-track pilot project to deploy flash pyrolysis reactors producing 250,000 tonnes of bio-oil from ligno-cellulosic biomass by 2016. Once the technology is well understood, expand production to one million tonnes by 2020

- Develop Biofuels Policy;
- Introduce biomass conversion technologies that provide transportation fuel, shaft power, generate electricity or provide process heat, through demonstration pilot projects in rural areas that have an existing agriculture and forestry economic base;
- Develop Long-Term Partnership Agreements with key maritime and fishing industry stakeholders for the production and marketing of liquid biofuels.

Goal #3: Reduce by 50 per cent the number of rural households that are now using firewood for fuel to other more environmentally friendly biofuels cooking systems such as plant oil and biogas cookers, or solar cookers

- To implement a Pilot Community Biogas Production Programme in communities with significant livestock;
- To implement a Pilot Programme for the Introduction of Plant Oil Stoves using local palm oil;
- To implement a Pilot Programme for the Introduction of Solar Cookers;
- To implement a Pilot Programme for the Introduction of Improved Wood Stoves.

Goal #4: Development of a Solid & Liquid Biofuels Export Marketing Plan 2012-2033

- The premise is that significant biofuels production would be based on the use of the cohune palm as the feedstock in an integrated system that would, in addition to biofuels, produce other products such as edible oil, soap, and animal feed. The prototype project is the Flowers Bank project now under development. Significant biofuel production would also come from plant materials like *Leucaena L.*, *Acacia mangium*, and *Arundo donax* plantations developed in partnership with private sector and qualifying for carbon credits.

Goal #5: Increase Hydro Power from 55 MW to 70 MW by 2033

- Revise the technical assessments of hydro resource capacity to identify new sources and to determine the potential for expansion;
- Develop expansion plans to inform government approval and investment decisions.

Goal #6: Development of a Wind Energy Development Plan 2012-2017

- Conduct wind assessment study;
- Conduct feasibility studies;
- Develop wind energy demonstration;
- Develop wind energy policy.

Goal #7: Development of a Solar Energy Development Plan 2012-2017

- Conduct rural community lighting assessment to identify energy needs and accessibility in pursuit of sustainable energy for all (SEFA);
- Development of Solar Cooling and PV Policy.

3.3 Strategic Element #3: To triple the amount of modern energy carriers derived from Agricultural, Forestry and Fisheries production and processing, including municipal solid waste (MSW) by 2020

Waste to energy projects are to be seen as an environmental and social need not to be decided by solely economic parameters.

Goal #1: To identify waste material suitable for energy production, the location, availability and quantities

- Conduct a national survey to identify waste material suitable for energy production, the location, availability and quantities.

Goal #2: To create a municipal solid waste energy conversion programme to supply fuel for 5MW of electricity.

- Develop and Implement a Pilot Project for the design of low-cost separation facilities in rural communities; separation will be done on an organic non-organic basis – the non-organic material will be separated into combustible and non-combustibles.
- Develop and Implement a Pilot Project Demonstrating Anaerobic Fermentation and Algae Systems that convert organic waste into fuel.
- Develop and Implement a Pilot Demonstration Project demonstrating the conversion of combustible material by furnace, pyrolysis technology, and fuels cells into electricity or feedstock material.
- Introduce technology transfer programme for distribution of anaerobic fermentation technology, producer gas technology and algae systems.

Goal #3: To introduce a waste-water management programme to utilize high biological oxygen demand (BOD) waste-water from distilleries, brewers, municipal and agricultural sources for the purpose of energy production either as electricity or to provide energy services such as cooking/heating, or desalination

Anaerobic fermentation and algae systems will be used as the technology for converting high BOD liquid waste.

- Develop and Implement a Wastewater Management Pilot Project to produce energy as electricity from waste generated by municipal sewage treatment plants
- Develop and Implement a Wastewater Management Pilot Project to produce energy as electricity from waste generated by agro-industries, and brewers and distillers.
- Develop and Implement a Wastewater Management Pilot Project to provide energy services for cooking/heating or desalination from waste generated by the tourist industry.

Goal #4: To introduce an agro-industrial waste management programme to utilize high lingo-cellulosic (saw dust and lumber cuttings, rice hull, etc.) and high moisture material (citrus skins, market waste, waste fruit, abattoir waste, etc.) for electricity generation, heat, animal feeds and fertilizers

Three key technologies referred above (anaerobic fermentation, fuel cell, pyrolysis, and algae) will provide conversion systems.

- Develop and Implement an Agro-industrial Municipal Waste Management Pilot Project to utilize market waste for electricity generation and fertilizers.
- Develop and Implement a Community Agricultural Waste Management Pilot Project to utilize waste generated on small farms in rural areas, for animal feeds and fertilizers.
- Develop and Implement a Pilot Project to Manage Waste Generated by the Forestry and Rice Industries to utilize the waste generated by saw mills, furniture manufacturers, and rice producers and farmers, for electricity generation and fertilizers.

3.4 Strategic Element #4: Build the Ministry of Energy, Science and Technology and Public Utilities (MESTPU) institutional capacity to accomplish its mandate by strengthening the Energy Portfolio through increase in professional staff, training and human resource development, acquisition of office supplies, materials and equipment, and funding to undertake institutional studies and audits, public awareness and education, and for traveling to national conferences and fora

Building capacity of the MESTPU is mandatory pre-requisite to the successful implementation of this Strategy. The goal in this instance is to establish a management system that is efficient, flexible, and transparent that would facilitate the implementation of the strategic objectives and outputs in the time available, with the financial resources allocated according to the technical specifications and quality standards articulated by the project documents. This component will provide support to other elements of the strategy for the efficient planning, monitoring and evaluation of the strategy.

Goal #1: To build the institutional capacity of the Ministry of Energy by increasing the number of professionals, including engineers, economists, policy analysts, architects, and researches to provide the capacity to implement the Sustainable Energy Strategy 2012-2033

- Prepare Terms of References, identify and hire professional staff in the MESTPU;
- Equip the MESTPU with the necessary tools, materials, supplies, equipment, machinery, and communication necessary for the operations of the portfolio and to facilitate the staff and professionals in their day-to-day activities.

Goal #2: Build capacity of tertiary institutions to develop and implement, by 2015, energy-focused curriculum that includes courses with concentrations in and combinations of forestry management, agriculture and energy security, and natural resources management, to provide the human capital and the institutional capacity needed for successful implementation of the Sustainable Energy Strategy 2012-2033

- Develop curriculum and course outlines, recruit lecturers, and seek sponsorship for scholarships for first cohorts.

Goal #3: Develop a public education and awareness programme to inform the public about the benefits of transforming the current fossil-fuelled economy to a low carbon economy in order to help meet the goals of the Sustainable Energy Strategy 2012-2033

- Create public education and awareness plan with key messages that target stakeholders in the energy sector, the private sector including manufacturers, sugar companies, distillers and breweries, the tourism industry, and financial institutions, and the general public;
- Create public education and awareness plan that targets rural communities and farmers, and which has a gender-based component targeting women in rural agriculture;
- Create an internal public education and awareness plan that targets the public service, starting with the MESTPU.

- Create an education and awareness plan that targets children at the early childhood, primary and high school levels that includes demonstration projects, e.g., biogas units for cooking, water conservation, composting.

Goal #4: Develop a Resource Mobilization Strategy to help finance the activities detailed in the Sustainable Energy Strategy 2012-2033

- Develop a comprehensive strategy that provides a framework for effective and successful mobilization of resources to help finance the activities in the energy strategy;
- Develop partnership agreements at the local level with the government, bilateral sources and financial institutions to finance energy investments;
- Provide support to the SIDS DOCK National Coordinator in the development and implementation of the Belize SIDS DOCK Project Pipeline and to facilitate the establishment and provide support to the SIDS DOCK National Financing Mechanism.

4.0 POTENTIAL BENEFITS OF IMPLEMENTING THE SUSTAINABLE ENERGY STRATEGY (2012-2033)

The Strategy provides a framework for the coordinated development of Belize's energy sector and recommendations for a national sustainable energy policy that provides the foundation for collective action in the areas of improving energy efficiency, and the development of renewable energy. The document identifies the appropriate technical and financial requirements necessary to implement policies, programmes, projects and action plans to improve access to reliable and affordable energy services for sustainable development sufficient to facilitate the achievement of international development goals including the Barbados Programme of Action for the Sustainable Development of SIDS (BPoA) and the Mauritius Strategy for its Further Implementation(MSI), the Millennium Development Goals (MDGs) and the SEFA, and as a means to generate other important services that mitigate poverty, and help reduce environmental degradation.

Bringing about a sustainable energy sector that promotes sustainable development is not consistent with a stand-alone energy sector. The Strategy notes that transforming the energy sector through a combination of continual improvements in energy efficiency and conservation along with development of renewable energy resources will provide significant socio-economic benefits and a path to sustainable development and poverty reduction, but it will require the development of an integrated and effective energy sector that, with greater policy coherence, is intended to ensure synergy between sectors that have significant impact and influence on the energy sector and socio-economic development. This requires linkages between agriculture and energy, between water and energy, transport and energy, and waste management and energy. A more integrated energy sector brings greater sustainability, and cost savings and benefits to the local population.

Benefits from Development of Renewable Energy Resources & Energy Efficiency and Energy Conservation

Based on the global experience, Belize can derive significant benefits from the development of renewable energy resources, the implementation of energy efficiency and conservation programmes, and the commercialization of renewable energy technologies. Energy efficiency and energy conservation have proven with growing documented evidence to be the cheapest sources of energy and in some cases, investment in areas like lighting and solar water heating pay for themselves in a matter of months and/or a few years. These opportunities should always be given priority as they provide the best cost benefits. National benefits from energy efficiency and conservation accrue with the greater level of participation. The Strategy recommends large scale participation and efficient delivery and quality guaranteed energy efficiency and conservation technologies.

Biomass Resources

In the case of biomass and in particular sugarcane-based biofuels, socio-economic benefits include diversification of the national and regional economy, improvement in regional trade, improvement in the economic value of crops like sugarcane, improved household incomes, generation of sustainable employment and improved future for the agriculture sector, and more stable energy prices.

Sustainable energy based on biofuels has significant potential social and environmental benefits. In the case of co-generation, there are significant benefits from biofuels. For example, a typical ethanol distillery in Brazil that produces 20 million litres of ethanol per year employs 150 full-time industrial workers. To supply the distillery with sugarcane, 455 agricultural workers are employed in central Brazil, but in North-eastern Brazil, sugarcane crop yields are lower and around 1,800 agricultural workers would be needed. Ethanol production from sugarcane can provide up to 15 times more employment than extraction and refining of petroleum to vehicle fuels. In the majority of SIDS, small and medium-scale production of biofuels such as plant oils are cost effective at small scale if markets are developed, can be a source of increased rural employment and improved water resource protection.

The Strategy recommends development of a biofuels industry in Belize, which has available and suitable land resources, as it can help address both the mitigation and adaptation obligations under the UNFCCC, but it also represents major adaptation approaches. Biofuels production uses crops that are much more resilient to nature's destructive forces such as tropical storms/hurricanes, floods, droughts, and fires. Other crops grown for food or exports such as vegetables, tobacco, bananas, coffee, and spices are not as resilient and therefore are much more vulnerable to climate change. Additionally, the production of raw material should result in improved land use leading to reduced soil erosion, improved fresh water resources, and improved

coastal environmental quality. These environmental benefits are significant and invaluable to Belize, if the country is to be successful in pursuing sustainable development and the Horizon 2030 vision.

Wind & Photovoltaic (PV) Resources

An assessment of wind resources is recommended, as the country could derive potential benefits. Commercial wind farms now operate in close to 80 countries, and presents many benefits for both developed and developing countries: increased energy security; stable power prices; economic development which both attracts investment and creates jobs; reduced dependence on imported fuels; improved air quality; and, of course, (CO_2)emissions reductions. Each of these factors is a driver in different measure in different locations, but in an increasing number of countries they combine to make wind power the generation technology of choice. Wind energy is a key solution in the fight against climate change, and the technology is on track to saving 10 billion tons of CO_2 by 2020. This means that more than 65 per cent of all emissions reductions pledges tabled by Annex 1 countries at the climate negotiations in Copenhagen in 2009 could be met by global wind energy alone. Moreover, wind energy is becoming a substantial factor in economic development, providing more than 350,000 'green collar' jobs today, both in direct and indirect employment. By 2020, this figure is projected to increase to over 2 million[6].

In the case of PV, where there is grid power readily available, there is a valid argument against deploying PV, as they are usually more expensive than power from the grid. PV is the energy solution of choice for island communities and other remote communities where grid expansion is not an economic option. Certainly, price of thin-film technology continues to fall; but there is a need to keep an eye on concentrating PV's (CPV) for the co-production of heat and electricity. In general, however, given that conventional energy is very costly, PV systems in the case of Belize would be very competitive. Additionally, it should be recognized that the high price of conventional energy sources and similar high prices from indigenous energy sources do not exert the same socio-economic impacts. Conventional energy systems require the continual exports of foreign exchange to pay for imported fuel. This is not the case for renewable energy, once the initial investment is repaid there are no significant export of foreign exchange and additionally, the cost from that technology is fixed for the rest of the economic life. That means a predictable price for energy services which makes for a more positive business environment for the private sector and households.

Waste-to-energy

The Strategy recommends a number of activities that are intended to effectively manage waste to reduce negative eco-system consequences. Waste-to-energy

[6]Global Wind Energy Council (2008).*Global Wind Energy Outlook 2008*. Available at: <http://www.gwec.net/index.php?id=92&L=0>

technologies are recommended as they represent a unique contribution to the development of a low carbon economy in Belize. Considering Belize's fragile environment, appropriate waste-to-energy systems characterized by low/no emissions, cost equivalent to conventional energy systems, and toxic residue are critical to keeping the green economy sustainable. Technologies recommended include advanced anaerobic fermentation that can replace conventional wastewater treatment systems and significantly reduce land resources for wastewater treatment or from doing discharges into the ocean. Additionally, such technologies would also be able to process, along with the wastewater, all the organic material contained in municipal solid waste, to generating energy and fertilizers.

Benefits of SIDS-wide Collective Action

As a member of the SIDS DOCK, the Strategy recognizes the opportunities of Belize being part of a collective SIDS-wide policy approach to sustainable energy development, particularly with regards to aggregate purchasing to get better prices, collective approaches to technology developers, collective approaches to seeking investment financing and in research, development, and demonstration.

The availability of financing is one of several barriers to investment in renewable energy and energy efficiency and conservation in small island and low lying costal states. Many renewable energy technologies are characterized by high initial capital costs with relatively low operating costs compared to thermal alternatives. This cost structure can present an obstacle to obtaining financing for renewable energy investment and, despite the high cost of petroleum fuels-based generation, factors such as remoteness, very small scale and limited private sector interest in investing, means that renewable energy projects still have an incremental cost compared to thermal alternatives. The energy policies are needed to ensure improved energy efficiency, for example, in the importation of appliances and vehicles, and to provide SIDS with collective bargaining strength in energy technology transfer. The energy technologies that will bring about this transformation will be characterized by its fit with the natural resources of these countries, ability to address environmental threats and challenges, maintaining environmental quality in a cost-effective manner, and augmenting water resources and food security.

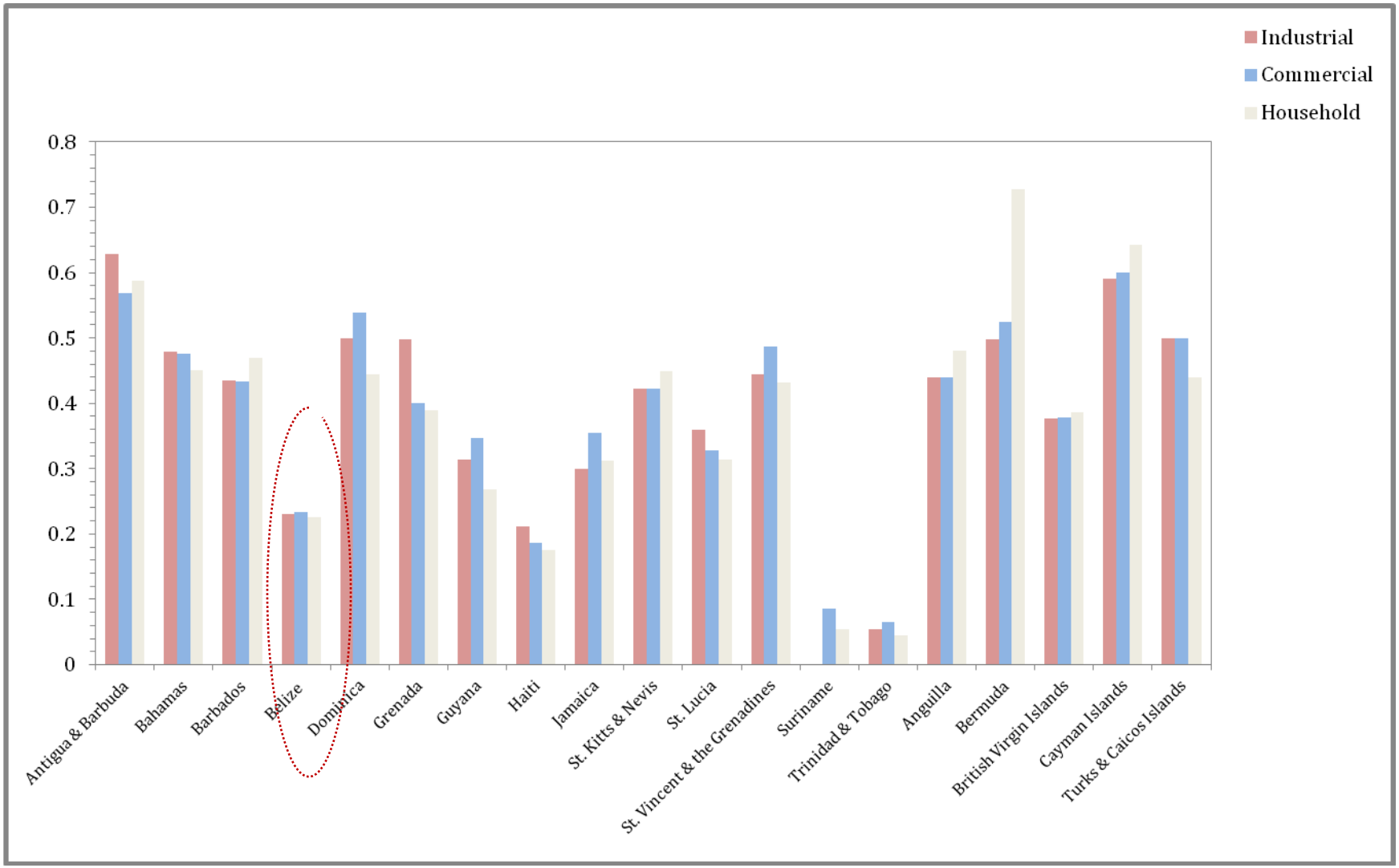
The transition to a sustainable energy economy to provide the foundation for a low carbon economy in Belize will require putting in place an inclusive and dedicated capacity development strategy, so as to be more sustainable, that provides the individual and institutional capacity necessary to plan and manage the sector. There are a number of critical technical skills that are essential for the implementation of a successful renewable energy programme that will require trained technical personnel. Increasingly, SIDS governments are looking to regional institutions to help fill the professional needs of the national energy sector, and

given the limitation of financial resources at the national level to retain professional capacity it is anticipated that this trend will continue.

This regional approach is a proven model for the provision of effective professional support to assist the implementation of sustainable energy development with one of the most famous cases being the Tennessee Valley Authority (TVA)[7] in the US. There is, however, need for more leadership from the SIDS tertiary institutions in providing the opportunity for training professionals in key aspects of sustainable energy. Aside from Singapore, no other SIDS-based tertiary institution is providing training to generate the professional skills needed to staff the transition. Neither the University of the West Indies (UWI) nor the University of the South Pacific (USP) currently provide any training in this area nor neither do the various national universities. The energy-related training, where offered, continues to focus on conventional engineering disciplines.

[7] The Tennessee Valley Authority is the nation's largest public power provider and a corporation of the U.S. government. TVA was established by Congress in 1933 to address a wide range of environmental, economic, and technological issues, including the delivery of low-cost electricity and the management of natural resources. TVA's power service territory includes most of Tennessee and parts of Alabama, Georgia, Kentucky, Mississippi, North Carolina and Virginia, covering 80,000 square miles and serving more than 9 million people. TVA sells electricity to 155 power distributor customers and 56 directly served industries and federal facilities.

Figure 4: Electricity Tariffs, CARICOM member and associate member states[8]



[8]Source: CARILEC (2011)

PART II

Science, Technology & Innovation (STI) Strategic Options for Implementation (2012-2017)

1.0 INTRODUCTION

The Science, Technology and Innovation (STI) Strategic Options for Implementation document provides recommendations for short-term interventions in furtherance of the development of the *Belize Science, Technology and Innovation (STI) National Strategy and Action Plan for Sustainable Development (2013-2030).* The STI national strategy adheres to the vision of the people of Belize, where the natural environment is valued and protected as the basis for all economic activity. Belizeans know that protection and preservation of the natural environment determine the quality of their lives, and they collectively visualize a society – *One Belize* where development planning is based on the principles of environmental sustainability, an outcome of *Horizon 2030*, the Belize National Development Framework.

The STI national strategy and action plan provides for the development and coordination and implementation of a comprehensive, integrated and transparent approach that develops a longer-range culture of investment and support for Science, Technology and Innovation to position Belize to be globally competitive in key markets, to overcome barriers to accessing global markets, and to understand and respond to unpredictable markets, external shocks, and hazardous events. The ultimate goal of the strategy and action plan is to utilize STI to act as a catalyst to reduce poverty, promote sustainable livelihoods, and improve the quality of life of the population. The strategy will be integrated with the country's development and national energy policies that support the provision of accessible and affordable energy services - from renewable energy sources - as an important focus of the STI Strategy. The STI Strategy will set out a baseline from which Belize's innovation performance could be measured, and will function as the road map that will lead Belize from where it is now, to where it would like to be by 2030.

Based on preliminary secondary research, pre-assessment phase of the STI system in Belize, desk reviews of stakeholder consultations (e.g., public consultations related to: Horizon 2030 and the Social Viability of Cruise Tourism in Southern Belize), reviews of sector strategies prepared by respective Ministries, and a 2010 private sector assessment, a number of STI Strategic Options have been recommended for implementation in the short-term in the next five (5) years, and intended to accomplish two goals: (1) to accelerate the promotion of innovation through the development and utilization of modern scientific and technological capabilities to provide the basic needs of the population and to be competitive in the

global market, and; (2) to restructure the entire science and technology machinery, infrastructure, and programmes in order to make them more responsive to national needs and priorities in all sectors of the economy. To achieve these goals, at least five (5) strategic options will be addressed through the development of a number of components, including sector-specific projects recommended for implementation over the 5-year period.

In March 2012, the Government established the Ministry of Energy, Science and Technology and Public Utilities (MESTPU), tasked with an ambitious mandate aimed at strategically integrating energy, science and technology into national development planning and decision-making. The MESTPU will be responsible for overseeing and managing the implementation of the Strategic STI Options.

2.0 JUSTIFICATION FOR SELECTION OF STI STRATEGIC OPTIONS FOR IMPLEMENTATION

More than one third of the world's population lacks the resources and information to meet basic human needs such as adequate food, clean drinking water, sanitation, good health provision, shelter and education. Science, technology and innovation can play a crucial role in alleviating poverty. They have led to a wide array of developments, from boosting agricultural productivity to providing the means to generate energy cheaply. Developments in science and technology can make a significant contribution to meeting the key commitments of the 8 Millennium Development Goals (MDGs). National Science and Technology (S&T) capacity are directly required to reach, sustain, and monitor 24 of the 48 MDG Indicators. Research shows that significant progress can be made in responding to problems associated with poverty and stimulating economic growth and that there are benefits to countries with sound S&T strategies in place that include: (a) investment in human resources training and development; (b) the demand for knowledge by the private sector; (c) public policies that provide the appropriate enabling environment for strong knowledge institutions, and; (d) the level and quality of the information and communication technologies systems that permit the flow and dissemination of knowledge and information[9].

The selection of STI Strategic Options is based on the prevailing socio-economic situation facing the country, and against the background that Belize and its people face the prospect of lagging even further in its development goals and aspirations for a *One Belize*, and includes but is not limited to the following challenges:

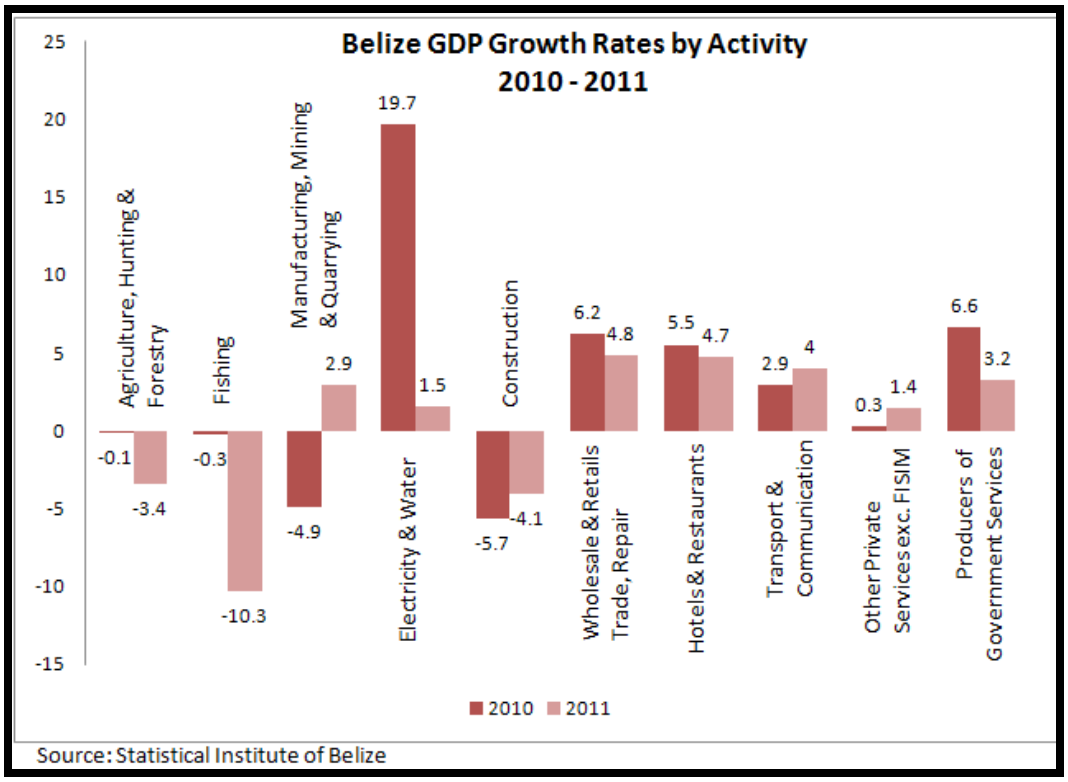
- Belize is not on track to achieve four of the eight MDG goals by 2015, including the core poverty and indigence reduction goals expressed in MDG1,

[9] The World Bank Available at: <http://www-wds.worldbank.org/servlet/WDSContentServer/WDSP/IB/2003/05/23/000094946_03051404103334/additional/112512322_20041117155524.pdf>

as well as MDGs 2 (education goals), 3 (gender goals) and 8 (debt management goals)[10].

- Public debt burden near 80 per cent of GDP – limiting fiscal policy space.
- More than half of all households are either poor or susceptible to falling into poverty, with poverty still being greatest in the rural areas (56.6 per cent) than in urban areas (30.3 per cent).
- Unemployment is high (14 per cent) - women are disproportionally affected recording twice the unemployment rate of men (16.7 per cent).
- Imperfect labour market with sizeable informal sector comprising about 16 per cent of labour force.

Figure 5: Belize GDP Growth Rates by Activity (2010-2011)[11]



- Small population (312,698) limits the size of the domestic market and potential economies of scale.
- Manufacturing sector is limited to agricultural processing and basic import substitution activities. Manufactured products fell from a peak of 13.5 per cent of total exports in 2005, to a meagre 1.4 per cent of total exports in 2008.

[10] United Nations Development Report (2010), *Belize Millennium Development Goals (MDG) Report 2010*. Available at: <http://www.undp.org.bz/wp-content/uploads/2012/01/Belize-MDG-Report-2010.pdf>

[11] Statistical Institute of Belize, *Belize GDP Growth Rate by Activity 2010-2011*. Available at: <http://www.statisticsbelize.org.bz/dms20uc/dm_browse.asp?pid=9>

Today, Belize's main exports in the manufacturing sector are limited to essential oils, paper and paperboard, and items made of wood.

- Globally, Belize stands at 107 in the ranking of 183 economies on the ease of trading across borders[12], yet the economy depends strongly on trade with the world economy, both as a market for domestic produce and as a source of the wide range of products that would be costly or impossible to produce domestically.
- Domestic interest rates for commercial loans higher than those in the United States and other small, open Caribbean countries with similar monetary/exchange rate arrangements (such as Bahamas, Barbados, and the Organization of Eastern Caribbean States) - low national saving and fiscal/monetary interactions play a role.
- Private sector development, particularly in the SME sector, is impeded by difficulties in obtaining affordable long-term capital for investments.
- Dependence on traditional agriculture production - exports largely concentrated in a few crops (sugar, bananas and citrus) - these commodities face continued challenges and uncertainty considering loss of EU price guarantees and increased competition from Latin American-based producers.

Figure 6: Production of Selected Commodities (2007-2011)[13]

Production of Selected Commodities

	Units	2007	2008	2009	2010	2011
SUGARCANE	long tones	1,185.5	1001	810.7	1,165.2	919.7
ORANGE	90-lb boxes	5,098.9	5,863.6	4,842.2	3,985.4	4,844.5
GRAPEFRUIT	80-lb boxes	998.3	1,775.3	1,294.9	967.7	634.6
BANANAS	40-lb boxes	3,441.7	4,340.0	4,699.9	4,286.0	3,933.6
SUGAR	long tons	93.1	87.5	82.9	93.5	105.2
ELECTRICITY	KWH	203.1	206.9	248.8	306.0	310.9
WATER	Gallons	1,762.9	1,831.7	1,879.5	1,927.5	1,950.2

Source: Statistical Institute of Belize (Units are denominated in thousands)

- Belize currently imports 88 per cent of fossil fuels used and has one of the highest energy prices in the world – the dependence on imported liquid fuels for transportation continues to make Belize extremely vulnerable to

[12] Doing Business 2012 – Belize Profile

[13] Statistical Institute of Belize, *Production of Selected Commodities 2007-2011*. Available at: <http://www.statisticsbelize.org.bz/dms20uc/dm_browse.asp?pid=9>

international oil-price shocks which can significantly disrupt economic planning and deter foreign direct investment within the industrial sector.

- Increased demand is placing new threats on the quality and quantity of freshwater resources. Approximately 85 per cent of households have public piped water into the dwelling/yard – more than half (51 per cent) of households use bottled water as their main source of drinking water.
- Decreasing primary education enrolment; less than half (49%) enrolled in secondary level; very low tertiary participation rates; largely untrained teaching force; lack of common approach to establishing standards and raising quality

2.1 Science, Technology and Innovation (STI) Strategic Options for Implementation

The following strategic options are being recommended for implementation over the next 2-5 years. These five strategic options optimally fit the needs of *One Belize*, the needs of the MESTPU, and aspirations of the stakeholders. A number of supportive components are also recommended to achieve success.

1. Introduce a STI Capacity Building and Institutional Strengthening Programme to strengthen the skills, competencies, abilities, and operations and services of the MESTPU to guide the development of a national culture of investment and support for STI over the next 5 years, and to respond to Belize's development goals.

2. Promote STI as important powerful ingredients to foster economic growth and competitiveness of Belize in the global market.

3. Promote Microenterprise Development for Rural and Vulnerable Populations to support entrepreneurial activities.

4. Promote Information and Communication Technologies (ICT) to support development of a culture of investment and support for STI with a focus on the information and knowledge economy and ICTs in the socio-economic sectors.

5. Build the sustainability of the MESTPU to accomplish its mission.

3.0 STI STRATEGIC OPTIONS COMPONENTS

3.1 Introduce a STI Capacity Building and Institutional Strengthening Programme to strengthen the skills, competencies, abilities, and operations and services of the MESTPU to guide the development of a national culture of investment and support for STI over the next 5 years, and to respond to Belize's development goals.

Science and Technology (S&T) plays an important role in promoting long-term economic growth, and in building a base for a science-based knowledge society – which is increasingly central to socioeconomic development. The establishment and maintenance of an indigenous S&T workforce allows countries to be more than just consumers of other nations' technological exports, and provides means for citizens actively to improve their own situations and economic well-being[14]. The ability of countries, and their public and private sectors, to create, acquire, assimilate, utilize and diffuse S&T knowledge is now a major determinant of economic competitiveness.

Highly qualified researchers, professionals and technicians are required to manage the maintenance and expansion of the country's science, technology and innovation capacity. The MESTPU, as the lead Ministry, will have to ensure that appropriate incentives are put in place to retain the human capital developed, and will have to make special effort to decrease the likelihood of a "brain drain". The Government will also have to address a number of weaknesses that contribute to this "brain drain," including less than desirable working conditions (including lack of instrumentation and technical support), and lack of access to high-level research networks, remuneration, among other factors.

A number of capacity building and institutional strengthening programmes and activities are proposed:

- Development of STI Policy and Action Plan;
- Development of a framework for merging public STI entities and a projected implementation budget for operationalization of an STI Division within the MESTPU;
- Increase the allocation of financial resources to support the Ministry's operations and structure;

[14] United Nations Educational, Scientific and Cultural Organization (UNESCO), *Science, Technology and Gender*, Available at: <http://www.unesco.org/new/en/natural-sciences/science-technology/sti-policy/global-focus/gender-issues/gender-discrimination-limits-socio-economic-growth-warns-report/>

- Strengthening MESTPU's capacities in research, analysis, monitoring, and evaluation by reviewing and rationalizing the Ministry's staff to assess human resource requirements for STI;

- Strengthening the MESTPU's human skills base by increasing the number of scientists, technicians and engineers through the establishment of a Graduate Programme in Natural and Environmental Sciences at the University of Belize. Currently, Belize offers no graduate degree program in the natural sciences. As a result, the cost of pursuing advance training in the sciences is prohibitive, because Belizeans must leave Belize to find graduate programs in Central America, the Caribbean, the US, or elsewhere[15].

- Strengthening the capacity of the public sector to mainstream science and technology into their sectoral programs and projects;

- Establish STI Fund to invest in government-supported research in the physical sciences and engineering and focused on improving all aspects of science, technology, engineering, and mathematics (STEM) education.

Development of a Science, Technology and Innovation for Women capacity building programme to increase women's involvement and input in S&T, to enhance human potential, and to improve the use of technology, especially in the vital developmental areas of water resources management, food production and processing and sanitation.

- Support Establishment of the Belize STI Centre of Excellence as the Leading Strategic Institution on STI in Belize, in order to broaden and intensify development and training programs in STI.

3.2 Promote STI as important powerful ingredients to foster economic growth and competitiveness of Belize in the global market

Technological adoption and the ability to innovate are critical competitiveness drivers that have both become important elements for firms to compete and prosper, and that will remain important going into the future. Those economies that are innovative and that harness the latest technologies will be better able to adjust to the rapidly changing global economy and confront future vulnerabilities. It is these economies that will be best able to sustain their competitiveness. Competitiveness refers to the ability of the enterprise, industry, country to produce and sell goods and services in domestic/foreign markets at prices and with the quality that ensure

[15] Young, Colin (2008), *Belize's Ecosystems: Threats and Challenges to Conservation in Belize*. Available at: <http://tropicalconservationscience.mongabay.com/content/v1/08-03-03-Young.htm>

long-run viability and sustainability. Competitiveness can be examined at three levels[16]:

- Enterprise: the ability to produce/market products of superior quality and lower costs than those offered by domestic/international producers
- Sector/industry: the extent to which the sector/industry offers potential for growth and to attract a good return on investment
- National/country: the extent to which the business environment is conducive to growth/development thus enhancing the capacity of the economy to improve the standard of living on a sustainable basis.

Currently, Belize, which is in the efficiency-driven stage of development[17], is one of the least competitive economies, ranking 123 out of 142 countries, as reported in the recent Global Competitiveness Report 2011–2012, published by the World Economic Forum's Centre for Global Competitiveness and Performance. Of the seven Caribbean countries covered in the report, Belize ranked second to last, ahead of Haiti (141). The overall ranking has placed Barbados at the top of the Caribbean (42), followed by Trinidad and Tobago (81), Jamaica (107), Guyana (109), Dominican Republic (110), and Suriname (112). Belize was added to the country coverage for the first time in the three decades that the report has been published.

The Global Competitiveness Index/Report focuses mainly on national competitiveness using a set of composite indices. The Report looks at the main factors influencing national competitiveness – quality of the macro-environment, the quality of public institutions and technology/innovation. From the onset, the goal has been to provide insight and stimulate discussion among all stakeholders on the best strategies and policies to overcome the obstacles to improved competitiveness. As shown in the Figure 3, Belize ranks very low in terms of technological readiness[18] and technological innovation, and education (compared to other countries in the report). A strong innovation capacity will be very difficult to achieve without a healthy, well-educated and trained workforce that is adept at absorbing new technologies, and without sufficient financing for R&D or an efficient goods market that makes it possible to take new innovations to market.

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[16] A Caribbean Perspective on the Global Competitiveness Index and Report, Andrew S Downes PhD, Professor of Economics and Director, Sir Arthur Lewis Institute of Social and Economic Studies, University of the West Indies, Cave Hill Campus, BARBADOS, October 2009, Presented at the Ideas Forum, Arthur Lok Jack School of Business, UWI, St Augustine, October 7, 2009. Available at: <http://www.amchamtt.com/>

[17] Efficiency-driven stage of development is when countries must begin to develop more efficient production processes and increase product quality because wages have risen and they cannot increase prices. At this point, competitiveness is increasingly driven by higher education and training, efficient goods markets, well-functioning labor markets, developed financial markets, the ability to harness the benefits of existing technologies, and a large domestic or foreign market.

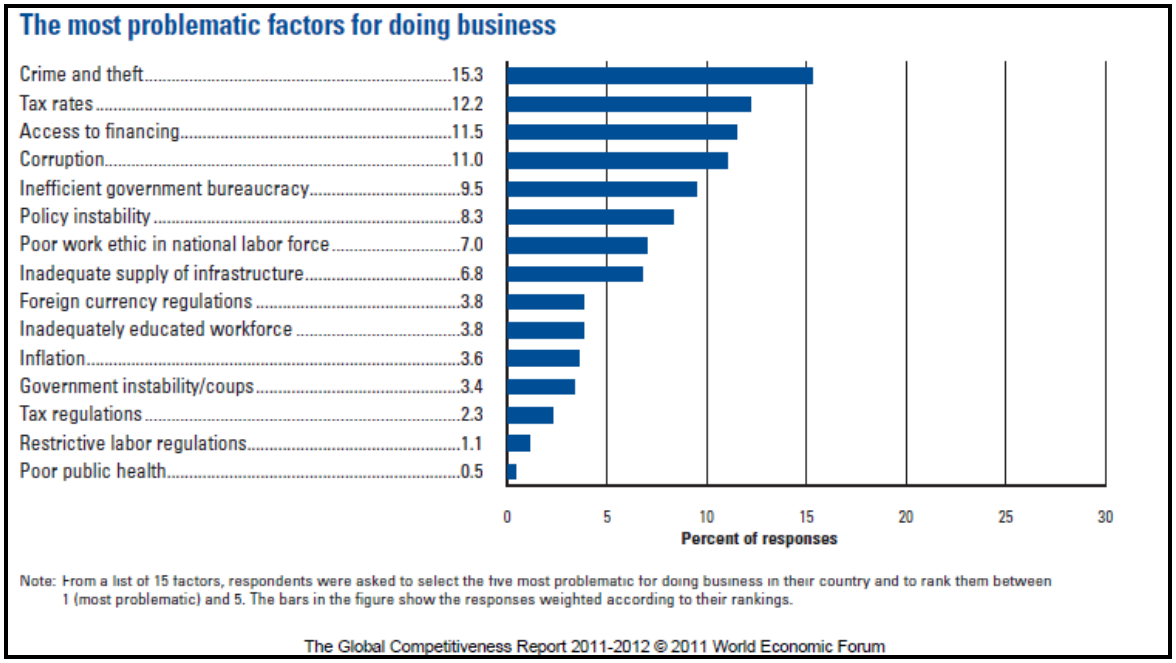
[18] The technological readiness pillar measures the agility with which an economy adopts existing technologies to enhance the productivity of its industries, with specific emphasis on its capacity to fully leverage information and communication technologies (ICT) in daily activities and production processes for increased efficiency and competitiveness

Figure 7: Belize's Technological readiness and Innovation Scores/Rank[19]

	9th pillar: Technological readiness				12th pillar: Innovation		
9.01	Availability of latest technologies	4.6	92	12.01	Capacity for innovation	2.3	131
9.02	Firm-level technology absorption	3.9	129	12.02	Quality of scientific research institutions	2.4	128
9.03	FDI and technology transfer	3.4	136	12.03	Company spending on R&D	1.9	140
9.04	Internet users/100 pop.*	14.0	101	12.04	University-industry collaboration in R&D	2.5	132
9.05	Broadband Internet subscriptions/100 pop.*	2.9	84	12.05	Gov't procurement of advanced tech products	2.8	125
9.06	Internet bandwidth, kb/s/capita*	2.6	79	12.06	Availability of scientists and engineers	2.4	140
				12.07	Utility patents granted/million pop.*	0.0	90

Figure 8 below shows, the most problematic factors for Belize from the perspective of Belize's business leaders. As the figure illustrates, crime and theft, tax rates, access to financing, corruption, and inefficient government bureaucracy are seen to be significant hindrances to doing business in Belize. These are issues that must be tackled in order facilitate the wealth and job creation that is still so needed across the country. Despite efforts to tackle the issue, crime and theft remain pervasive and are singled out by business executives as the most problematic factor for doing business in the country. Policy instability is now a major concern, and the business community assessed this indicator at levels similar to inefficient government bureaucracy.

Figure 8: The most problematic factors for doing business[20]



[19] *Doing Business 2012: Doing Business in a More Transparent World – Belize Profile;* A co-publication of The World Bank and the International Finance Corporation (IFC), Washington, D.C.
[20] World Economic Forum (2012) *The Global Competitiveness Report 2011-2012*, Editor, Professor Klaus Schwab, Geneva, Switzerland

A number of programmes and activities are proposed to support the economic growth and competitiveness of Belize in the global market:

Establish a Belize Centre for Excellence in STI to provide incubation support services for start-up micro, small and medium enterprises;

Establish Entrepreneurship Program for Innovation to promote economic diversification and productivity in Belize through the promotion of technology-based entrepreneurship;

- Development of a National Diversification Strategy to empower the private sector to extend their range of goods or services, sell more products to their existing customers, or reach out to new markets in order to increase their growth prospects through retooling and reengineering, thus increasing their capacity to keep up with technology.

- Establish a National Private Sector Research & Development Fund to support Belize private sector with predictable and sustained investments in scientific research. The government plays a crucial role in supporting the fundamental scientific research upon which the private sector builds its technology base - innovation, scientific discovery, and technological breakthroughs serve as major engines for promoting renewed economic growth – this will require investments in science and technology, plus entrepreneurial willingness to capitalize on the dividends of scientific research by bringing those research dividends into commercialization.

- Review of business laws, tax code, trade policies, and regulatory environment to ensure cohesiveness and that they work together to assure the products of Belize science and technology companies, both large and small, are introduced to the national and international marketplace competitively and without facing inappropriate barriers.

- Promote competitiveness though the adoption, adaptation and dissemination of appropriate technology

3.3 Promote Microenterprise Development for Rural and Vulnerable Populations to support entrepreneurial activities

Microenterprises make a major contribution to aggregate employment, production, and national income of Belize. Microenterprises are also an important vehicle for low-income people to escape poverty through market-driven, productive activities. Government will need to promote the conditions necessary for the growth and development of the microenterprise sector in Belize, and support programmes that focus on technology that is used in direct service to microenterprise clients: a

favourable policy and regulatory environment; strong, sustainable institutions providing financial and nonfinancial services to meet the demand of microenterprises; improved access of low-income and disadvantaged micro-entrepreneurs (including women and indigenous peoples) to financial and business services; and expanded, continuous and permanent flows of resources for investment in microenterprise.

The agriculture sector has been the bedrock of the Belizean economy and the main source of livelihood of many generations. In 2006, it employed approximately 30 per cent of the work force and contributed to 15 per cent of GDP and 75 per cent of foreign exchange. In 2006, 51,240 households were involved in the agriculture sector in one or a combination of the following agriculture activities: crops, livestock and aquaculture[21]. Agriculture now accounts for 9.7 per cent of GDP and employs 10.2 per cent of the work force[22]. Agriculture saw one of its steepest declines of 2.5 per cent in 2009, (11.7% of GDP), the largest contraction over the period 2006-2009. Performance was dampened by the fallout from the floods of 2008, which led to a decline in value added for the major export crops. Sugar cane output fell by 6.3% to 917,728 long tons, the smallest harvest in 22 years, and citrus output was down by 7.7%. Only fisheries reported higher value-added in 2009, with output rising by 9.4 per cent, as a result of increased production of farmed shrimp and conch[23].

From feeding a population expected to reach 400,000 by 2050[24] to looking after soil, water and natural habitats, and as can be seen above, Belize's farmers face increasing challenges. What's more, they are under greater pressure from the changing climate and a shrinking agricultural workforce. As a result, farmers need innovative tools that improve sustainability more than ever. Providing farmers access to plant science innovations as well as the knowledge and skills to use them responsibly can make a major impact on their farms. Agricultural innovations come from both public and private sector research and almost always involve a lot of time, resources and financial uncertainty. Research priorities for both sectors depend on a complex mix of factors, including benefits to farmers, consumers and the environment, as well as a return on research investment. By working together through public-private partnerships, these two sectors can pursue unique or otherwise speculative projects. They can also bring together the necessary experience, knowledge, investment, technologies and resources to address agricultural issues which may have been overlooked by a single-sector programme

[21] Ministry of Agriculture and Fisheries, Government of Belize. Available at: <http://www.agriculture.gov.bz/Agriculture_Dept.html>

[22] Central Intelligence Agency (CIA), *The World Factbook, Belize*. Available at: <https://www.cia.gov/library/publications/the-world-factbook/geos/bh.html)

[23] Economic Commission for Latin America and the Caribbean (ECLAC), *Economic Survey of Latin America and the Caribbean 2009-2010, Belize.* Available at: <www.eclac.org/publicaciones/xml/4/40254/Belize.pdf>

[24] Statistical Institute of Belize, *Population Estimates & Projections 1980 – 2050.* Available at: <http://www.statisticsbelize.org.bz/shownews.asp?newsid=43>

or approach. For national governments, public-private partnerships offer an efficient way to bring timely and relevant tools to local farmers, while helping to build agricultural knowledge at a local level. For the private sector, collaboration provides an innovative approach to financial and resource needs, and helps develop potential new markets. As a result greater innovation can be put in the hands of our world's farmers.

The following are recommended for implementation:

Support and promote public-private partnerships – To (a) improve the efficiency of developing locally-adapted innovation; (b) enable technology to be distributed more effectively to local farmers; (c) help farmers continuously improve and make the most of sustainable agricultural practices; (d) promote the effective and responsible application of new technologies; and (e) provide social and economic value to farmers and communities.

- Develop financing mechanisms to reach the grass roots - a critical factor in making sustainable, decentralised energy options accessible to poor people is affordability. The up-front cost of new technologies, whether an improved cook stove or a micro-hydro power plant or solar dryer for grains, is extremely high for poor people. Appropriate financing and subsidies can give low income communities, households or entrepreneurs the ability to afford to invest in new energy technologies. Achieving this aim will require a sustained effort by the international community, as well as new local partnerships involving NGOs and private sector. There are good practice models that can be replicated.

- Promote appropriate technologies that are economically viable, socially beneficial, and environmentally sound. Appropriate technologies can increase employment, generate income, and enable people to meet their basic needs. Appropriate technologies can also conserve or rehabilitate the environment. They should promote equity, whether among genders, generations, class, or other social divides. Appropriate Technologies encompass:
  - Shelter (blocks);
  - Textiles (handloom);
  - Paper (handmade paper [banana] production units);
  - Soil (vermicomposting);
  - Energy (solar dryers).

- Develop and implement Multi-purpose Community Telecentres (MCTs), owned by the communities themselves, to demonstrate the transformation of the knowledge base and empowerment of communities to manage their own development through access to appropriate facilities, resources, training and services. Connectivity to rural areas and poor communities is essential for

bridging the Digital Divide. Today, there are favourable developments in ICT technologies that enable remote communities to be connected, such as satellite and wireless technologies. People need access to telephones, faxes, photocopying machines, e-mail and Internet services to strengthen them personally and professionally, as well as for community development and empowerment. A telecentre is an institution providing public access to the Internet and other telecommunications services in small and usually marginal places. Community-based support groups and non-governmental organisations are the appropriate institutional base for meaningful telecentre initiatives in small or remote places. But these organisations must have a way to ensure that their efforts are financially viable. Revenue would be earned not only through providing Internet telephone services, but also through facilitating the electronic transfer of remittances from migrants in the United States to their families in Belize.

- Improve banking technology by using mobile phones to facilitate remittances, transfers and payments, and enable savings – this was found to have the potential to increase income by allowing households to smooth consumption and accumulate assets. State-led expansion of the banking sector in rural areas was found to increase the supply of banking services, which in turn was found to reduce rural poverty, increase rural wages and increase agricultural investment[25].

- Develop Pilot Market Information and Credit Facility - The recent growth of electronic commerce or e-commerce has challenged the myth that one of the keys to successful retailing is place. Although not prevalent and barely evident in Belize, interactions are now taking place over the Internet. This has taken trading opportunities a long way forward, allowing an interactive, yet remote contact between the parties. In fact, technology has dramatically changed consumer and producer involvement in and expectations from some of their trading experiences.

  The Marketing Facility Services must be able to accommodate a number of public sector entities whose aim is to support efficient and sustainable market information services to the farmers and customers. Market information is crucial to enable farmers and traders to make informed decisions about what to grow, when to harvest, to which markets produce should be sent and whether or not to store it. Market information can be used by those involved in the marketing process to make better marketing

[25] Pande, R.; Cole, S.; Sivasankaran, A.; Bastian, G.; Durlacher, K. *Does poor people's access to formal banking services raise their incomes?* EPPI-Centre, Social Science Research Unit, Institute of Education, University of London, London, UK (2012) 102 pp. ISBN 978-1-907345-26-5. Available at: <http://www.dfid.gov.uk/r4d/Output/189522/Default.aspx>

decisions. The Food and Agriculture Organization (FAO) has defined such a market information service as:

> *A service, usually operated by the public sector, which involves the collection on a regular basis of information on prices and, in some cases, quantities of widely traded agricultural products from rural assembly markets, wholesale and retail markets, as appropriate, and dissemination of this information on a timely and regular basis through various media to farmers, traders, government officials, policymakers and others, including consumers.*[26]

The primary objective of this market information and credit facility is to increase the degree of knowledge of market participants (farmers, traders and consumers) about the market. Improved access to information leads to an improved understanding of the working of the market. This means that the decisions made by the participants should be more informed and the profitability of their operations should be enhanced. The market information service will therefore focus on the information needs of each business partner and target groups. This market service will be complemented by an Automated Teller Machine (ATM) {with enough machines to service the marketing facility and surrounding community}. ATMs have provided an important expansion of banking services that has benefited all consumers. Before the introduction of ATMs in Belize, bank customers' access to their cash was limited to traditional banking hours. Customers often found themselves waiting in long lines on Friday afternoons just to withdraw enough cash to carry them through the weekend. On-site ATMs will open a whole new world of convenience for customers and clients by allowing access to banking services 24 hours a day, 365 days a year.

3.4 Promote Information and Communication Technologies (ICT) to support development of a culture of investment and support for STI with a focus on the information and knowledge economy and ICTs in the socio-economic sectors

Information and Communication Technologies (ICTs) are a diverse set of technological tools and resources to create, disseminate, store and manage information. Multiple studies throughout the world have proven conclusively that telecommunications development leads, not follows, economic development. ICTs facilitate networks that link people to other resources and ideas and promote communication and collaboration. Networks that connect the new facility to

[26] *Market information Services – Theory and Practice*, AGS Bulletin No. 125, Rome, 1997, Available at: <http://www.fao.org/waicent/faoinfo/agricult/ags/AGSM/_Toc526440117>

broader regional and national efforts can bring in new resources and share local innovation to stimulate broader and political and economic change. Information more than ever is becoming a priceless commodity whose value increases with time and is becoming a critical resource for development. For the developing world, the Internet is considered by many to be a powerful tool for development that will allow countries to leap-frog ahead, economically and socially.

Businesses, and society as a whole, rely heavily on information and communication technology, mainly as a means to communicate data and valuable information, which is collected and translated to feed into organizational processes and for crucial decision making. With the development of the Internet, there has been an increase in the number of opportunities arising enabling firms to succeed financially, particularly private limited companies. ICT is an essential resource to business activities due to the development of high bandwidth telecommunications networking, integrated distribution systems, and database systems that allow businesses to operate in a global way. ICT enables communication between different companies via state-of-the-art technology, consisting of telecommunications equipment such as high-tech web cameras and Integrated Service Digital Networks (ISDN), resulting in high speed data transmission, crucial for video conferencing. There are also significant opportunities for the manufacturing sector – ICT has a major role to play in supporting process improvement and collaboration, delivering dramatic reductions in cost and time, enabling market penetration of new business models and technologies, and managing data and interoperability throughout the design, build and use phases of an asset, product or service.

However, similar to what pertains in the developing world, only a small number of SMEs in Belize are aware of the benefits of ICT adoption. The main driving forces for ICT investment are to provide better and faster customer service and to stay ahead of the competition. Several SMEs outsource most of their ICT activities. Lack of internal capabilities, high cost of ICT and lack of information about suitable ICT solutions and implementation are some of the major barriers in adopting ICT. There is a need for more focus and concerted efforts on increasing awareness among SMEs on the benefits of ICT adoption. There is also need for training facilities in ICT for SMEs, measures to provide ICT products and services at an affordable cost, and availability of free professional advice and consulting at reasonable cost to SMEs.

Mobile technologies are opening new channels of communication between people and governments, potentially offering greater access to public information and basic services to all. No other technology has been in the hands of so many people in so many countries in such a short period of time. In fact, globally, more people now have access to a mobile device than to justice or legal services. Recent estimates indicate that ICTs could be accessible to everyone by 2015 and bring internationally agreed development targets ever closer to achievement. We are witnessing a new wave of democratization of access to innovative ICT channels, propelled by state-of-

the-art technologies and diminishing barriers to entry. Furthermore, close to 80 million mobile subscribers, most of them in developing countries, have no access to the electrical grid — and yet use a mobile phone[27].

Mobile technologies are starting to have an indelible impact on human development, enhancing democratic governance and other development areas such as health, education, agriculture, employment, crisis prevention and the environment. For instance, studies have suggested that increased mobile ownership is linked to higher economic growth. It is also likely to have twice as large an impact on economic growth in developing countries as in developed ones because the starting point of infrastructure in poorer countries is so much lower in terms of landlines and broadband access. Leapfrogging of traditional infrastructure requirements such as landlines is possible in low-income countries as mobile technologies have lower investment costs. Other benefits include increased telecom-based tax revenues, greater employment opportunities, and overall increased productivity, not to mention a thriving telecom industry that attracts foreign direct investment. As emergency response tools, mobile technologies have helped establish networks of communication between citizens, organizations and government agencies in times of crises. They are also being used to educate and keep citizens and vulnerable stakeholders abreast of environmental and energy-related issues, including weather patterns, climate change and responsible environmental stewardship.

The following are recommended for implementation:

- Develop and implement a national ICT policy and strategy to guide investments in ICT;

- Develop a modern legislative framework to regulate the appropriate use of ICT for e-commerce (e.g., cyber-security);

- Develop an e-commerce policy to promote economic development and diversification through access to a reliable and secure ICT infrastructure; to increase efficiencies and reduce the transaction costs of doing business in Belize, and; to support public education and training in the field of electronic commerce;

- Develop a programme for developing ICT for e-Commerce, aimed at creating a well-developed ICT sector and driving the adoption of usage of ICT in all dimensions of business operations to create competitive advantage at the business and country levels;

[27] United Nations Development Programme (2012) *Mobile Technologies and Empowerment: Enhancing human development through participation and innovation*. New York, N.Y. Available at: <http://www.undpegov.org/mgov-primer.html>

- Implement ICT Strategy that includes recommendations for modernization of the delivery of public services – e-commerce;

Increase awareness among SMEs on the benefits of ICT adoption by setting up designated training facilities in ICT for SMEs, and which will also introduce measures to provide ICT products and services at an affordable cost, and provide free professional advice and consulting at reasonable cost to SMEs;

- Encourage public investment and develop public-private partnerships for extending connectivity, services and information through increased mobile ownership in rural areas.

3.5 Build the Sustainability of the MESTPU to Accomplish its Mission

In Belize, as in most other Caribbean countries, the government is the largest landowner; the largest fleet owner; one of the largest single employers; and the largest landlord or owner/operator of buildings. It is also therefore the largest consumer of energy, the largest producer of most environmental impacts; the greatest single source of support for social capital; and so on. Governments need to put their internal operations on a firm sustainability foundation. Just as most governments try to conduct government operations and public enterprise according to sound business practices, sustainability principles should now be seen as integral to this process.

Many benefits of sustainability apply equally to the public and private sectors. These include lower energy costs and economic incentives through cap-and-trade programs such as the European Union Emissions Trading Scheme (EU-ETS). The public and private sectors also share a desire to protect the environment for future generations. The public sector has additional incentives to adopt sustainable technology and business practices:

- Improving service effectiveness: Savings from more efficient power usage can be invested in government and educational services.
- Fulfilling government's role as a public steward: The public sector has a social and fiduciary responsibility to conserve scarce resources.
- Enhancing employee recruitment and retention: Across the Caribbean, public sector employees migrate in record numbers and governments need to attract the best and brightest workers to replace them. New college graduates tend to prefer to work for employers committed to sustainability.

The government employs a number of mechanisms in order to directly finance its own production and delivery of services in a manner that is efficient, equitable, sustainable, transparent, and improves quality of life. The direct tools available to the government for mobilizing resources for the energy, water and S&T sectors come from among others, taxes, domestic and foreign borrowing, investment

incomes, grants, disposal of assets and non-tax revenue. The stark reality in most developing countries like Belize is that whilst there is severe budgetary pressure as a result of ever increasing demand for government expenditure, there is a limited scope for raising extra tax revenues. The government will need to develop a comprehensive strategy to mobilize additional resources for the MESTPU. The development of partnerships with local, national, regional and international institutions and other stakeholders is one way to achieve its goals.

Public-private partnerships (PPPs) have provided a principal vehicle for foreign direct investment (FDI) into public utilities and infrastructure in developing countries. Adequate physical infrastructure is a key element of a sound investment climate and development agencies can help countries mobilise private investment through Overseas Development Assistance (ODA) spent on relevant infrastructure. However, the developing world needs far more financing for infrastructure than can be provided through ODA and domestic public finances alone. The cost of maintaining existing infrastructure and undertaking necessary extensions of its coverage is estimated at 7 per cent of developing country GDP, equivalent to about USD 600 billion per year. Public spending on infrastructure in developing countries is presently around 3 per cent. Also, bilateral ODA for infrastructure has dropped from USD 15 billion in 1996 to USD 8 billion in 2002, and international financial institutions' lending for infrastructure has dropped precipitously[28]. One solution is to expand the use of public-private partnerships in utilities, relying on ODA to enhance the quality of projects, reduce risks and raise profitability. The economic rationale for doing so, in effect subsidising private enterprises, rests on the presumption of market imperfections, e.g., lack of appropriate regulations.

In public-private partnerships, the public and private sectors join forces to design, finance, build, manage or maintain infrastructure projects. Such partnerships can take many forms, depending upon the exact allocation of risks and responsibilities. Figure 9 lists the most common forms of PPPs in utilities.

[28] Organisation for Economic Cooperation and Development (2005). *The New Partnership for Africa's Development (NEPAD)/OECD Investment Initiative - OECD Investment for African Development: Making it Happen - Encouraging Public-Private Partnerships in the Utilities Sector: The Role Of Development Assistance*, Imperial Resort Beach Hotel Kama Hal, Entebbe, Uganda, 25-27 May 2005. Available at: <www.oecd.org/investment/investmentfordevelopment/34843203.pdf>

Figure 9: Characteristics of alternative forms of PPP[29]

	Operation & maintenance	Ownership	Investment	Commercial risk	Duration (years)
Management support	Public and private	Public	Public	Public	1-2
O&M	Private	Public	Public	Public	3-5
Leasing	Private	Public	Public	Semi-private	8-15
Concession	Private	Public	Private	Private	20-30
BDO	Private	Public	Public	Private	20-30
BOT / BOO	Private	Public / private	Private	Private	20-30

Source: Gruber (2003) and OECD Secretariat.

Also of critical importance is the development of a MESTPU Strategic Plan 2012-2015, which would set the direction for the Ministry over the next three to five years, acting as a compass and a high-level guide. The Strategic Plan will describe how the MESTPU would achieve its energy, S&T, environmental and economic mandates, and it would prioritise actions based on departmental targets, e.g., in the areas of Green House Emissions (GHG) emissions, energy, water, and waste reduction - these goals and priorities will shape the work of the MESTPU.

The following are recommended for implementation:

- Develop a comprehensive strategy to mobilize additional resources for the MESTPU – The MESTPU will need to develop a resource mobilization strategy that includes these important objectives:
  a) Enhance understanding of funding needs and opportunities and improve energy, S&T, and water resources management and planning at the national, regional and international levels;
  b) Facilitate integration of energy, S&T, and water into relevant sectoral and cross-sectoral development planning and budgets and development cooperation programmes;
  c) Rationalize and improve coherence and coordination between funding sources and mechanisms;
  d) Catalyse on opportunities for innovation;
  e) Improve effectiveness and efficiency in accessing external funding;
  f) Provide a transparent framework to facilitate dialogue with, and engagement of, all relevant stakeholders in designing, preparing and subsequently implementing the MESTPU resource mobilization strategy.

- Explore PPPs as a way of introducing private sector technology and innovation in providing better public services through improved operational efficiency - Develop partnerships with regional and international institutions and other stakeholders as an alternative additional source of funding to meet the funding gap. Whilst recent attention has been focused on fiscal leveraging

[29] OECD, 2005

of projects, governments look to the private sector to help them deliver infrastructure for a number of other reasons.

- Develop a MESTPU Strategic Plan 2012-2015 – to set the direction for the Ministry over the next three years – a compass, a high-level guide that describes how the MESTPU will achieve its energy, S&T, environmental and economic goals mandated, and which prioritizes actions based on departmental targets, e.g., in the areas of GHG emissions, energy, water, and waste reduction - these goals and priorities will shape the work of the MESTPU.

4.0 SECTOR-SPECIFIC PROJECTS

Utilization of STI to Promote Food Security, Energy Security, Environmental Protection and Economic Growth

The MESTPU, in partnerships with relevant Ministries, will be utilizing STI to promote food security, energy security, environmental protection and economic growth, targeting the energy and water sectors. The recommended sector-specific projects for implementation in the short- to medium-term are expected to improve the livelihoods of several disadvantaged communities, preserve and protect significant portions of the River Valley environment, increase sanitation and hygiene in several rural schools, and increase the competitiveness of the local rice and corn industries. The objective is to show that Belize can, in the short- and long-term, implement strategies and projects that could lead to better food and energy security across the country.

The sector-specific projects proposed targets districts with unemployment rates higher than the national average, e.g., Cayo (18.3%) and Stann Creek Districts (15.3 %); districts with underutilized land not suited to conventional agriculture primarily because of soil conditions, e.g., Corozal, Belize, Stann Creek and Toledo Districts; districts located in low lying areas, particularly in the Toledo and Stann Creek Districts; and most importantly, lands not being utilized because of water issues - in some cases flooding, and in some areas soils with low levels of fertility and/or drainage due to soil characteristics that combine to make food production marginal or futile, e.g., Belize, Stann Creek, Toledo, and Orange Walk Districts.

The problem that Belize faces with regard to its water resources is the declining quality resulting from delayed sewage systems investment and the limited available potable water for the rural population – in 2010, about one-half of households nationally, used bottled water as their main source of drinking water. Water sector projects aim to introduce technologies that promote improved sanitation and hygiene in rural schools, environmental protection are targeted for areas where there is existing problems with illnesses related to poor water quality, particularly in the Toledo, Belize, and Corozal Districts.

Belize has vast amounts of under-utilized and/or marginal agricultural lands that are suitable for the production of under-exploited crops such as *Leucaena L.*, *Acacia mangium*, and *Arundo Donax* for biofuel production. The aim of the energy sector projects is to promote energy security through the development of renewable energy resources and improving energy efficiency by introducing technologies that:

(a) Reduce post-harvest crop losses;
(b) Promote development of a rural small-scale bioenergy industry;
(c) Convert municipal and agricultural waste to energy;
(d) Promote development of a commercial biofuels industry;
(e) Increase energy efficiency and promotes energy conservation.

4.1 Energy Projects

Rice, Corn and Beans Post-Harvest Technology - Introduction of Solar Drying Technology

Currently, farmers are experiencing production losses of key staple foods that the majority of the rural population depends upon - corn, beans and rice. Due to inadequate post-harvest facilities, these grains do not get to dry properly, often times developing mould because of climatic conditions, thus of poor quality and not meeting human consumption requirements reducing food availability. Drying technologies are essential to reduce post-harvest losses for grains, especially during uncertain weather conditions. The plan is to develop and test low cost, locally-produced solar crop dryer, especially designed for remote rural populations – this technology is currently undergoing testing in the Flowers Bank community. The deployment of this technology will improve grain production and quality, while improving food security at the community level.

In the case of Flowers Bank, the solar dryer is being tested with cohune nuts, where drying is required to extract the kernels from the shell to facilitate oil production to make value-added products such as scented soaps and candles, cohune virgin oil for cooking, cohune meal for animal feed, and activated charcoal. The successful introduction of solar drying will provide the foundation for the introduction of other technologies and innovation to help rural communities have more secure incomes in order to achieve food security at the household level. This project is important for the targeted areas because this District is particularly vulnerable to the impacts of climate change, and traditional food systems are likely to be adversely affected.

Introduce Gasification Technology – Introduction of Bioenergy (Butane Substitution) for Commercial Crop Drying

Bioenergy has a significant greenhouse gas (GHG) mitigation potential, provided that the resources are developed sustainably and that efficient bioenergy systems are used. Certain current systems and key future options including perennial cropping systems, use of biomass residues and wastes and advanced conversion

systems are able to deliver 80 to 90 per cent emission reductions compared to the fossil energy baseline[30]. The plan is to introduce gasification technology in at least two rice factories, with one in Punta Gorda, Toledo District, in order to displace the use of costly butane, and reduce disposal problems for rice husks.

Currently, rice husks present a disposal and environmental problem for factories. The gasification system will accept the rice husks as input fuel and convert it to a gas, and the gas in turn will be used as a substitute for butane, in specially designed burners. The resulting gas is referred to as producer gas.

Expected Outcomes: Reduction in post-harvest losses; improved economics in commercial crop drying by minimizing use of butane; environmental benefits - gas from husks is carbon neutral; if the Cooperative/Rice Mill is more efficient and profitable then the members will derive more income.

Introduction of Biofuel (Diesel Substitution) Technology

The conversion of biomass of different origins, for example, agro-residues to usable energy carriers, is viable for small-scale operations of up to 50MW of power, based on the international experience. Biofuels facilities of 5-10 MW scale are within the capability of communities to feed and operate, creating and retaining wealth within the local economy. On the other hand, agro-industrial residues such as sugarcane bagasse, rice husks, maize cobs, etc., are some of the cheapest sources of biomass since they are waste products and are already available in one location; therefore, they require no production costs and minimal collection and transportation costs, especially if they are converted to biofuels, nearby. Very often the collection and transportation costs of biomass residues can determine whether the biofuels produced are cost competitive with fossil fuels or not.

Under-exploited crops such as *Leucaena L.*, *Acacia mangium*, and *Arundo Donax* can be grown on marginal lands not well suited for food crops. The ability of these crops to produce raw material for the production of biofuels means that Belize now has an additional option for generating further economic development from its land resources on lands that cannot now be sustainably used for food production. Existence of local biofuels industries creates new markets for farmers whose available lands were not suited to conventional agriculture primarily because of soil conditions, in some instances these lands have been used for pine tree production. Other lands to be utilized are in areas that are flood prone and low lying, some in the River Valley, particularly in the Toledo and Stann Creek Districts. In the north,

[30] Intergovernmental Panel on Climate Change (2011), *Special Report on Renewable Energy Sources and Climate Change Mitigation (SRREN),* Final Release, IPCC Technical Support Unit Working Group III. Edited by Edenhofer, Ottmar; PichsMadruga, Ramón; Sokona, Youba; Seyboth, Kristin; Matschoss, Patrick; Kadner, Susanne; Zwickel, Timm; Eickemeier, Patrick; Hansen, Gerrit; Schlömer, Steffen; and von Stechow, Christoph. Available at: <http://srren.ipcc-wg3.de/report/IPCC_SRREN_Full_Report>

in Belize and Orange Walk Districts, there are lands not being utilized because of water issues, i.e., not enough rainfall so agriculture is marginal. On these various lands, it is planned to conduct research using the under-exploited crops like *Arundo Donax* or wild cane, *Acacia mangium and Leucaena L.*, to determine the feasibility of using such lands for biofuels initially for power generation.

On the wetlands, e.g., in Stann Creek and Punta Gorda, where *Arundo Donax* has already established itself in significant areas, research will be conducted to determine levels of production, employment, and investment for construction of the first processing facility, with capability of producing 100 tons a day, from plant material, to produce 25 tons of biodiesel per day (equivalent to 150 barrels of petroleum oil per day) and approximately 10 tons of activated charcoal per day. The Ministry is now in the process of identifying areas and doing resource assessments. For marginal lands, it is planned to undertake research with *Acacia mangium*, and *Arundo Donax*, which has self-established in areas in Belize and Orange Walk Districts.

Expected Outcomes: Reduction in imported fuel; increased employment; enhanced production of biofuels for power generation; decreased energy costs, e.g., for people who run shrimp farms and who suffer from high fuel prices.

Introduce LED Lighting and Solar Cooling To Improve Energy Efficiency and Conservation in the Public Sector

Most government buildings are located within the Ring Road, making it conducive to undertaking a comprehensive audit of government buildings to determine the best technologies that will bring about significant reduction in electricity use in those buildings, for lighting and cooling. The introduction of LED lighting technology consumes less than 10 per cent of conventional lighting and could bring significant savings. Solar cooling systems do not require electricity to provide cooling services – cooling is the major user of electricity in government buildings, using up to 60 per cent of electricity.

4.2 Water Projects

Introduce Anaerobic Fermentation Technology - Environmentally Sound Technology to Improve Water Quality

Approximately 12 per cent of the population is connected to the sewage system, and 68 per cent have access to piped water. The three existing municipal sewerage systems serves 48,800 consumers and treats about 1,860,000 gallons of sewage per day: Belize City - 37,500 consumers and treats about 1,500,000 gallons of sewage per day; Belmopan - 7,900 consumers and treats 200,000 gallons per day; and San Pedro Town - 3,400 consumers and treats about 160,000 gallons of sewage per day[31]. The water which the Belize Water Services (BWS) draws from the Belize River to

[31] Belize Water Services, Wastewater Treatment. Available at: <http://www.bws.bz/waste-water/>

provide water for Belize City is experiencing reduced quality as a result of contamination. Management of urban sewage is a major financial and technology challenge.

The introduction of anaerobic fermentation technology is intended to significantly reduce the contamination of rivers and coastal areas caused by sewage systems, as well as produce electricity to increase the country's energy security. The plan is to first conduct feasibility studies for new facilities where existing conventional sewage projects have funding approval, e.g., in Placencia and San Pedro, and to work with private sector parties who could directly use the energy from the plant to construct a system for Belmopan. Anaerobic fermentation systems utilize a mixture of micro-organisms functionally in an oxygen-free environment to decomposing organic material into gases such as methane and hydrogen which are burned to produce energy either as heat, steam of electricity.

Introduce Water Purification Systems for Rural Schools without Potable Water

Schools without potable water in rural areas depend on water pumped from wells. The use of such water without any treatment carries risk of illness for pathogens such as *E. coli* and Coliform bacteria which get into well water as a result of soak away sanitation systems. The technology to be introduced will use photovoltaic (PV) electricity to provide the energy for treating contaminated well water to provide safe drinking water for rural schools. The technology used will be determined based on locational testing – one system will be based on the use of ultraviolet light, the other will be based on the use of electromagnetic waves – the technology behind microwave ovens.

Introduce Hygiene & Sanitation Systems with Low Water Requirements for Rural Schools

The use of unsafe water sources such as waterways, standpipes, public wells and private catchments to provide drinking water has been halved, but remains relatively high in Corozal, Orange Walk and Toledo[32]. A major cause of ground water pollution in rural communities is from basic sanitation systems with nutrient and micro-organisms that migrate into the ground water systems. The introduction of low water requirement toilets will begin providing an alternative system to the conventional.

Introduce Ocean Thermal Energy Conversion (OTEC) Technology to provide San Pedro with Electricity and Freshwater

Ocean thermal energy, which is based on converting incoming solar radiation into electricity, is continuously available in almost all ocean locations between the tropics. In this system, the tropical ocean acts as a giant solar energy collector. In addition to providing sustainable electric power, OTEC also produces two valuable

[32] *Main Results of 2010 Population & Housing Census*, 3 May 2011, Government of Belize

by-products: significant volumes of potable water, and large quantities of cold, nutrient-rich water that can be used for aquaculture. The geography and geology of San Pedro gives the island significant potential for the use of the thermal gradient between surface and 1000 meters in depth for the production of potable water as well as meeting the island's base load requirement for electricity without use of any petroleum fuels, through the use of OTEC technology. Introduction of OTEC technology will be done in cooperation with the SIDS DOCK organization.

Expected Outcomes: energy production in the form of electricity for the grid; improved fresh water quality; and improvements in coastal environmental quality, e.g., reduction in sewage related contamination of reefs. These outcomes are critical to climate change adaptation by the marine environment.

5.0 CONCLUSION

The MESTPU Strategic Plan provides direction and a planned pursuit of the vision and mission of the MESTPU for the next few years. This plan represents the direction and focus of the MESTPU from 2012 to 2017. It provides the Ministry with the ability to channel resources in a direction that yields the greatest benefit to the country. The Strategic Plan will enable the Ministry to plan and execute continuous organisational improvements and to achieve competitive advantage in order to generate sufficient revenue to support the projects and programmes.

The Strategic Plan is a dynamic document that is constantly updated and provides the Ministry with a framework that supports the economic growth and competitiveness of Belize in the global market through the promotion of energy and food security, improved access to potable water, and utilization of science and technology to advance the wellness and livelihoods of the population to lead longer, wealthier and more productive lives. The projects introduced use technologies to help boost private sector competitiveness and agricultural productivity, to providing the means to generate energy using renewable resources, to providing potable water for school children attending rural and/or remote schools. Important outcomes include poverty alleviation, increased employment, particularly among youth, women and rural communities, increased private sector competitiveness, increased performance of public utilities, and an indigenous S&T workforce that will allow Belize to be more than just a consumer of other nations' technological exports, but also to provide a means for citizens to improve their own situations and economic well-being.

A strong innovation capacity will be very difficult to achieve without a healthy, well-educated and trained workforce that is adept at absorbing new technologies, and without sufficient financing for R&D or an efficient goods market that makes it possible to take new innovations to market. Through a series of public-private sector partnerships, the Ministry will be pursuing investments in energy, water,

and science and technology to support the private sector and rural communities, including development and deployment of renewable energy technologies to displace imported fossil fuel, the establishment of a Belize Centre for Excellence in STI to provide incubation support services for start-up micro, small and medium enterprises, setting up of designated training facilities in ICT for SMEs, and investment in Marketing Facility Services to accommodate a number of public sector entities whose aim is to support efficient and sustainable market information services to enable farmers and traders to make informed decisions about what to grow, when to harvest, to which markets produce should be sent and whether or not to store it. It is important to note that entrepreneurs must be willing to capitalize on the dividends of scientific research by bringing those research dividends into commercialization.

The strategy also recognizes the major role women play in achieving food and energy security through the introduction of a Science, Technology and Innovation for Women Capacity Building Programme aimed at increasing women's involvement and input in S&T, to enhance potential, and to improve the use of technology, especially in the vital developmental areas of water resources management, food production and processing and sanitation. Farmers are also targeted with specific projects aimed at improving the efficiency of developing locally-adapted innovation, enabling technology to be distributed more effectively to local farmers, helping farmers continuously improve and make the most of sustainable agricultural practices, promoting the effective and responsible application of new technologies, and providing social and economic value to farmers and communities.

The effects of S&T on poverty and economic growth underlie their importance for development. However, achieving progress in S&T capacity depends on good policies and practices that foster the appropriate environment implemented consistently over the long-term. To facilitate the implementation of the Strategy, a number of new policies, strategies and action plans are proposed, including an energy efficiency and conservation policy; STI Policy and Action Plan; National Diversification Strategy; National ICT Policy and Strategy; e-Commerce Policy, and; a Resource Mobilization Strategy. The framework for these policies recognizes the interconnectedness of the areas upon which S&T bears particularly energy and water. The policies that affect human resources development, demand for knowledge from the private sector, public support for and management of knowledge institutions, and access to information and communication technologies (ICT) infrastructure will be coordinated and harmonized in order to create the conditions in which S&T capacity deepens and consolidates.

The Ministry will also need to quickly increase its human skills base. To do this, the MESTPU will strengthen and formalize its partnership with the University of Belize, to improve all aspects of science, technology, engineering, and mathematics

(STEM) education by increasing the number of scientists, technicians and engineers through the establishment of a Graduate Programme in Natural and Environmental Sciences. Currently, Belize offers no graduate degree program in the natural sciences. The capacity building efforts include the Geology and Petroleum Department (GPD) which has responsibility for the management of the country's hydrocarbon resources.

Finally, implementation of the MESTPU Strategy will require significant resources. The direct tools available to the government for mobilizing resources for the energy, water and S&T sectors come from among others, taxes, domestic and foreign borrowing, investment incomes, grants, disposal of assets and non-tax revenue. The stark reality in most developing countries like Belize, is that whilst there is severe budgetary pressure as a result of ever increasing demand for government expenditure, there is a limited scope for raising extra tax revenues. In light of this, the MESTPU will be developing a comprehensive strategy to mobilize additional resources that includes development of partnerships with local, national, regional and international institutions and other stakeholders.