



TRAINING MANUAL

Innovative Fiscal and Regulatory Incentives for Energy Efficiency and Renewable Energy Initiatives

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The Learning Product – Innovative Fiscal and Regulatory Incentives for Energy Efficiency and Renewable Energy Initiatives in the Caribbean

Course Description:

This course will be designed for the officers within government departments who have responsibility for guiding the country's energy policy and energy management framework. Other stakeholders also will include private sector representatives who have interest in providing energy efficiency equipment and renewable energy solutions to the market towards advancing improvements in both energy efficiency and meeting renewable energy targets.

The course will provide insight into all aspects of energy management with specific emphasis on energy efficiency as well as renewable energy. Emphasis will be placed on highlighting issues and challenges that countries face in pursuing energy efficiency and renewable energy strategies. International and regional best practices will be highlighted as a means of showcasing how various countries have overcome the barriers to advancing renewable energy targets and increasing energy efficiencies towards meeting national energy goals.

The curriculum is divided into five modules and is designed to be covered over a 3-day period. The course will be designed to ensure practical application of the learning. The course also is designed to enable the Caribbean to demonstrate leadership in energy efficiency practices and the adoption of renewable energy strategies, serving as a model for other small island developing states.

Target Group:

The target group is expected to include:

- Officers of Government ministries, departments and agencies (MDAs) and local authorities who are responsible for energy management and who have direct responsibilities for countries' national energy policy, energy efficiency strategies as well as for advancing the introduction and use of renewable energy into their countries' energy mix
- Key private sector entities who have a stake in energy efficiency or renewable energy
- Non-governmental organizations who may focus on energy management projects and who play a role in educating communities or key sections of society on the importance of energy conservation and efficiency and renewable energy

Objectives:

Upon completion of this course, participants will be able to:

Knowledge:

- Understand the importance of energy efficiency and conservation to national development

- Understand the importance of renewable energy technologies to advancing national development agendas
- Understand the core elements required to develop energy efficiency and renewable energy policies

Performance:

- Develop relevant strategies that could help countries advance their energy efficiency and renewable energy agendas
- Know how to develop national energy efficiency and renewable energy policies
- Be able to develop relevant and dynamic national strategies to overcome the barriers and challenges associated with energy efficiency and renewable energy

Attitude:

- Appreciate the importance of pursuing energy efficiency and renewable energy options to support national development

Course Modules

- Module 1: Rationale for Advancing Energy Efficiency and Renewable Energy Policies
- Module 2: Issues and Challenges Facing the Region in the Effective Introduction of Energy Efficiency and Renewable Energy Technologies
- Module 3: Removing the Barriers to Advance the Introduction of Energy Efficiency and Renewable Energy Strategies and Technologies
- Module 4: Developing Energy Efficiency and Renewable Energy Policies and Action Plans – Advancing the EE and RE Agenda of Countries
- Module 5: Train the Trainer

Proposed Curriculum

The training will deliver the five course modules listed above and will include a range of topics as presented below. Note that the topics at this point do not represent an exhaustive list.

Module 1: Rationale for Advancing Energy Efficiency and Renewable Energy Policies

- Energy Basics
- Overview of the energy sector in the Caribbean
- Overview of the CARICOM Energy Policy and some select country national policies (with emphasis on energy efficiency and renewable energy)
- Global trends in energy efficiency
- Global trends in renewable energy – including new and emerging technologies
- Drivers for increasing energy efficiency (economic, social and environmental)

- Drivers for advancing renewable energy (economic, social and environmental)
- Benefits of promoting energy efficiency
- Benefits of establishing renewable energy sectors within countries
- Measuring Energy Usage
- Conducting an Energy Audit

Module 2: Issues and Challenges Facing the Region in the Effective Introduction of Energy Efficiency and Renewable Energy Technologies

- Renewable Energy Use in the Caribbean
- Overview of fiscal and regulatory barriers to implementing energy efficiency measures and renewable energy technologies
- Requirements for Deploying RE Technologies in the Region
- Guidelines towards improving energy conservation and efficiency
- Presentation by countries based on country studies – Belize, Curaçao, Jamaica, Guyana
- Case Studies

Module 3 – Removing the Barriers to Advance the Introduction of Energy Efficiency and Renewable Energy Strategies and Technologies

- Removing the Barriers – Towards Advancing the Renewable Energy Sector – Policies and Strategies to Promote Renewable Energy Development and Deployment
- Power Sector Restructuring Policies that can Influence Renewable Energy Development
- Distributed Generation Policies that can Influence Renewable Energy Development

Module 4: Developing Energy Efficiency and Renewable Energy Policies and Action Plans – Advancing the EE and RE Agenda of Countries

- Key elements of national renewable energy policies
- Key elements of national energy efficiency policies
- Renewable energy indicators and targets
- Energy efficiency indicators and targets
- Developing individual country policies
- Developing individual country action plans

Module 5: Train the Trainer

- Tips to Implement the Course as a Train-the-Trainer Model
- Facilitation Skills
- Training Methods and Materials

Module 1: Rationale for Advancing Energy Efficiency and Renewable Energy Policies

Energy Basics

Defining Energy

Energy is simply defined as the ability to do work. Energy is the engine for the social and economic development in the past, present and future. It is the basis for progress and prosperity of nations and societies.

Demand for energy increases tremendously in order to fulfill technological needs and the development of standards of living in a world with ever increasing individual demands for energy. Meanwhile, conventional energy sources are being depleted; and the development of new and renewable sources of energy has not yet reached an economically feasible level that permits their widespread use as alternative sources.

Consequently, the need has arisen to plan and analyze energy policies within the framework of a country's socio-economic development process – thus the importance of energy efficiency and conservation.

Forms and Sources of Energy

Energy is divided into two broad categories. Kinetic Energy (energy doing work) and Potential Energy (stored energy). There are various forms of energy, mainly:

- Heat – also referred to as thermal energy
- Light – also referred to as radiant energy
- Mechanical
- Electrical
- Chemical
- Nuclear

All forms of energy exist as either renewable or non-renewable energy sources.

Sources of energy fall into two categories, namely:

- Conventional Energy Sources – also referred to as non-renewable energy
- Environmentally Preferable Sources – also referred to as renewable energy sources

Conventional Energy Sources

Most conventional energy sources are also referred to as non-renewable forms of energy as they are not considered to be sustainable energy sources, that is, there exists a limit to these

resources – these resources are exhaustible and can eventually be depleted. Such sources of energy also tend to cause serious environmental impacts as well as pose risks to human health.

Conventional energy sources would not be economically competitive if they were to be sold at their full costs, which would include damage to the environment and human health, security risks and long-term storage costs. Though these costs are not yet reflected in energy bills, they are nonetheless borne by society as they are paid for through higher health insurance premiums and long-term depletion of resources.

Sources of conventional energy include:

- Coal, Oil and Natural Gas – commonly referred to as fossil fuels. Fossil fuels are formed over millions of years by heat action from the earth’s core and pressure from rock and soil on the decayed remains of prehistoric plants and animals.
- Nuclear – derived from splitting uranium or plutonium atoms.
- Large hydro-power facilities

Table 1: Environmental Impacts of Some Major Fossil Fuel Industries

Sector	Air	Water	Soil/Land
Coal mining and production	<p>Emissions of dust from extraction, storage and transport of coal.</p> <p>Emission of carbon and sulphur dioxide from burning slag heaps.</p> <p>Methane emissions from underground formations.</p> <p>Risk of explosions and fires.</p>	<p>Contamination of surface water and ground water by highly saline or acidic mine water.</p>	<p>Major surface disturbance and erosion.</p> <p>The subsiding of the grounds located above the mines.</p> <p>Land degradation as a result of large slag heaps.</p>
Oil Refineries	<p>Emissions of sulphur dioxide, nitrogen oxides, hydrogen sulphide, hydrocarbons, carbon monoxide, carbon dioxide, particulate matter, other toxic</p>	<p>Use of large quantities of water for cooling.</p> <p>Emissions of hydrocarbons, caustics, oil, chromium and effluent from gas rubbers.</p>	<p>Hazardous waste sludges from effluent treatment such as tars, and spent catalysts</p>

Sector	Air	Water	Soil/Land
	<p>organic compounds and foul odours.</p> <p>Risk of explosions and fires.</p>		

Environmentally Sound Sources of Energy

Environmentally preferable energy sources are usually referred to as renewable forms of energy as they are considered to be sustainable energy sources that cause relatively few environmental impacts and pose a low risk to human health. Environmentally preferable energy sources include:

- Solar
- Wind
- Low impact hydropower
- Geothermal
- Biomass

Solar

The sun is ultimately the source of all energy, except geothermal and nuclear. The sun provides energy to the planet and to the food we eat.

For example, solar energy derived from the sun’s radiation that is used to produce photovoltaic systems (PV) change sunlight directly into electricity and are commonly used in areas where extending electrical wires is not economically viable. These areas may include:

- Rural homes
- Remote research stations
- Free way call boxes
- Solar powered instruments – for example, calculators

The price of PV cells though once very high has decreased steadily over the last 25 years increasing the potential for expansion. Solar thermal systems use the sun’s energy to heat a fluid such as water for use or to produce steam which then turns a turbine and generator for electricity production.

The Importance of Energy to National Development

Energy is particularly important to a country’s economic growth and development, as it supports such diverse economic activities as transportation, agriculture, and manufacturing. It is also a major contributor to health and well being, as it provides services such as heating, lighting, and refrigeration.

Energy has become just as important to mankind as water and air. The energy sector is particularly important to a country's economic growth and development. Energy is important, as power is needed for diverse economic activities such as, commercial use, residential use, transportation, agriculture and manufacturing.

Energy management, through conservation and improved energy efficiency are considered to provide the greatest scope for reducing the requirements for energy and its impacts on the environment.

Table 2: Key Energy Terms

Key Term	Definition
Energy Security	<p>Energy security is an umbrella term that covers many concerns linking energy, economic growth and political power . The energy security perspective varies depending upon one's position in the value chain. Consumers and energy-intensive industries desire reasonably-priced energy on demand and worry about disruptions. Major oil producing countries consider security of revenue and of demand to be integral parts of any energy security discussion.</p> <p>Oil and gas companies consider access to new reserves, ability to develop new infrastructure, and stable investment regimes to be critical to ensuring energy security. Developing countries are concerned about the ability to pay for resources to drive their economies and fear balance of payment shocks. Power companies are concerned with the integrity of the entire network with emphasis on safety and reliability.</p> <p>Policymakers focus on the risks of supply disruption and the security of infrastructure due to terrorism, war or natural disaster. They also consider the volumes of security margins – the amount of excess capacity, strategic reserves, and infrastructure redundancy. Throughout the value chain, prices and supply diversity are critical components of energy security.</p>
Energy Conservation	<p>Energy conservation is the saving of energy by any means including energy efficiency – it could also entail being more frugal – for example, turning lights off when not in use or providing information of ways to reduce energy. Some of the common meanings associated with energy conservation include:</p> <ul style="list-style-type: none"> • Using less energy in a particular application

Key Term	Definition
	<ul style="list-style-type: none"> • Finding ways to purchase particular forms of energy at lower cost. This is usually accomplished by negotiating with energy providers or by using energy under less costly conditions. (Paradoxically, the latter method may increase energy consumption considerably.) • Shifting to different energy sources of lower price • Using "free" or "renewable" energy sources • Shifting to energy sources that are considered to be more desirable, or less undesirable, with regard to non-efficiency concerns such as availability and pollution. Such shifts typically involve serious compromises. • Conserving water and materials, as well as energy sources
Energy Efficiency	<p>Energy efficiency refers to the efficient conversion and use of energy and is a measure of the productivity provided per unit of energy consumed. It employs devices and practices, which result in less energy being used for the same task and function. An example would be a fluorescent bulb as opposed to an incandescent bulb. Other ways in which energy efficiency can be enhanced are through retrofits and capital improvements.</p> <p>Technological advances have allowed for increases in energy efficiency, reducing energy demand while increasing economic activity. Studies have indicated that energy savings of 20 – 30% could be obtained globally over the next 3 decades through improvements in energy using technologies and energy supply systems. Furthermore, technological advances will allow companies to enhance profits as a result of the reduction in energy use and materials. Direct costs will be minimized through less resource inputs and lower disposal costs. Resource efficiency can enhance productivity, streamline production and improve workplace conditions.</p>
Energy Management	<p>Energy Management is defined as the steps taken to minimize usage and wastage of energy.</p> <p>An Energy Management Programme is the process (a coordinated set of activities) for implementing measures to ensure responsible energy use through:</p>

Key Term	Definition
	<ul style="list-style-type: none"> • Policy setting • Energy auditing • Behavioural change through awareness campaigns and training • Identifying and implementing technical and procedural solutions • Planning for future facilities and services • Periodic Review for continuous improvement <p>An Energy Management System (EMS) is a control system (often computerized) designed to regulate the energy consumption of a building by controlling the operation of energy consuming equipment, appliances and systems, such as for ventilation and air conditioning, lighting and water heating.</p>

Other Terms Related to Energy (Place in an appendix or Glossary of Key Energy Terms)

Acid Rain - This occurs when oxides of nitrogen, sulphur and carbon react with rain water

Air Pollution - The presence of contaminants or pollutants in the air that do not disperse properly and interfere with human health or welfare, or produce other harmful environmental effects, such as global warming and acid rain

Alternative Energy - Also referred to as environmentally preferable sources of energy and may include low impact hydro power, geothermal, biomass, solar and wind

Ambient Temperature - Refers to air temperature. It usually means the outside air temperature

Ballast - A device that provides starting voltage and limits the current during normal operation in electrical discharge lamps (such as fluorescent lamps). There are several types of ballasts, they may be electromagnetic or electronic, attached directly to the lamp or separately wired, disposable or reusable. Some have features that improve power factor, reduce harmonic distortions, suppress radio interference, and even provide constant illumination during brownouts

Biomass - Energy that is stored in plants and other organic matter .e.g. Wood and forest residues, animal manure and waste, grains and cane trash

Cathode Ray Tube (CRT) - A CRT is a specialized vacuum tube in which images are produced when an electron beam strikes a phosphorescent surface. The CRT in a computer display for example is similar to the "picture tube" in a television receiver

Compact Fluorescent Lamp (CFL) - A CFL is a type of fluorescent lamp whose visible light is produced by a mixture of three phosphors on the inside of the lamp. They give off light when exposed to ultraviolet radiation released by mercury atoms as they are bombarded by electrons. The flow of electrons is produced by an arc between two electrodes at the ends of the tube. An essential part of any compact fluorescent system is the ballast. The ballast provides the high initial voltage required to create the starting arc, and then limits current to prevent the lamp from self-destructing

Luminous Efficacy - The ratio of light from a lamp to the electrical power consumed, including ballast losses, expressed as lumens per watt

Energy Consumption - The amount of energy used. The term excludes electrical generation and distribution losses

Energy Conservation Technology - Equipment that produce the same level of end-use services (lighting and heating) with less energy. They include technologies such as fuel cells, energy-efficient appliances, lighting, and vehicles

Energy Resources - Anything that can be used as a source of energy

Fluorescent Lamp - A tubular electric lamp that is coated on its inner surface with phosphor. It contains mercury vapour that provides ultraviolet light which causes the phosphor to emit visible light. Examples include, compact fluorescent bulbs and regular fluorescent tubes

Geothermal Energy - Natural heat from within the earth which can be extracted from reservoirs, for example, geysers, molten rock and steam spouts

Global Warming - Phenomenon that occurs as a result of the build up of emissions of carbon dioxide and other greenhouse gases which causes an increase in global temperatures. It has been identified by many scientists as a major global environmental threat

Greenhouse Effect - The Greenhouse effect is a natural phenomenon without which the earth's surface would be too cold (approximately 34 degrees Celsius colder than it is today) to enable habitation as we currently know it. Most of the sun's energy, which is mainly short wavelength radiation, passes through the atmosphere and warms the earth's surface. Heat energy, in the form of long wavelength infrared radiation, is in turn released back into the atmosphere. While some of this heat escapes into space, most of it is absorbed or held by carbon dioxide, water vapour and other greenhouse gases that exist in low concentrations in the atmosphere.

By absorbing heat, these trace gases become warmer, and heat is sent out from the atmosphere in all directions. Some go back to earth to be stored whilst the rest passes into

space. This process keeps the earth habitable. The composition of the atmosphere is however changing as the amount of carbon dioxide, methane, nitrous oxide and chlorofluorocarbons (CFCs) it contains is increasing. As a result of this, the increase in the greenhouse gases will cause less heat to be lost to space and instead be reflected back to earth causing an increase in temperature.

Greenhouse Gases - Carbon dioxide, nitrous oxide, methane, low-level ozone, water vapour and chlorofluorocarbons (CFCs). When these gases accumulate in the atmosphere they contribute to the greenhouse effect

High-Intensity Discharge (HID) Lamps - HID lamps use an electric arc to produce intense light. They also require ballasts, and they take a few seconds to produce light when first turned on because the ballast needs time to establish the electric arc. They are commonly used for outdoor lighting and in large indoor arenas. The three most common types of HID lamps are mercury vapor, metal halide, and high-pressure sodium

Hydropower - Power obtained from the movement of masses of water. Hydropower plants convert the energy contained in flowing water, like rivers and streams, into electricity

Incandescent Light - Incandescent light is produced by a tiny coil of tungsten wire that glows when it is heated by an electrical current. The three most common types of incandescent lights are standard incandescent, tungsten halogen, and reflector lamps.

Kilowatt (kW) - A unit of measure of the amount of power needed to operate equipment, equivalent to one thousand (1,000) watts

Kilowatt-Hour (kWh) - A measure of electrical energy equivalent to power consumption of 1000 watts for 1 hour. It is the most commonly used unit of measure indicating the amount of electricity consumed over time

Leaking Electricity - The energy drawn by electronic equipment that consume power [e.g. TVs, VCRs, telephone answering machines, cordless phones etc.] when they are turned off or in stand-by mode, while connected to a source of supply.

Liquid Crystal Display (LCD) - LCD is the technology used for displays in calculators, digital watches, smaller computers, portable devices including Mobile Telecoms (Telecommunication) pagers, phones and other instrumentation monitors. Like light-emitting diode and gas-plasma technologies, LCDs allow displays to be much thinner than cathode ray tube (CRT) technology.

Lumen - A measurement of light output from a lamp. For example, a 100-watt incandescent lamp produces about 1750 lumens.

Occupancy Sensor - A control device that senses movement in a given space, used to turn lights on or off.

Renewable Energy - Resources that are inexhaustible or can be regenerated over time. These include solar, wind, geothermal, hydropower and biomass. Renewable resources also include some experimental or less-developed sources such as tidal power, sea currents and ocean thermal gradients.

Retrofit - To modify (machinery, vehicles or equipment) so as to incorporate changes and developments after manufacture

Smog - A fog made heavier and darker by smoke and chemical fumes; also a photochemical haze caused by the action of solar ultraviolet radiation on atmosphere polluted with hydrocarbons and oxides of nitrogen from automobile exhaust

Solar Power - Electricity generated from solar radiation

Thermostat - An automatic control device designed to be responsive to temperature and typically used to maintain set temperatures by cycling the HVAC system

Watt - A unit of measure of electric power at a point in time, as capacity or demand

Overview of the Energy Sector in the Caribbean¹

Caribbean countries depend heavily on *fossil fuels* to meet their energy demand. Trinidad and Tobago is the major producer and only net exporter of petroleum, petroleum related products and natural gas. Suriname exports some amount of crude oil but imports LPG, gasoline and diesel oil. Suriname, Barbados and Belize are producers of crude oil to supply some of their domestic needs but overall are net importers. Barbados produces natural gas for sale on the domestic market to residential, commercial and special users.

Dependence on imported fossil fuels within CARICOM has created significant macro-economic challenges for the fuel importing countries. The value of energy imports compared to total imports in the importing Member States have progressively increased over the years. This scenario has a deleterious impact on macroeconomic sustainability. Petroleum derivative imports account for between 40% and 60% of total export earnings for countries such as Jamaica and Guyana with a larger industrial base. For the tourism / service oriented Member States such as Belize, Grenada, Saint Vincent and the Grenadines and Barbados, petroleum imports range from 13% to 30% of export earnings.

Primary consumption of petroleum products within CARICOM in 2007 totaled 220.46 million barrels of oil (boe) equivalent with Trinidad and Tobago accounting for 148.96 million boe. Total primary energy consumption per capita in CARICOM for 2007 was 319.38 boe with Trinidad and Tobago recording 120.83 boe of the total. Consumption of petroleum products within CARICOM, totaled 224,000 boepd with Jamaica leading at 77,000 boepd, followed by Trinidad and Tobago's 43,000 boepd and the Bahamas 36,000 boepd. Distillate and residual fuel oil accounted for 57% of all the petroleum products consumed in 14 of the 15 CARICOM Member States in 2008. These fuel oils are used mainly in power plants for electricity generation. The other major categories of petroleum products consumed in 2008 were motor gasoline and other petroleum products that accounted for 16% and 13% respectively.

Electricity consumption increased in all CARICOM Member States over the period 1998 – 2007, except in Haiti where it remained relatively stable. The contribution of renewable energy in CARICOM is miniscule compared to the vast potential available. Renewable energy contributed about 9% to the total primary energy consumed between 1998 to 2007, however there has been a gradual decline over the subsequent years as the share of renewable energies for electricity generation declined, while the overall output grew in this period. Belize,

¹ Taken from the CARICOM Energy Policy 2013

Jamaica and Suriname recorded significant increases in renewable energy electricity mainly from hydropower. Wind powered generation was added in Jamaica and St. Kitts and Nevis and pockets of biomass based energy in other countries. Electricity consumption for heating water in Barbados decreased due to increased penetration in the utilization of solar water.

The **electricity market** is characterized by a mix of state-owned and private or partially private utilities. All of the utilities within CARICOM are vertically integrated except for Trinidad and Tobago where generation is unbundled from transmission and distribution. Investment plans for generation and transmission and distribution, as well as performance standards for various areas of service, are lacking in some of the utilities in smaller Member States. Table 1 presents a snap shot of the electricity market in CARICOM Member States:

Table 3: Snapshot of the electricity market in CARICOM Member States

Country	Main Utilities	Peak Demand ⁶	System Energy losses (%)	Generation Mix
Antigua and Barbuda	Antigua Public Utilities Authority	51 MW in 2009	23% in 2009	Diesel engines
Bahamas	Bahamas Electricity Corporation – state- owned	308 MW in 2008	15%	Diesel engines and gas turbine
	Grand Bahama Power Company – privately owned		8.9%	Steam turbines and diesel engines
Barbados	Barbados Power & Light – privately owned	166 MW in 2009	6.6% in 2009	Residual fuel oil and diesel for steam and gas turbines
Belize	Belize Electricity Limited – nationalised by the Government in June 2011	76.2 MW in 2009	11.7% in 2009	HFO, hydro, bagasse, gas turbine and diesel
Dominica	Dominica Electricity Services Ltd. DOMLEC – privately owned	17.17 MW in 2011	8.6% in 2011	Diesel engines and hydro

Country	Main Utilities	Peak Demand ⁶	System Energy losses (%)	Generation Mix
Grenada	Grenada Electricity Services Ltd. GRENLEC – privately owned	30.5 MW in 2009	9.2% in 2009	Diesel engines
Guyana	Guyana Power & Light Inc. – state-owned	94 MW in 2009	34.2% in 2008	HFO, diesel and bagasse
Haiti	Electricité d’Haiti (EdH) – state-owned	latent demand: est. 550 MW	about 50%	Diesel engines, hydro
Jamaica	Jamaica Public Service Company - privately owned	644 MW in 2009	24% in 2009	Wind, hydro, steam turbines, diesel, gas turbines, combined cycle
Montserrat	Montserrat Utilities Ltd.	about 2 MW		Diesel engines
St. Kitts and Nevis	St. Kitts Electricity Department (SKED) – state-owned	30 MW in 2008	15% est. in 2005	Diesel engines
	Nevis Electricity Company Ltd. (NEVLEC) – state-owned	9 MW in 2008	20.3% in 2008	Diesel engines, wind
Saint Lucia	Saint Lucia Electricity Services Ltd. (LUCELEC) – private/public enterprise	55.9 MW in 2009	9.3% in 2009	Diesel engines
St. Vincent and the Grenadines	St. Vincent Electricity Services Ltd. (VINLEC) – state-owned	24.5 MW in 2008	8.3% in 2008	Diesel engines and hydro
Suriname	Energy Companies of Suriname (EBS) through its subsidiary Electricity Company of Paramaribo (EPAR) -	145 MW in 2009 (total generating capacity is 408 MW)	9.5% in 2008	Hydro, HFO, and diesel

Country	Main Utilities	Peak Demand ⁶	System Energy losses (%)	Generation Mix
Trinidad & Tobago	Trinidad & Tobago Electricity Commission - state-owned	1,182 MW in 2009	9.6% in 2009	Natural gas
	PowerGen established in 1994 - private/public enterprise			

Barbados, Belize, Dominica, Guyana, Jamaica and Trinidad and Tobago have independent statutory **regulatory authorities** for the electricity sector. The Bahamas has an autonomous regulatory authority; however its jurisdiction has not been extended to the electricity sector. Saint Lucia has expressed intention to set up a regulatory commission in its National Energy Policy of 2010. A World Bank Study in 2006 - 2007 recommended the creation of sub-regional regulatory authority proposed as the Eastern Caribbean Electricity Regulatory Authority (ECERA). Once established, ECERA could monitor and regulate the electricity sector in the OECS to optimize cost and technical resources. OECS Member States confirmed their commitment to set up ECERA at the 49th meeting of the OECS Authority in Tortola, in May 2009. ECERA will be located in Saint Lucia in keeping with the agreed proposal. The first phase of the ECERA programme has been launched with Grenada and Saint Lucia. Other OECS Member States have expressed interest in joining ECERA at a later date.

After Trinidad and Tobago, Suriname is the next largest oil producer within CARICOM. Barbados is also exploiting relatively small quantities of petroleum, but closed its oil refinery in 1998 and has since been sending its oil to Trinidad and Tobago for processing. At present refinery capacity exists only in Suriname, Jamaica and Trinidad and Tobago with total capacity in 2009 of 211,000 boepd, with Trinidad and Tobago accounting for three quarters of this amount. The following table shows the capacity in the three CARICOM Member States during the period 2000 to 2009.

Table 2: Crude Oil Distillation Capacity (thousand barrels per day).

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Suriname	7	7	7	7	7	7	7	7	7	7
Jamaica	34.2	34.2	34.2	34.2	36	36	36	36	36	36

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Trinidad and Tobago	160	160	160	160	165	165	175	168	168	168
Total	201.2	201.2	201.2	201.2	208	208	218	211	211	211

With respect to **exploration and production**, Trinidad and Tobago accounts for 88% of crude oil production in the Region and 99% of the natural gas production in both the onshore and offshore environments. Trinidad and Tobago is the largest supplier of LNG to the United States (US), accounting for 75% of the US total net imports in 2008. However, over the years LNG producers in Trinidad and Tobago have diverted suppliers to markets other than the US where higher prices are obtained. Jamaica has been searching for hydrocarbons since 1955 but without success. In a new attempt to explore oil and gas potentials, nineteen (19) offshore and four (4) onshore blocks were offered in the 2010 bid round (third bid round in six years) with closure date in March 2011. Guyana remains optimistic about the prospects of discovering hydrocarbons in commercial quantities despite decades of search not yielding positive results.

Economic, Social and Environmental Issues related to Energy Use and Consumption

Energy Production and Use – Economic Issues

Although there are many economic benefits from modern energy service, there are also many costs (both direct and indirect) attached to the use of fossil fuels and some biomass as sources of fuel, including:

- Direct costs (reflected in the price) and its effect on a country's balance of payments and foreign exchange reserves
- Indirect costs, related to air pollution, water pollution, and global warming

Direct Costs

Direct costs related to energy use include the cost of oil imports for non oil-producing nations and the impact these costs have on foreign exchange reserves.

Oil-importing countries spend large portions of their foreign exchange earnings each year to acquire energy and are vulnerable to price and supply disruptions. The spot price for crude oil, has been and continues to be variable.

The foreign exchange required for fossil fuel imports has been a heavy burden on the balance of trade of many oil-importing developing nations. Oil imports tend to account for a significant proportion of total imports in many developing countries, and since oil consumption is deeply rooted in the energy systems of many oil-importing countries, any increase in oil prices leads to a significant increase in the total costs of imports. In the absence of an equivalent increase in exports, trade balances deteriorate sharply. In most situations, governments in developing

countries finance the resulting deficit on the balance of trade either by borrowing, or utilizing foreign exchange reserves.

Indirect Costs

Not all the costs of energy production and consumption are readily apparent. The production of energy from fossil fuels has significant economic impacts that are not reflected in the price of energy itself. The most direct impact of higher fossil fuel use could be an increase in air pollution levels, especially in urban areas. The generation of energy from fossil fuels produces emissions of sulphur dioxide, nitrogen dioxide, lead, mercury, suspended particulate matter, and fine airborne particles, resulting in the deterioration of air quality. Air pollution from burning fossil fuels contributes to:

- Illness, which results in increased health care costs
- Acid rain, which causes damage to crops, forests, lakes and buildings

Human Health Effects

Every year, an estimated 3 million people worldwide die or suffer serious health effects as a result of air pollution. Some of these health effects include respiratory diseases, such as asthma, chronic obstructive pulmonary disease, cardiovascular disease, and cancer of the lung. Many studies consistently show the direct link between mortality rates and daily ambient concentrations of suspended particulate matter. Around 30-40 percent of cases of asthma and 20-30 percent of all respiratory diseases may be linked to air pollution in some populations.

Damage from Acid Rain

The gaseous pollutants emitted from the combustion of fossil fuels can contribute to acid rain. Acid rain is formed when oxides of nitrogen, sulphur, and carbon react with rain. Acid rain kills aquatic life, trees, crops and other vegetation, damages buildings and monuments, corrodes copper and lead piping, damages such man-made things as automobiles, reduces soil fertility, and can cause toxic metals to leach into underground drinking water sources.

The acid in acid rain comes from two kinds of air pollutants – sulphur dioxide and nitrogen oxides. These are emitted primarily from utility and smelter “smokestacks” and automobile, truck, and bus exhausts, but they also come from burning wood. Fossil fuels contribute to approximately half of the emissions of sulphur dioxide. Other components of acid rain, nitric oxide and nitric dioxide, are emitted mainly from power stations and exhaust fumes.

Acid pollution contributes to acid haze, increases the corrosive effect of rainfall on buildings and structures and makes the lands and waterways that receive it less productive. Acid pollution also reduces food production and timber harvests by impairing plants’ photosynthesis.

The Economic Costs of Global Warming

Of the gases emitted when fossil fuels are burned, one of the most significant is carbon dioxide, a gas that traps heat in the earth’s atmosphere. Over the last 150 years, the use of fossil fuels

have resulted in more than a 25 percent increase in the amount of carbon dioxide in our atmosphere. Fossil fuels are also implicated in increased levels of atmospheric methane and nitrous oxide, although they are not the major source of these gases. As early as 1896 scientists suggested that burning fossil fuels might change the composition of the atmosphere and that an increase in global average temperature might result. This increase in the average temperature of the atmosphere, oceans, and landmasses of Earth due to the emission of “greenhouse gases” has been termed enhanced global warming.

Greenhouse gases are primarily produced from burning fossil fuels for energy production, manufacturing, transportation, and other uses. About 82 percent of all manmade greenhouse gases are in the form of carbon dioxide that is created by burning fuels to generate electricity and power vehicles. Energy production is the single largest contributor to global warming.

It is theorised that global warming will lead to potentially serious environmental and economic consequences including:

- More extreme weather events
- Dislocation of agricultural and commercial activities
- Expansion of desert regions (desertification)
- Rise in sea levels, especially in small island developing states (SIDS)
- Damage to natural habitats and ecosystems

It has been estimated by the UNFCCC that the loss of land, damage to fisheries, losses of agricultural productivity and water supplies could cost the world more than US\$304.2 billion per year. The potential impacts of global warming on agriculture, property values and insurance, and the tourism industry, are discussed below.

Agriculture

Global warming has the potential to have great effects on crops and weather conditions around the world. If global warming trends continue, high temperatures everywhere may reduce agricultural productivity around the world. Some of the potential impacts of global warming on agriculture include:

- Flooding of farmland and increased sodium levels of coastal soil due to sea level rise
- Disease infestation and crop failure due to extreme weather events, such as hurricanes and droughts
- Drying of soil due to higher air temperatures

Insurance and Property Damage

Global warming also contributes to a rise in sea levels and could also result in an increase in the intensity of hurricanes by over 50 percent. With a large number of the world’s cities in coastal areas, this is a significant problem. Buildings and roads close to the water could be flooded and they may suffer damage from hurricanes and tropical storms. Property insurers are predicting that worsening storms caused by global warming could eventually bankrupt the insurance

industry. Insurance companies are now trying to form strategic alliances, and pool resources which could cover severe economic loss from global warming.

Tourism

In many island states, tourist beaches, cultural and historic sites, fishing centres and other areas of special value may become susceptible to the effects of global warming. The cost of protecting the land from the sea and preventing constant erosion would be enormous. Global warming – and the resultant rise in sea level – would affect tourism both directly and indirectly in the following ways:

- Loss of beaches to erosion and inundation
- Salinisation of freshwater aquifers
- Increasing stress on ecosystems
- Damage to infrastructure from tropical and extra-tropical storms
- An overall loss of amenities, which may jeopardise the viability and threaten the long-term sustainability of this important industry

Energy Production and Use – Social Issues

Poverty

Access to electricity services, stimulate and promote development through improvements in health, education, and by providing opportunities for entrepreneurship. Yet it is estimated that 1.7 billion people – 28 percent of the world's population – lack access to electricity. In addition, poor people often spend long hours gathering fuel and pay higher unit prices for energy, while electricity subsidies favour urban elites.

The oil crises in the early 1970s left many developing countries with huge debt burdens. Heavily indebted countries are often caught in a downward spiral of debt service that diverts resources from economic development; oftentimes further increasing poverty. Large debt service payments mean that vital social services must be sacrificed in order to meet these payments.

The debt crisis exacts an enormous toll on the environment, as natural resources are pillaged in return for foreign exchange with which to pay back foreign creditors. Governments cut back expenditure on social services, healthcare, environmental conservation, employment and other programmes. In Africa, for example, some countries spend 4 times as much on debt repayments than they do on healthcare.

Global warming would affect the poor much more than any other socio-economic sector of the economy. This is because this sector of the society is less able to adapt to changes that could potentially affect their supply of food and water. Furthermore, when developing countries face natural disasters, the cost of rebuilding becomes even more of an issue as these countries are already heavily burdened with debt. These countries still have to continue to pay existing debt

payments, as well as make arrangements to service new debt accrued from the natural disaster.

Health

Energy use affects human health by contributing to air pollution, water pollution, land pollution, and global warming.

Air Pollution

Air pollutants that are produced by fossil fuel combustion include such gases as carbon monoxide, nitrogen oxides, sulphur oxides, and hydrocarbons etc. The most important effects of air pollution are those on human health. Air pollutants enter the body primarily through the respiratory system and less through the skin. Air containing gaseous pollutants enter the nose and reach alveoli in the lungs after passing through the larynx, trachea and left and right bronchi. Particles enter further into the lung depending on their size. Large particles are trapped in the nostril by the cilia, leading to the lungs. Only particles, smaller than 10µm reach the inner regions of the lungs (bronchioles and alveoli). Table 3 outlines the impact that air pollutants can have on human health.

Global Warming and Human Health

Global warming will have a variety of other effects on health.

- The redistribution of precipitation would markedly increase the number of people living in regions under extreme water stress
- The geographical range of temperature-sensitive tropical diseases, such as malaria and dengue fever, would expand as a warming climate will change the zone of risk for insect borne diseases
- An increase in heat waves, more people will suffer from heatstroke, heart attacks, and other ailments aggravated by the heat. In July 1995, a heat wave killed more than 700 people in the Chicago area alone

Population Displacement

Although not significant contributors to global warming, small island states are considered to be as much as two times more vulnerable than large continental landmasses to the effects of global warming due to rising sea levels. Today, 50-70 percent of the global population live in coastal areas. Eventually, the rising waters could take away land inhabited by people, forcing them to move. These conditions could increase environmental refugees and international economic migration. Population displacement due to environmental degradation has significant economic, sociocultural, and political consequences. Currently, developed nations pay US\$8 billion each year to accommodate refugees, one seventh of the foreign aid supplied to developing nations.

Table 5: Health Impacts Associated with Air Pollutants

AIR POLLUTANTS	IMPACTS ON HUMAN HEALTH
<p>Carbon Monoxide - enters the atmosphere mainly from vehicle emissions. It is a colourless, odourless gas produced by incomplete burning of carbon in fuels. It is also produced from the combustion of natural and synthetic products such as cigarettes.</p> <p>Carbon monoxide can be effectively eliminated by the use of catalytic converters in cars.</p>	<p>This colourless, odourless gas combines with haemoglobin faster than oxygen to inhibit the supply of oxygen to the blood. This can result in headaches and dizziness.</p> <p>Very high concentrations can lead to death.</p>
<p>Particulate Matter - can be defined as visible smoke consisting of small solid particles such as airborne dust, dirt, soot, smoke and liquid droplets that are directly emitted into air.</p> <p>Chemical components of SPM include lead, nickel, arsenic and those present in diesel exhaust.</p>	<p>High levels of suspended particulate matter can increase the risk of serious respiratory disorders and cancers. They affect the respiratory system by bypassing the respiratory system's own mucus-filtering process to penetrate the lungs. Particulate matter may inhibit the removal of harmful substances in the mucus flow causing such illnesses as bronchitis.</p>
<p>Hydrocarbons or Volatile Organic Compounds (VOCs)</p>	<p>VOCs cause health problems such as eye and throat irritation. In the long run, some of them are suspected to cause damage to the liver.</p> <p>Some hydrocarbons can be carcinogenic.</p>
<p>Nitrogen Oxides –react with VOCs to produce ozone and acidic precipitation. These compounds cause damage in both the rural and urban environments by accelerating the corrosion of metal objects such as statues and increasing acidity levels in rivers and streams.</p>	<p>Nitrogen dioxide can irritate the lungs and lower resistance to respiratory infections, such as influenza, cause bronchitis and pneumonia, as well as lung tissue damage. Continued or frequent exposure to concentrations that are much higher than those found in the ambient air may cause increased incidence of acute respiratory illnesses in children.</p>
<p>Sulphur oxides</p>	<p>Exposure to high concentrations of sulphur oxides can:</p> <ul style="list-style-type: none"> • Affect breathing, respiratory illnesses, alterations in pulmonary defences • Aggravate existing cardiovascular disease <p>Children, the elderly and persons with asthma, cardiovascular disease or chronic lung disease such as bronchitis, are more susceptible to adverse</p>

	health effects associated with exposure to sulphur oxides.
<p>Lead –Historically, lead emissions primarily came from automobiles using leaded gasoline. High levels of lead, primarily from vehicle emissions, have been identified as the greatest environmental danger in a number of large cities in the developing world. In many parts of the world emissions of lead have dropped significantly because of the increased use of unleaded gasoline in catalyst-equipped cars and the reduced lead content in leaded gasoline.</p> <p>Lead can enter the diet through several channels, for example, through dust in the air. Exposure to lead can also come through other pathways such as the ingestion of water tainted with lead or particles such as paint chips.</p> <p>Absorption of lead into the body has a “half life” of 20 years.</p>	<p>Even at relatively low concentration levels, serious health effects associated with exposure to lead can be observed. Lead components can damage the kidneys, liver, reproductive system, digestive system, blood formation, basic cellular processes and brain function.</p> <p><i>Some estimates for Bangkok show that the average child has lost four or more IQ points by the age of seven because of elevated exposure to lead. In adults the consequences include risks of higher blood pressure, heart attacks, strokes and death.</i></p> <p><i>In Mexico City, lead exposure contributes approximately to 20% of the incidence of hypertension. In addition, a 1998 study showed that where ambient lead levels were high because of the use of leaded gasoline, more than a quarter of newborns had levels of lead in their blood high enough to impair neurological and motor-physical development.</i></p>
<p>Benzene – 1-2% of gasoline by weight and given off as a vapour by hot engines and fuel tanks and is present in automobile exhausts as a by-product of the combustion of other aromatic compounds in gasoline.</p>	It contributes to the development of cancer in humans.
<p>Ozone – occurs naturally in the upper layers of the atmosphere. In the upper this important gas shields the earth from the harmful ultraviolet rays of the sun. However, at the ground level it is a pollutant with highly toxic effects. Vehicles and industries are the major sources of ground level ozone emissions.</p>	Exposure to ozone can cause the eyes to itch, burn and water. It also lowers the resistance to colds and pneumonia. It is also associated with the increase in respiratory disorders such as asthma.

Energy Production and Use – Environmental Issues

Current fossil-based energy sources contribute tremendously to environmental degradation in the form of water pollution, air pollution, deforestation, and global warming. This degradation has grave implications for plant and animal life. New, renewable, energy sources are being developed. These energy sources, though much more “environmentally-friendly” than current

sources, also can have a negative impact on the natural environment. This means that, even with renewable energy sources, we must conserve on the use of energy if we are to truly minimise mankind's impact on the natural environment.

The Impacts of Energy Production and Use on Ecosystems and Biodiversity

Ecosystems are of fundamental importance to environmental function and sustainability. Energy production has adverse effects on the environment as the mining, drilling, and pipeline installation for the supply of energy can disrupt entire ecosystems. Additionally, the extraction of coal from mines can cause severe erosion and the destruction of natural habitats, and can leach toxic chemicals into nearby streams and groundwater supplies.

The Environmental Impacts of Global Warming

Computer models suggest that the Earth's changing climate will cause most places to have different ecosystems within 50 years. Rare, isolated, or slow-moving species could lose out to weeds and pests that can move or adapt quickly. Though the extent of the effects of global warming are uncertain, they potentially include the disruption of global weather patterns and ecosystems, flooding and severe storms and droughts.

Climatic variations that lead to new rainfall patterns and temperatures may cause the extinction of plant species and the animals which depend on them. Changes in global climate will be associated with regional changes in average temperature, precipitation patterns, and other climatic attributes that affect trees. Distributions of species and forest composition would change. Widespread species are not at risk of extinction but loss of genetic variation could occur. Species with localized distributions are at risk of extinction.

Coral reefs are among the world's most beautiful and diverse ecosystems and represent crucial sources of income and resources through their role in tourism, fishing, building materials, drug and biochemical development, and coastal protection. Important drugs have been obtained from reef organisms, including the HIV-fighting AZT, which is based on chemicals derived from a Caribbean reef sponge. And there is still much to be discovered. Scientists have only identified perhaps 10 percent of the more than 1 million species believed to inhabit coral reefs.

Tourism alone generates billions of dollars for countries associated with coral reefs – US\$140 billion by Caribbean reefs. Some 90 countries are economically dependent upon corals. Polynesian nations could lose up to US\$2.5 billion and suffer unemployment in the 75 percent range due to global warming and its impacts on fishing and tourism.

Thermal Pollution

During the electricity-generation process, burning fossil fuels produce heat energy, some of which is used to generate electricity. Because the process is inefficient, much of the heat is released to the atmosphere or to water that is used as a coolant. Heated air is not a problem, but heated water, once returned to rivers or lakes, can upset the aquatic ecosystem. Many organisms, particularly cold-blooded ones, are especially vulnerable to changes in temperature. Moreover, as water temperature rises, the water holds less oxygen, so organisms may die from

oxygen starvation if not from the heat itself. Heat-loving organisms cannot become established because the output of hot water varies, decreasing to nothing when the plant shuts down.

Potential Environmental Consequences of Alternative Energy Sources

Renewable energy use generally produces less negative impacts on the environment than fossil fuels. However, renewable energy production has some drawbacks, mainly, for example, solar thermal energy involving the collection of solar rays through collectors (often times huge mirrors) needs large tracts of land as a collection site. This can affect natural habitats. The environment is also impacted when buildings, roads, transmission lines, and transformers are built. Moreover, the fluid most often used with solar thermal electric generation is very toxic and spills may occur. Toxic chemicals are also used in making batteries to store solar electricity through the night and on cloudy days. Manufacturing this equipment has negative environmental impacts.

Wind power development too, has its downside, mostly involving land use. The average wind farm requires 17 acres of land to produce one megawatt of electricity, about enough electricity for 750 to 1,000 homes. However, farms and cattle grazing can use the same land under the wind turbines. Additionally, wind farms could cause erosion in desert areas. Most often, wind farms affect the natural view because they tend to be located on or just below ridgelines. Bird deaths may also occur due to collisions with wind turbines and associated wires.

Hydropower, although considered the cleanest form of conventional energy, can have significant environmental impacts if large facilities are built. This is used because large hydropower facilities require the construction of dams. The impacts of large hydropower facilities include the destruction of entire ecosystems – having effect on fish and other water species – the loss of scenic natural areas, and reduced water flow for other uses. Large dams can block the natural flow of water, thereby degrading water quality. In addition, people are sometimes displaced and prime farmland and forests are lost in the flooded areas above dams. Downstream, dams can change the chemical, physical, and biological characteristics of the river and land.

However, small, run-of-the-river projects are free from many of the environmental problems associated with their large-scale relatives because they use the natural flow of the river, and thus produce relatively little change in the stream channel and flow.

Global Trends in Energy Conservation and Efficiency

The development of an energy efficient economy is a crucial, difficult and motivating challenge for all countries. The high oil prices and the limited public resources for investment in energy supply and, in the long-term, the prospective depletion of fossil energy resources and the risk of climate change provide strong incentives for the exchange of experience on energy efficiency policies: it is a win-win strategy as it addresses at the same time many strategic issues.

World Energy Council, 2008

Globally, the imperative to significantly improve efforts in energy conservation and energy efficiency remains a priority. Issues such as the global economic crisis, rising debt among nations, energy security, emerging constraints in energy supply and climate change concerns all contribute to the pace in which countries continue to promote energy conservation and efficiency programmes and develop associated policies. Also, the objectives of the Kyoto Protocol have raised the level of importance given to the development of energy conservation and efficiency policies.

Improvements in energy conservation and efficiency are considered to provide the greatest scope for reducing the requirements for energy and its negative impacts on the environment. These imply that energy conservation and efficiency are “low hanging fruit” on the “energy tree” and effective implementation of a range of measures can help address a number of objectives at the same time and at a low or negative cost. These objectives include:



Up to about 30 years ago, the global energy system was about 34% efficient, meaning that only a third of the world's energy input was being converted into useful energy (Nakicenovic et al. 1998). Since then, improvements to the efficiency of the global energy chain have led to this figure increasing to about 39%. Energy efficiency currently enjoys strong global commitment.

Economic, energy security and environmental challenges all serve as catalysts for the development and implementation of energy conservation and efficiency policies and programmes. The G8 countries for example have been very active in developing and implementing energy efficiency policies for several decades, but particularly since the early 2000s. Their efforts have taken the form primarily in focus on energy performance in buildings as well as energy efficiency and labelling requirements for energy-using products and electrical appliances.

Countries such as Canada and the United States have focused on implementing the ecoENERGY Efficiency Initiative that promotes smarter energy use across buildings, industry and transport sectors. The United States government has begun updating energy efficiency standards for vehicles, lighting, domestic appliances and federal buildings as well as supporting utility demand response programmes.

In Japan, energy conservation is at the heart of its national energy policy and has put in place an Act "Rational Use of Energy" to support its conservation efforts. Key elements of this Act include the requirement for annual reports from as many as 14,000 designated energy management factories on their medium and long-term plans for capital expenditures for energy-efficient equipment. These factories also are required to appoint energy managers. Japan also has adopted the "Front Runner Plan" for energy conservation. This plan sets forth specific measures for achieving its goal of improving energy consumption efficiency by at least 30% by 2030 compared with 2003.

Across sectors, there are several innovations worldwide in energy conservation and efficiency – many of which can be adopted and/or adapted to the Caribbean context. Some of these include:

- energy performance standards and associated labelling for appliances
- fuel efficiency standards for heavy-duty vehicles
- low rolling resistance and appropriate inflation levels for tyres
- promotion of energy management in industry
- creation of incentives for utilities to promote energy efficiency, including setting energy efficiency targets for utilities
- use of cleaner technologies in the manufacturing sector

Globally, advancements in energy conservation and efficiency have yielded some valuable lessons. Some of these include:

- Political will and commitment are important to successful implementation of energy efficiency measures, with the participation and commitment of state and local governments being as important as that of national governments in many instances.
- Regulatory interventions are required for norms and certification programs.
- A range of policy measures have been used and have been typically sector focused.
- Energy efficiency policies and measures should be accompanied by legal and institutional frameworks that remove market distortions.
- Policy should be long term in nature, with proper pricing signals for investors, as well as consider demand and supply aspects.
- Many energy efficiency projects have associated technical assistance program support.

Rationale for the Development of National Energy Conservation and Efficiency Objectives

The rationale for the development and implementation of national energy conservation and efficiency objectives centres around the economic, social and environmental benefits that countries stand to achieve. In addition to alleviating the economic burden of imported oil, conservation and efficiency also can contribute to reduced energy investment requirements, and make the best use of existing supply capacities to improve the access to energy. There are many possibilities for countries, where the largest energy savings, in absolute terms, can be made in the industrial and transport sectors. Interventions aimed at improving energy efficiency in the residential sector can contribute significantly to improving the quality of life of households while reducing costs.

All countries, whether developed or developing, are subject to three major constraints that makes the push for energy conservation and efficiency are priority - market pressures and rising oil prices, long-term energy security needs and degradation of the climate, with increasing local impacts.

Drivers for Energy Conservation and Efficiency

There are many different reasons why countries have a strong desire to enhance efforts in energy conservation and efficiency. Some of these are:

- High energy intensity
- Growing global demand for energy and rising energy costs
- Energy conservation and efficiency offers a no regrets solution – it represents the fastest, cheapest and cleanest way to stretch energy supplies requiring relatively low investments

- The Clean Development Mechanism (CDM) of the Kyoto Protocol can provide further benefits to the economy through the trading of carbon credits that can be derived from the implementation of energy efficiency projects.
- The production, storage, transportation and use of energy derived from fossil fuels has negative effects on human health, ecosystems and biodiversity, and also contributes to global warming. Conserving energy can therefore reduce adverse effects on human health and the environment.

Economic Drivers

- Supports broad economic growth
- Reduce dependence on oil
- Maintain reliability of grid infrastructure
- Make the best use of existing supply capacities to improve the access to energy
- Reduce need for large-scale capital investments in power supply
- Savings in foreign exchange

Social Drivers

- lower utility bills to consumers
- Attracts jobs

Environmental Drivers

- Protects public health
- Reduces carbon emissions

Benefits of Promoting Energy Conservation and Efficiency

Energy efficiency and conservation represents the best immediate hope to reduce a country's use of oil and the attendant negative environmental impacts. Some key benefits of promoting energy conservation and efficiency programmes are expected to include:

- **Reduction in oil dependence and the demand for foreign currency to make payments for oil purchases – this it generates savings which can be utilized for other economic and social programmes and developmental activities.**
- **Improvements in energy use in the transportation, manufacturing, building, and other economic sectors**
- **Improved air quality**
- **Reduced greenhouse gas emissions**
- **Increased energy security**
- **Deferred need to invest in new infrastructure**
- **Waste reduction**
- **Freeing up of capital and hedging of fuel risks**
- **Enhanced competitiveness**

Exploring the Scope for Promoting Energy Conservation and Efficiency

Improvements in energy conservation and efficiency (ECE) can play a significant role in addressing energy security and achieving environmental and economic objectives. Many studies over the years have identified major barriers to the implementation of ECE initiatives on a sustained basis in developing countries.

The generic barriers include: technical, informational, financial/economic, managerial/entrepreneurial and organizational, risk and/or uncertainties, and policy and legal/regulatory. All of these barriers are relevant to Caribbean countries. In addition, traditional attitudes and inertia influenced by cultural norms are among other factors that can thwart the meaningful adoption of ECE measures.

The areas of focus advancing ECE in a country include: public sector, private sector (households, industrial, commercial, and tourism), electricity, transport, codes and standards, energy conservation and efficiency market, renewable energy technologies, environment, institutional framework and technical capacity development.

Global Trends in Renewable Energy

The term “renewable” is generally applied to those energy resources and technologies whose common characteristic is that they are non-depletable or naturally replenishable.

Renewable resources include solar energy, wind, falling water, the heat of the earth (geothermal), plant materials (biomass), waves, ocean currents, temperature differences in the oceans and the energy of the tides. Renewable energy technologies produce power, heat or mechanical energy by converting those resources either to electricity or to motive power.

Renewable energy is derived from resources that are generally not depleted by human use, such as the sun, wind, and water movement or from resources that can be rapidly replenished such as biomass. These primary sources of energy can be converted into heat, electricity, mechanical energy, and transportation fuels in several ways. There are some mature technologies for conversion of renewable energy such as hydropower, biomass, and waste combustion. Other conversion technologies, such as wind turbines and photovoltaics, are already well-developed, but they have not achieved the technological efficiency and market penetration that they are expected to ultimately reach.

Renewable energy and its associated technologies are therefore essential contributors to sustainable energy as they generally contribute to world energy security, reducing dependence on fossil fuel resources, and also provide opportunities for mitigating greenhouse gas emissions.

High and fluctuating oil prices have continued to stimulate strong debate locally of the role that renewable energy may play in producing electricity, displacing fossil fuel use, and impacting the need for power transmission equipment and replacing aged equipment.

Today, renewable energies cover 25% of global power capacity from all sources and delivered 18% of global electricity supply in 2009 (RE 21, 2010).

Many countries around the world and particularly those in emerging economies are increasingly recognizing the potential role of renewable energy within a portfolio of low-carbon and cost-competitive energy technologies capable of responding to the emerging major challenges of energy security, climate change, and access to energy. Globally, there is much active renewable policy development with more than 100 countries enacting some type of

policy target and/or promotion policy related to renewable energy, up from 55 countries in early 2005.

In contrast to conventional energy sources, there has been a continued and significant reduction in the cost for renewables over the last 20 years. As an example, the cost of wind energy per kWh has fallen by 50% over the last 15 years while at the same time the size of the turbines has increased by a factor of 10. Solar photovoltaic systems today are more than 60% cheaper than they were in 1990.

Energy security denotes the uninterrupted supply of diverse forms of energy in adequate quantities and at affordable prices. Since access to energy is the lifeblood of economic growth and social well-being, most countries are striving to achieve energy security. With rapid economic development expected to take place in developing countries such as China, India and Brazil, along with unprecedented world population growth to approximately 9 billion² by 2050, the appetite for energy is expected to grow. However, volatility in oil prices, dwindling oil reserves, geopolitical tensions and concerns about global climate change impel countries to make the transition to low carbon economies and access sustainable forms of energy. Many countries, especially the developed ones, have therefore turned their attention to renewable energy (RE) as a sustainable source of energy.

Renewable energy—including biomass, geothermal, hydropower, solar, wind, tidal, and wave—offers tremendous benefits for meeting global energy needs. Building on a foundation of hydropower, biomass combustion, and geothermal power pioneered during the industrial revolution in the late 1800s, new forms of renewable energy began to be developed and commercialized, including solar, wind, and several forms of advanced bioenergy.

Today, these renewable energy technologies are the fastest growing energy technologies (particularly wind and solar) and are cost competitive in a variety of grid, off-grid, and remote applications worldwide.

²Population Division of the United Nations.

The development of RE coupled with energy efficiency and conservation may allow countries to meet their energy needs with limited use of fossil fuels. RE now accounts for almost a quarter of global energy consumption but fossil fuels remain the dominant sources of energy. Energy scenarios have predicted that investments in existing and new renewable energy technologies (RETs) will continue to grow as countries try to accomplish their sustainable development goals.

Today, in a number of countries, renewables represent a rapidly growing share of total energy supply—including heat and transport. The share of households worldwide employing solar water heating continues to increase and is now estimated at 70 million. Additionally, investment in new renewable power capacity in both 2008 and 2009 represented more than half of total global investment in new power generation.

Among the renewable energy options that are currently in wide use in some regions and are now ready for large scale introduction in many areas include:

- Biogas for decentralized cooking and electricity
- Small Hydro Power for local electricity
- Small Wind Power for water pumping and local electricity
- Solar Photovoltaics for local electricity
- Solar Collectors for water and space heating
- Ethanol and Biodiesel for agriculture and transportation
- Large Hydro Power for grid electricity
- Large Wind Power for grid electricity
- Geothermal Energy for heat and grid electricity
- Biofuels



Technologies and Trends in Renewable Energy

Eighteen (18%) percent of the world's electricity is generated from RE. However, there are countries that depend primarily on RE for their electricity needs, for example Iceland (100 percent), Brazil (85 percent), Austria (62 percent), New Zealand (65 percent), and Sweden (54 percent). The primary forms of RE technology use wind, hydro, solar, geothermal and biomass as their energy source.

Wind



Wind turbines have been used within the region for hundreds of years to pump water from deep wells, or to grind sugarcane or grain. Modern wind turbines use the mechanical energy extracted from the wind to generate electricity. There are two types of wind turbines, namely vertical axis and horizontal axis turbines. The vertical axis has the advantage that it does not need to be aligned into the direction of the wind and can therefore extract energy best in very turbulent conditions. Another major advantage is that the gears and generator are on the ground and make for easy maintenance and require less structural support. It had the disadvantage that the turbine is close to the ground where the wind speeds are lower.

The energy obtained from the wind is proportional to the cube of the wind speed and is proportional to the area covered by the blades. Hence the trend is to increase the size of the turbine and place them in areas with higher and more constant wind speeds, for example, they are increasingly placed at greater elevation and offshore. There are several sizes and designs of available wind turbines depending on the application. Currently about 500 different designs exist and they range from as small as a few hundred watts to turbines capable of generating 5

MW. The most commonly used turbines in commercial scale applications range from about 600kW to 1.5 MW. For industrial application, the trend is towards larger turbines with blades of up to 40 m long and rotating at about 22 revolutions per minute; while for small systems the trend is towards architecturally elegant designs that can utilise turbulence caused by eddy currents present within the urban areas. On both scales, building turbines that can start extracting energy from lower wind speeds (even 2.5 m/s speeds) is a common thrust. The primary concern with wind energy is its intermittency and capacity factor of 20-40% are normal. In the past five years, annual wind capacity grew by 27% and continues to trend toward off shore development and distributed small-scale grid-connected turbines.

Hydropower

As in wind energy, the kinetic energy of a fluid, in this case water, is converted by turbine blades into rotational motion for the generation of electricity. About 20% of the world's electricity is generated from hydropower. Several variations are again available generally categorised by the size and application. Large hydropower plants range from a few hundred megawatts to about 10 gigawatts. Three plants exist worldwide upwards of 10GW with the largest being 22.5 GW. Small or mini-hydro plants are systems with generation capacity up to 10 MW. Micro-hydro refers to systems of a few hundred kilowatts and may be used for small communities. Pico hydro plants generate electricity in the range of a few kilowatts and are generally single user generators.

Hydroelectricity has one of the quickest response times; hence the ability to follow the demand load is of major advantage. It also offers very firm capacity although seasonal variations may affect smaller systems. Hydropower plants are very efficient and require low maintenance, hence the cost of electricity generation is low.

The micro-, mini- and pico-hydro plants may be designed as run-of-the-river systems. The water from the river or a small dam placed across the river is channelled into a penstock which then leads to the turbine and generator unit. No major flooding of the upper river region is required hence they cause little or no change in their surroundings and have minimal environment impact. However, for large scale generation damming and flooding are generally necessary and that may required some modification to the ecosystem. It has been noted that there may be several advantages to damming such as flood mitigation and water resource management. Where there is variability in the water resource due to seasonal changes, the hydroelectric dam can be a corrective measure. So with the required environmental impact assessment, the installation of dams for hydroelectricity may have several environmental advantages beyond RE.

Other forms of hydro power use energy from tides, waves, and under ocean currents. While the former is very mature, it has little relevance to Jamaica since we do not experience the tidal fluctuations necessary to make the application meaningful. Several designs of extracting the energy from the waves have been developed and tested. Some are currently at the commercialisation phase.

Solar



Solar energy generally finds two primary modes of usage, electricity generation and thermal energy for domestic or industrial heating. The electricity generation takes two forms, photovoltaic with direct conversion from sunlight to electricity and solar thermal electricity (STE) which is also sometimes referred to as concentrated solar power.

Currently the most cost effective mode of using solar energy is for heating purposes. Several application and matching technologies exist depending on the heating requirements. The most common use relevant to Jamaica is the domestic solar water heater. This simple technology generally uses an inexpensive flat plate collector. This consists of a blackened copper or aluminium plate which serves as the collecting surface. Copper pipes are welded to inlet and outlet pipes and placed on the collecting surface. The thermal energy is readily conducted from

collecting surface to the water in the pipes. The collector is enclosed in a glass covered box to reduce convective losses and to trap the incoming radiation via the greenhouse effect. The hot water is stored in the tank at the end of the outlet pipe.

Where higher temperature water is required the current trend is to replace the flat plate collector with vacuum tubes. These can achieve temperatures of up to 350° C. However since vacuum tubes are generally more expensive than plate collectors, the technology was more commonly used in temperature regions with lower solar irradiance or for applications requiring the higher temperatures generated. With the current decreases in price and the improvement in the vacuum technology we are seeing the penetration into the local domestic hot water systems.

Industrial uses of solar thermal energy tend to be in laundries and food processing plants where large quantities of hot water are required. Generally specialised collectors or the vacuum tube systems are often used in those facilities.

For electricity generation from sunlight, photovoltaic technology is the more popularly known. Here a semiconducting material converts the energy from the light into a direct current that can be used, stored or converted into an alternating current (ac) for appliances needing ac current. Although the technology generally found use in the space or satellite applications where remote, light weight, and static electricity generation was required, it is now a major contender in RE technology deployment globally. There has been a 20% annual increase in PV production since 2002 with about 21GW of PV installed by year 2009 with Germany alone installing 3.8GW in that year. The large global demand has kept prices high, but the general thrust is to reduce the cost of PV by innovations in manufacturing methods, the use of new materials and researching of techniques focused on improving the efficiency of the modules.

The most expensive technology to manufacture is the mono-crystalline silicon PV module. These require the manufacturing of a single silicon crystal that is then cut into wafers for the manufacturing of PV cells. The resulting modules have efficiencies of 18-25% and lifetimes of 25-35 years.

Polycrystalline silicon modules are less expensive to produce but the efficiencies are not as high since the grain boundaries within the cells inhibit the free flow of current. The efficiencies achieved range from 10-17%. Amorphous silicon with no crystal structure can be deposited at low temperatures onto a substrate such as glass to produce a solar module. The efficiencies achieved by this technology are generally 5-9%. But it has comparatively low production cost and uses much less material.

Semiconducting material other than silicon are used in the manufacture of thin film PV cells. Vapour deposition is used to coat a substrate with an ultra-thin sheet a few micrometres thick

of materials like cadmium telluride, copper indium diselenide or copper Indium gallium selenide. These yield PV with efficiencies with ranges of 7-10%. The major advantage is the limited amount of material used in their production and the less expensive production techniques that make them competitive in terms of electricity generation cost compared to the more efficient mono-crystalline modules.

Attempts at increasing the efficiency of modules have resulted in the production of triple junction PV cells. Each PV material has a semiconduction junction that is excited by light of a given energy. In these cells three such junctions are created, each sensitive to light of a different part of the spectrum. Thus a greater rate of conversion of the sunlight into electricity is realised with efficiencies near 40%. However, these are very expensive to produce and therefore tend to be used in specific applications. One method of taking advantage of their high efficiencies at reduced cost is to use them in concentrated PV systems. Here less expensive materials are used to build collectors and concentrators of the sunlight. This concentrated sunlight is then focused on an area of triple junction PV much smaller than the collecting area. Thus a reduced amount of the expensive PV material is used.

Solar thermal electricity uses the heat of the sun to directly generate electricity. There are currently four main types of STE plants in use or in an advanced developmental stage. The parabolic trough system uses long parabolic mirrors to focus the sunlight onto a Dewar tube located along the focal line of the mirror. The tube contains mineral oil which is used as the means of transferring the heat from the mirror field to the generator. At the generator the oil heats water to generate the steam that drives the turbine. The mirrors are generally aligned in the North-South direction and track the motion of the sun across the sky to within a degree. This technology is mature, for example, a 354 MW plant developed in the 1980's in the Mojave Desert in California is still generating electricity with 99% availability. At optimal capacity these plants deliver energy at USD 0.09-0.15 per kWh.

The plants require large expanse of flat land with gradient less than 2° to facilitate the alignment of the mirrors and the connections of absorbing pipes. The system requires centralised tracking only along one axis.

A technology that attempts at offsetting the need for more expensive parabolic mirrors is the Compact Linear Fresnel Reflector. It uses a field of long shallow curvature or flat mirrors to reflect the light onto an absorbing pipe that is stationary above the mirrors. Water flows through the absorber producing steam directly.

The dish engine system is relatively expensive but uses the more efficient Stirling engine to generate electricity. Each module consists of a 27 ft parabolic dish collector which focuses the sunlight onto the hot source of the 25 kW Stirling engine. Dual axis tracking is needed. A more

rigid structure, to support not only the mirrors but also the engine which moves with the system, is also required. This arrangement incurs greater maintenance costs. The economy of scale is required for this technology to become competitive.

The Power Tower system consists of an array of individually mounted flat mirrors each with area of about 140 m². These track the sun on two axes and reflect the sunlight onto a tall (above 100 m) tower. Molten salt (saltpetre) at a temperature of 550°C is used as the heat transfer fluid which allows for direct storage or steam generation. Two primary advantages of this system is the direct use of very low cost thermal storage which can alleviate the problem of intermittence of sunlight and the lack of need for extremely flat lands. The World Bank conducted a study that projects that this mode will become the leading mode of solar generated electricity globally by 2020 delivering energy at a cost of USD 0.05 per kWh, this of course is contingent on the technology achieving the required economy of scale.

Geothermal

The energy source is the heat trapped in the centre of the earth. This causes an increase in temperature of 3° C for every 100 m descent. In some places hot rocks or hot water reservoirs are closer to the surface than in other areas. These regions were the traditional sites for the location of geothermal plants, however, advances in the technology has increase the range of places where geothermal energy may be accessed. Currently, about 11 GW of geothermal capacity are installed globally. Normally wells are drilled to the hot water reservoirs. There are three types of systems depending on the temperature of the reservoir. In the dry steam system, the steam with temperature about 300° C is piped directly from the reservoir to the turbine for the generation of electricity.

In the flash steam process, hot water is extracted at temperatures above 180°C. As the water rises from the well, the reduction in pressure causes the vaporisation of some water into steam. The steam is separated from the remaining water and the steam is used to turn the turbine.

The binary cycle system uses lower temperature reservoirs of about 110 – 180°C. Here an organic fluid is used in a Rankine cycle with the heat of the extracted hot water used to power the cycle. The hot water vaporises the working fluid in a heat exchanger. The organic vapour turns the turbine while the water is returned to the reservoir for reheating.

Where the water and rock porosity required to create the necessary underground reservoirs do not exist, hot dry rock technologies are developed to allow for the extraction of geothermal energy. Most geothermal resource within drilling distance is in the form of these dry impermeable rocks. High pressure cold water is channelled through the well to the hot rocks. This may cause further fracturing of the rocks and increase their permeability. The heat is transferred to the water flowing through the rocks which is extracted at a nearby return

borehole. This hot water is then used to generate the steam for the turbine or used in the binary cycle system. Projects that demonstrate this technology are currently being developed.

Ocean Thermal Energy Conversion (OTEC)

In the tropics, the sea surface temperature has range 25-30°C. However, at about 1 km below the surface the temperature of the water falls to 4°C due to the limited penetrability of the sunlight in the water. This temperature gradient can be used to run a power cycle using an organic fluid with boiling point less than 20°C. Generally ammonia is used as the working fluid with boiling occurring at a heat exchanger using the warm surface water as the heat source. Condensation of the ammonia vapour occurs at heat exchangers with the cold water. The ammonia vapour turns the turbine. The technology has been demonstrated in principle. However due to the low temperature gradient, the theoretical efficiency is about 9% and about 3% will be realized. Thus massive amounts of water have to be transferred from great depth and this requires large expensive structures. It is proposed that the nutrient rich water be used in marine culture to help offset the cost of the plant. In principle this is an almost infinite stored energy resource; however, cost effective extraction of the energy has not been realized.

Biomass

There is a significant growth potential for biomass use in the transportation sector. About a tenth of world gasoline use could be displaced with Brazilian style ethanol production by 2020. Even more could be displaced as lignocellulosic conversion costs decline (IEA,2004). Biodiesel could potentially displace 5-10 percent of diesel use worldwide. Existing biofuels use is driven by government policies and subsidies which in turn, are generally agriculture-driven.

Rationale for the Development of Renewable Energy Objectives

Increasing the use of renewable energy in a country's energy supply mix will be one of the principal ways of achieving energy security for a nation. It is well known and documented that the principal driver of today's impressive renewable energy growth is policy. Growth of renewables is strongest where and when the policymakers have established favourable conditions.

Renewable energy greatly increases energy security since the supply is indigenous. It is also resistance to shock since both supply and generation are normally distributed. Further reduction in vulnerability is assured by the diversification of the energy sources used in implementing RE into the energy mix. However, due to variability of some RE technologies, the degree of penetration is important in determining its own vulnerability and hence the need for policy that correctly orchestrates the transition into a more RE dependent energy matrix.

RE may also improve the stability of the energy infrastructure by requiring less transmission and distribution. For example, solar thermal energy used domestically or industrially reduces the electricity transmission requirements. Further since RE for electricity is generally distributed generation, with usage closer to source, the need for and cost of distribution are reduced.

The energy security advantage of RE can only be realized when market penetration has reached a threshold. This threshold also affects the economy of scale which further facilitates reduced prices and continued market growth. Thus enabling policy is required to allow for the threshold market penetration to be realized.

For the Caribbean, as for many non-oil producing nations, the development and diffusion of renewable energy resources and technologies will help countries realise important economic, environmental and social objectives. Renewable resources such as wind, solar, hydro and biomass are indigenous to many Caribbean countries, and if developed adequately, can provide cleaner, and in the long term, more affordable alternatives to oil. This will not only lower the oil bill and lessen environmental impacts but also improve energy security through diversification of the energy base.

Drivers for Development of the Renewable Energy Sector in the Caribbean

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

Economic Drivers

- Security of energy supply
- Economic optimization
- Reduced costs of energy
- Development of new industry
- Provides opportunities for innovation
- Employment opportunities (and with energy feedstock production particularly in rural areas)

Social Drivers

- Social-economic cohesion - improving economic prospects in rural areas
- Improved access to energy services by providing reliable and affordable energy supply
- Public support

Environmental Drivers

- Sustainable use of natural resources
- Reducing the impacts of climate change
- Increased awareness of environmental issues
- Reducing Emissions

For Latin America and the Caribbean, the key market drivers for renewable energy and energy efficiency development are energy security, economic development, and climate change. Renewable energy advances energy security as it diversifies a country’s energy mix and reduces the impact of fossil fuel price uncertainty. Renewable energy is good business, can be profitable, and is able to boost economies in the short, medium, and long term. It stimulates economic development to include developing markets, building industries, generating jobs and incomes, and reducing poverty. Climate change benefits from renewable energy as it helps ensure a cleaner environment and it reduces carbon dioxide and other harmful emissions.

As Figure 1 shows, market drivers for RE vary across countries. For example, in Europe, environment, climate change, and energy security are the key market drivers. In the US and Japan, energy security is the greatest driver for renewable energy followed by environmental, climate change, and consumer demand considerations. In developing countries, the prospects for energy access and economic development are the prime market movers.

Factors Affecting Demand for Renewable Energy						
	Climate Change ¹	Environmental Issues	Energy Security	Consumer Demand	Increased Reliability	Local Economic Development
Europe	●	●	●	◐	○	◐
Japan	◐	●	●	◐	○	○
United States	◐	◐	●	◐	◐ ²	◐
Developing Countries	○	○	◐	●	◐	●

- 1. Government vs. individuals
- 2. Region specific

● High ◐ Medium ○ Low

Figure 1: Factors affecting the demand for renewable energy

Benefits of Developing a Renewable Energy Sector

Renewable energy technologies have made tremendous advances in 25 years. Today, they offer significant advantages over conventional fuels for meeting energy needs worldwide. Renewable energy is indigenous, non-depleting, modular and environment-friendly and can meet a broad spectrum of energy demand. RE can provide energy access and meet unmet demand and can provide captive energy thus conserving fossil fuels and electricity. It also can augment grid power. Some key benefits of establishing a renewable energy sector include:

- Utilize locally available resources—the sun, wind, biomass, geothermal, and hydropower
- Reduce the need for fossil imports and their attendant foreign trade impacts
- Enhance energy security by diversifying the energy portfolio, improving price stability in times of rising fossil fuel costs, and reducing risks associated with future energy cost uncertainties
- Create local job, revenue, and income opportunities
- Are modular in nature which means that systems can be sited close to the load requirement—offsetting the need for costly grid extension, complementing consumers' ability to pay, and expanding as demand warrants
- Matched well to a variety of grid, off-grid, remote, and distributed applications; in many instances, renewable energy will be the least cost energy solution
- Conserve a country's natural resource base.
- Provide health benefits, particularly to women and children through the transition to cleaner combustion cooking fuels. Additionally, electric lighting, as an alternative to kerosene, provides better quality light while avoiding fumes, carbon monoxide emissions, and the serious fire hazards of kerosene use.
- Contribute to rural social and economic development through the provision of modern energy services, including lighting, heating, cooking, cooling, water pumping, transportation, and communications that enhance people's lives and livelihoods
- Renewable energy can also contribute to achievement of the Millennium Development Goals.
- Are environmentally beneficial, lacking the nitrogen and sulfur oxides that are harmful to humans, animals, and plants, and carbon dioxide and methane emissions which contribute to climate change.

RE Benefits in a Snapshot

- **Reduced transmission losses in the electricity system**
- **Potential for RE to provide employment creation and economic diversification thereby reducing poverty**
- **Greater energy security by displacing traditional energy sources with more sustainable sources of energy**
- **Improvements in balance of trade due to the displacement of imported oil**
- **Less emissions and cleaner sources of energy due to new access to more sustainable sources of energy**
- **Contribute to more affordable energy to consumers**
- **Reduced greenhouse gas emissions associated with electricity generation**
- **Supplement fossil fuels in transportation**

A Snapshot of the CARICOM Energy Policy

Vision of the Energy Policy

Fundamental transformation of the energy sectors of the Member States of the Community through the provision of secure and sustainable supplies of energy in a manner which minimizes energy waste in all sectors, to ensure that all CARICOM citizens have access to modern, clean and reliable energy supplies at affordable and stable prices, and to facilitate the growth of internationally competitive Regional industries towards achieving sustainable development of the Community

Objectives of the CARICOM Energy Policy

- Sustainable and secure energy supplies through diversification of energy sources
- Accelerated deployment of renewable and clean sources of energy supplies
- towards increased energy supply diversification and affordability
- Sustained growth of intra-Community trade in energy
- Increased energy efficiency and conservation in all sectors, including the transportation sub-sector
- Establishment and enforcement of labeling and standards for the importation of electrical appliances as well as standards for vehicles importation
- Increased investment in production, transformation and distribution of viable energy resources
- Strengthening and enhancement of the human and institutional capacities in the
- Community energy sector
- Programmed expansion of electricity generation, transmission, distribution and trade
- Improved access to affordable energy by the poor and vulnerable
- Greater use of renewable energy for electricity generation as well as in the transportation, industrial and agricultural sectors
- Coordinated approach to exploring and establishing an institutional framework for leveraging financing mechanisms for the development of viable energy resources
- Increased technology transfer and information sharing
- Established regional and national targets for emissions reduction with corresponding mitigation actions
- Strategies for maintenance of adequate energy reserves in the event of disasters
- Strengthened research, development and innovation efforts in energy sector especially in areas of clean and renewable energy sources and technologies

Overview of Some Country Energy Policies in the Caribbean

Aruba

Aruba's energy sector can be described as being in transition. In 2008, Aruba was 100% fossil fuel dependent with high emissions and ranked 9th in terms of per capita carbon emissions in the world. This is partly due to a small population supporting a tourism industry with 1 million tourists a year and energy-intensive oil refining and water production facilities. In 2010, 13% of the country's energy came from renewable energy sources.

Diversification of Energy Sources

- Since 2009, Aruba has had one wind park, the Vader Piet Wind Park, operated by an IPP; the IPP sells the power for a price that is fixed for 15 years (except for corrections due to inflation).
- The Government is considering the use of natural gas as a transition fuel for energy generation at WEB and also at the refinery (if reopened). This transition fuel will be imported as liquefied natural gas (LNG), which can also be used in a range of other applications, for example, fuel for cruise ships (a growing market) and for heavy vehicles and public transportation.
- An additional wind park will become operational in 2013 or 2014 which will increase the average wind power contribution to approximately 30% of the country's energy mix and will make Aruba one of the countries with the highest percentage of wind power in the world.
- Several hotels use solar panels for water heating.
- Aruba has one major bio fuel producer that at the moment collects waste cooking oil from approximately 60% of the local hotels and restaurants, thereby producing yearly approximately 45,000 gallons (\approx 1,100 barrels) of bio fuel. The bio fuel is used by vehicles.

Aruba’s energy policy framework comprises a long-term vision, four national goals and a range of strategies to move the energy sector to one that is modern, affordable to households and businesses and enables Aruba to become an example of wide-scale renewable energy penetration as part of its movement towards a green and sustainable economy.

<p>A modern, highly diversified, environmentally clean and efficient energy sector, which will provide Arubans with affordable energy supplies and long-term energy security</p> <p>Vision of Aruba's Energy Sector</p>	<p>Goal 1: Households and businesses are well aware of the importance of energy conservation, and use energy wisely with key economic sectors embracing eco-efficiency</p>
	<p>Goal 2: Aruba has modern energy infrastructure that enhances sustainable energy generation capacity and ensures that energy supplies are safely, reliably, and affordably transported to all consumers</p>
	<p>Goal 3: Aruba is a world class example of wide-scale deployment and use of renewable energy, moves closer to the green economy, and is internationally competitive and energy secure with a small carbon footprint, supporting long-term economic and social development and environmental sustainability</p>
	<p>Goal 4: Aruba has a well-defined and established governance, institutional, legal and regulatory framework supporting the future developments in the energy sector underpinned by high levels of consultation and citizen participation in this modernized energy sector</p>

Suriname

The National Energy Policy 2013-2033 supports the Sustainable Energy Framework for Suriname the objective of which is to increase the efficiency, transparency, sustainability and accountability of the power sector.

This Policy will provide the framework to achieve the country’s energy goals and will create a single energy policy, elements of which have been outlined in various documents, including the 2000 Energy Master Plan and the report, “Renewable energy potential and business opportunities in Suriname”.

Within the Caribbean, Suriname has the lowest reliance upon fossil fuels for the generation of electricity. The most significant source of energy is hydro-electricity, which is currently supplying 95% of the country’s electricity generation requirements. Twenty-six percent (26%) of the country’s total energy supply is generated through the hydropower system at Lake Brokopondo. Approximately 5% of electricity production is through small power generators, which use diesel fuel, in remote interior areas. Other sources of renewable energy used in Suriname include solar, biomass and wind energy.

Suriname has fossil fuel reserves, which are being exploited by the Staatsolie Company owned by the Government. Also Staatsolie is investing in further exploration of oil. Currently, the country has a refinery with a capacity of approximately 7,500 barrels per day. Suriname is nearing self-sufficiency in the production of oil, meaning that it could potentially join Trinidad and Tobago as a net exporter of energy. In the meantime, the country imports oil from Trinidad and Tobago.

The districts of Paramaribo, Wanica, Commewijne and the communities between Afobakka and Paramaribo can be described as being on 'the national grid'. All other districts and communities have to produce electricity with small equipment. This equipment mainly consists of diesel generators, but sometimes solar energy is applied on a small scale. Many villages in the interior of Suriname still rely on wood as their main energy source.

Suriname has a population of 550,000. The national electrification rate is 85%, with 79% of the population connected to the national grid and 6%, which live in the Hinterland (which accounts for 80% of the country), reliant on diesel units installed by the Department for Rural Energy (REEEP Policy Database). The remaining 15% of the population have no access to electricity.

Suriname's energy management framework comprises a long-term vision, five national goals and a set of strategies to transform the energy sector into one that is modern and affordable to the people of Suriname and that enables Suriname to become an example of wide-scale renewable energy penetration as part of its movement towards a green and sustainable economy.

A modern, efficient energy sector, providing all citizens and sectors with access to reliable and affordable energy supplies and long-term energy security towards enhancing the quality of life of all Surinamese, advancing international competitiveness and environmental sustainability

Vision of Suriname's Energy Sector to 2033

Goal 1: All citizens have access to reliable and affordable energy supplies and Suriname is able to meet its energy demands for households and industry, improving the quality of life of all

Goal 2: Suriname has modern energy infrastructure that enhances energy generation capacity and ensures that energy is transported safely, reliably and affordably to homes and communities throughout the country and the productive sectors on a sustainable basis

Goal 3: Suriname continuously engages in research and development to facilitate the wide-scale development and deployment and use of renewable energy, towards enhancing international competitiveness and energy security supporting long-term economic and social development and environmental sustainability

Goal 4: Suriname has a well-defined and established governance, institutional, legal and regulatory framework supporting future developments in the energy sector underpinned by high levels of consultation and citizen participation, including indigenous peoples

Goal 5: Surinamese are well aware of the importance of energy conservation, use energy wisely and continuously pursue opportunities for improving their use of energy

GROUP DISCUSSION ON OTHER NATIONAL ENERGY POLICIES: GUYANA, JAMAICA, GRENADA, BARBADOS, SURINAME

Measuring Energy Usage

Evaluating a Ministry's/Agency's Energy Use

Measuring Energy Usage

How much electricity do equipment and appliances use? You can usually find the wattage of most appliances on the nameplate on the back or bottom of the appliance. The wattage listed is the maximum power drawn by the appliance.

$$\text{Wattage} = \text{current} \times \text{voltage}$$

Often the letters UL can be found on the nameplate of the equipment or appliance, which means the products have been tested to safety standards. Adjusting volume or changing settings can affect the actual amount of power consumed. Many appliances draw small amounts of power even when they are turned off, while being connected to a power source. These "phantom loads" occur in VCR's, televisions, stereos, computers and increase the appliance's energy consumption a few watts per hour. Below is a list of some common items and the wattage used for each.

Appliance/Equipment	Wattage
Microwave	750 - 1100
Computer: CPU	120
Computer: Monitor	150
Desktop Computer and Monitor in Sleep Mode	1 - 20
Coffee Maker	900 - 1200
Ceiling Fan	65 - 175
Refrigerator	1725
VCR/DVD	17 - 21/20 - 25
19" Colour TV	110
Fax Machine	45
Scanner	400
Printer	660
Photocopier	1265
Central AC	3500

Appliance/Equipment	Wattage
Window Unit	500 - 1440
Regular Light Bulb	60 – 100
Compact Fluorescent Light Bulb	18

Calculating the Annual Costs for Equipment

The formula for the annual appliance/equipment operating cost is as follows:

$$\text{Watts X Hours Used per Day X Days Used per Year /1000} = \text{Kilowatt – Hour (KWH) Consumption per year}$$

Multiply this number by your local utility's rate per kWh consumed (In Jamaica the cost is US\$8.9 dollars/kWh- calculated from JPSCo's bill by dividing the kWh rate by the US\$ exchange rate) to calculate annual cost.

EXAMPLE:

If the Senior Director for Environment uses a computer (270 watts – monitor and CPU) 6 hours a day for 120 days per year, how much does it cost the Ministry to run this computer per year?

$$270 \times 6 \times 120 / 1000 = 194.4 \text{ kWh}$$

$$194.4 \text{ kWh} \times \text{J\$}8.9 = \text{J\$}1,730.16$$

Calculating Lighting Costs

6 – 10% of electricity bills are usually lighting costs. The most common bulbs are either fluorescent/compact fluorescent bulbs or incandescent bulbs.

How much energy can we save by switching from incandescent bulbs to fluorescent bulbs?

1. Search the office and count the number of lights in each room. If an incandescent bulb is used, this represents three times the energy used by the fluorescent bulb and must be counted three times.
2. Calculate the number of hours the lights are used in each room each day.

3. Enter the data below.

	Number of Lights	Number of Hours	Lights X Hours = TOTAL
First Floor Left Wing			
First Floor Right Wing			
Second Floor Left Wing			
Second Floor Right Wing			
Minister's Office			
Outside Lights			

- Each energy efficient CFL bulb saves 50 watts, how many watt-hours could you save if you replaced all bulbs with CFLs?
- Total hours of operation X 50 watts = _____ Watt hours you would save each day
- Divide your answer by 1,000 since there are 1,000 watt-hours in a Kilowatt-hour (which is how your utility bills you)
- Watt hours / 1,000 = _____ kilowatt-hours you would save
- Take this answer and multiply it by 240(the working days in a year) to calculate the Kilowatt-hours saved in a year.
- Kilowatt hours X 240 = _____ Kilowatt-hours saved in a year
- To calculate the amount of money your ministry could save in a year, take the Kilowatt-hours saved in a year times the cost per Kilowatt-hour (J\$8.9).
- Kilowatt-hours saved X \$8.9 = _____ Amount saved per year!

9. In addition to saving money, we use less electricity! Using less electricity means producing less greenhouse gases. If we assume that every kilowatt-hour saved removes 2 pounds of carbon dioxide from the air, how much greenhouse gases could be prevented?
10. Kilowatt-hours saved in a year X 2 pounds = _____pounds of greenhouse gas prevented

Conducting an Energy Audit

An energy audit is a technical review of energy used by energized systems in a building or process. It involves the assessment of the way energy is managed and the procedures which control it, in order to determine what measures can be taken to make the facility more energy-efficient.

The audit can identify problems that may, when corrected, lead to significant financial savings over time. During the audit, one can pinpoint where the facility is wasting energy and determine the efficiency of the facility's heating and cooling systems.

An energy audit may be applied to an individual facility, a group of facilities or all facilities. It is an important step in developing an energy efficiency programme. Audits may be carried out early in the development of an energy management programme, or at critical times during the operation of the programme. Over time, further audits may be appropriate, as the functions of a facility may change and the range of cost-effective energy technologies available will continue to expand.

An energy audit is not a substitute for a planned energy management programme. Energy auditing is only one element of an energy management information system. Without supportive management, there may be difficulties implementing the findings effectively.

Defining the Objectives of the Energy Audit

The audit objectives will be determined by the level of detail required by the organization. The amount of detail may depend on the size of the organization, the type of operations and the nature of any issues associated with the organization. Some examples of simple energy audit objectives include:

- The annual quantity and cost of each form of energy – electricity, gas, oil
- Energy consumption patterns based on previous billing information
- Sources of energy consumption

A more detailed energy audit could provide:

- Actual consumption measurements for all energy-using devices
- A comparison of a site's energy consumption with industry benchmarks and averages
- Information on opportunities for reducing energy use, tariff structure changes or fuel substitution to provide financial savings
- Estimates of the investment required to achieve savings

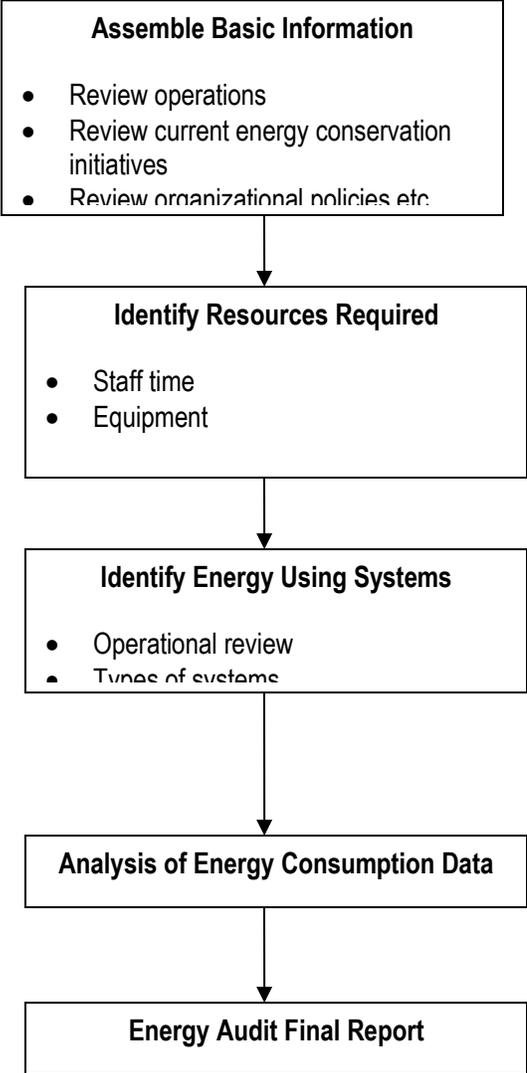
While information at this stage is likely to be estimated, it should allow for an accurate forecast of the financial opportunities that exist and the likely resources required.

These steps do not cover energy management related to motor vehicles. This information can be found in the chapter on Fleet Management.

A facility can obtain initial energy audit information without actually performing the audit if the following have been done:

- Conducted a previous energy audit and/or developed energy conservation initiatives
- Collected energy audit data from a similar facility for which they are responsible
- Interviewed the person responsible for resource management

The Figure below provides an outline of the steps involved in an energy audit.



Steps for Conducting an Energy Audit

Step 1: Assemble Basic Information

i. Review Operations

Certain basic information about the operations of an organization should be reviewed and recorded at this stage. This includes:

- number of occupants
- site location and size of facility or part of the facility under investigation
- type of establishment
- internal activities, for example; office space, cafeteria(s), maintenance commercial industrial and grounds keeping
- type of heating, cooling, lighting and other energy-using systems employed
- external environmental conditions
- energy conservation training records (if in existence)

ii. Collect Data on Energy Usage

Electricity bills for the past twenty-four months should be obtained for review if possible. It is critical for organizations to collect and retain all bills and other records for some established period of time in accordance with established GOJ policy. Information for this time period can be used later in the audit to determine consumption patterns and can aid decision makers when making predictions on future consumption patterns.

Maintenance and service records should also be collected as these will assist in determining the general condition of equipment and whether it is being maintained according to manufacturers' specifications.

iii. Identification of any existing Energy Conservation Initiatives

During the initial phase of the audit programme, it is important to identify any current energy conservation initiatives. This will provide start-up information for the audit and for later efforts in conservation planning.

Basic questions to be asked relate to:

- Identifying what conservation methods are in place
- Noting any organisational policies, quotas or budgets for energy conservation
- Determining any reductions in energy use based on the above methods
- Date and recommendations of the most recent energy audit

Step 2: Identify Resource Requirements

Before starting the audit, an estimate should be made of the resources required to carry out the project. If resources are limited, or the operation is a highly complex one the use of consultants specializing in energy auditing should be considered. Figure 2, Resource Requirements Checklist, gives a sample format to document the resource requirements. One of these checklists can be used for each operating area of an establishment.

Resource requirements may include the following:

- Adequate time for assigned people to carry out audit tasks to ensure the quality of your audit data
- Any equipment that will be used during the audit (this depends on the level of detail of the audit)
- Personal Protective Equipment (PPE) that may be required prior to entry to certain areas

The type of equipment used during the audit depends on the parameters that will be measured and the expertise of the auditor. The types of instruments that can be used are summarised below:

PARAMETER	INSTRUMENT
Electrical System Performance: <ul style="list-style-type: none"> • Voltage • Current • Real Power • Apparent Power • Light Levels 	<ul style="list-style-type: none"> • Voltmeter • Ammeter • Wattmeter • Power Factor Meter • Light Meter
Air Velocity	<ul style="list-style-type: none"> • Anemometer – deflecting vane • Anemometer – rotating vane • Pilot tube
Pressure	<ul style="list-style-type: none"> • Manometer • Draft Gauge • Bourdon Gauge
Humidity	<ul style="list-style-type: none"> • Psychrometer
Real Temperature	<ul style="list-style-type: none"> • Infrared Camera system

PARAMETER	INSTRUMENT
	<ul style="list-style-type: none"> Infrared Thermograph

Sample Resource Requirements Checklist

Site / Location:		Audit Date:						
Description	Staff Required				Equipment Needed			
	Position	No. of Staff	Req. from	Req. to	Type	Quantity	From	To

Step 3: Identification of all Energy-Using Systems

The identification of all energy-using systems can be done through site visits and interviews. An assessment of the areas of operation covered within the scope of the audit, which utilize energy and the demand of each area, should be done.

For example, an office may have several conference rooms which are frequently used. The organization utilizes incandescent lighting for all the rooms rather than fluorescent. Based on this fact the energy demand of these rooms is approximately seventy-five percent more than if the rooms were fitted with compact fluorescent lighting fixtures.

One 20 watt CFL is equal to one 100 watt incandescent lighting fixture and lasts up to

All Energy-using Systems should be catalogued. Appendix III gives an outline of the different energy using systems. Lighting fixtures should be counted, cooling and ventilation units, heating equipment, office equipment, laundry, food service and cleaning equipment noted including type, wattage/power rating and duration of use for each.

For cooling and ventilation equipment information on the location of units and associated vents, maintenance records, sunlight impact on location are recorded. For heating equipment information on insulation and unit location is recorded.

The Table below is an example of a simple checklist that can be used to record the information.

Basic Energy Audit Questionnaire

1. What are the operating hours of the building / facility:
2. What is the average occupancy level:
3. List the activities which utilize energy (attach separately):
4. List the major energy using equipment (attach separately):
5. List all areas to change incandescent lights to fluorescent lights noting quantity of fixtures as well as exact location (attach separately):

#	ITEM	Y	N	NA	COMMENTS
	OFFICE EQUIPMENT				
1	Are PC monitors shut off and on sleep mode at the end of the work day?				
2	Are copying machines shut off and on sleep mode at the end of the work day?				
3	Are fax machines shut off and in sleep mode at the end of the work day?				
	LIGHTING				
1	Are local switches used to control lighting in very large spaces?				
2	Is lighting only used when needed?				
3	What percentage of lights is being shut off during/ after hours/weekends?				
4	Are there signs reminding persons to conserve energy such as "switch off lights" signs?				
5	Are there any areas with any special lighting needs?				
6	Are lighting sensors used in areas which are not frequently occupied?				

#	ITEM	Y	N	NA	COMMENTS
	HEATING / COOLING				
1	Is air conditioning (A/C) set for 73°F-75°F and shut down during unoccupied hours?				
2	Are fans frequently used? (list number)				
3	Are hot water pipes insulated?				
4	Are restroom exhaust fans shut off during unoccupied hours? Other building exhaust fans				
5	Do you have very large (>1HP) fans or motors operating in this building?				
6	Is the cooling system maintained (cleaned, serviced) according to a pre-determined maintenance schedule?				
	BUILDING ENVELOPE				
1	Are windows and doors kept closed whilst the A/C system is in use?				
2	Is weather stripping found to be adequate around windows/ doors? (reduce air leak)				
3	Is the building so designed and positioned to allow for the use of natural rather than artificial cooling?				
	TRAINING				
1	Have all staff received training (formal / informal) in energy conservation?				
	Miscellaneous				
1	Are there any previous energy audit reports for the facility?				
2	Is there an energy conservation programme in existence?				

#	ITEM	Y	N	NA	COMMENTS
3	Does the facility refer to any policy, guidelines or standards with regards to energy use and conservation?				

Step 4: Data Analysis

This step is critical in determining energy consumption patterns, areas of high consumption and factors that contribute to this trend. This phase of the audit can be further divided into a number of smaller steps.

i. Analyze energy consumption data

Using the bills collected in Step 1, the data can be analyzed over the time period under review in order to identify whether peaks or dips in consumption are seasonal or follow a particular trend.

ii. Assess the effectiveness of previous energy conservation programmes

If an organization has previously developed an energy conservation programme, the effectiveness of the programme based on the findings of the audit can be assessed. This is useful for informing the recommendations of the audit.

iii. Identify reasons for unscheduled maintenance of equipment

This information can assist in identifying situations of overuse or poorly utilized equipment. It may also indicate non adherence to maintenance schedules.

iv. Identification of areas for Reduction in Consumption

Based on the analysis in steps (i) – (iii) an organization can identify those areas which through either retrofitting, replacement of equipment or through the use of alternate energy-use practices, where savings can be accrued.

v. Calculate Payback Period

The payback period for any capital outlay, equals the amount of time it will take to recover the initial expenditure of retrofitting or replacing equipment as a result of the savings associated with its use.

Simple payback is calculated by dividing the capital cost of the energy conservation action by the net annual savings the action will provide:

$$\text{Simple Payback Period} = \frac{\text{Capital cost (\$)}}{\text{Net annual savings (\$/year)}}$$

Step 5: Prepare and disseminate Final Report

The information should then be compiled and a report including recommendations produced and disseminated to staff for feedback. The report should then be amended to incorporate the comments where appropriate. An energy management plan which outlines targets and timelines for achieving the recommendations contained within the audit report can then be completed.

Module 2: Issues and Challenges Facing the Region in the Effective Introduction of Energy Efficiency and Renewable Energy Technologies



Renewable Energy Use in the Caribbean – Select Country Examples

Belize

Renewable energy technologies have historically been used both in small, isolated applications and power plants in Belize. Currently, hydroelectricity, stand alone solar photovoltaics (PV), small wind electricity generation, solar thermal, hybrid systems (diesel/PV or diesel/wind), biomass cogeneration and biogas are being used at some scale. Hydroelectricity and biomass are the principal renewable energy technologies installed and operated in Belize; such outputs are captured in the energy balance for Belize. In contrast wind and solar have very low penetration; typically, wind and solar facilities are installed and operated on cayes and other remote areas.

Hydropower: The most recent assessment of Belize’s hydroelectric potential [] estimated that Belize could double its hydroelectric output by developing sites on the Macal and Mopan Rivers in the West and on principal rivers in the South of the country.

Biomass: Biomass energy resources are available naturally as forestry and agricultural residues, animal waste, landfill gas and more recently as energy crops. Fuel-wood and bagasse account for almost 22 per cent of total primary energy production.

Wind: Estimated mean wind velocity at 80 meters above ground is approximately 7 to 8 metres per second. Though some studies suggest that Belize’s potential for wind power is around 20 MW, no comprehensive wind assessment has been conducted.

Solar: Belize’s average solar radiation in an optimal tilt angle is roughly estimated at 2,000 – 3,000 KWh per square metres per year.

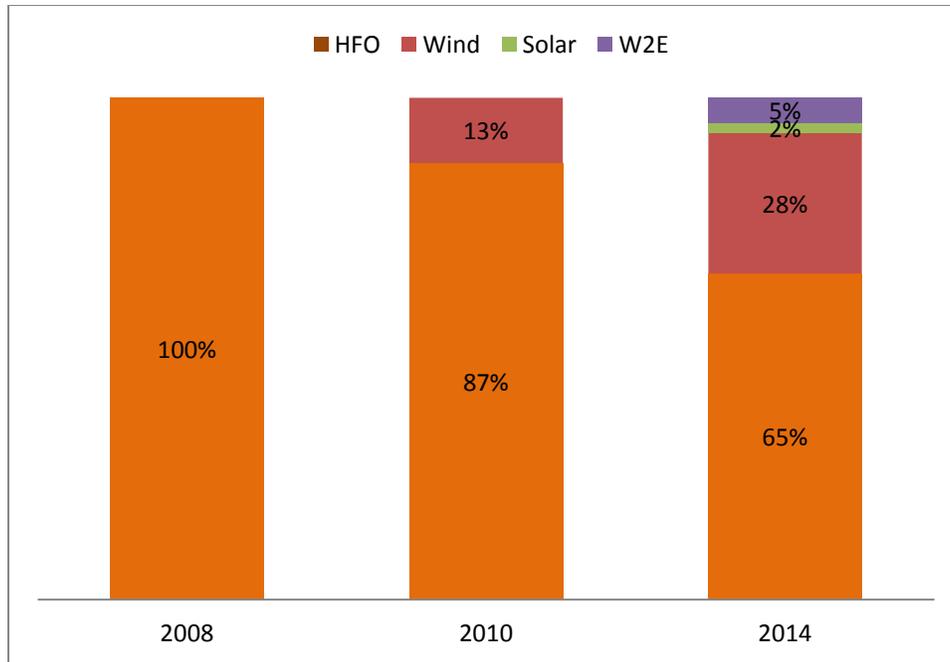
Aruba

Potential for use of Renewable Energy Sources

- Aruba has approximately 3,000 hours of sun per year and as such has started to utilize this potential for powering government-owned homes, the base of the Royal Marines and the office of the nature reserve, Parke Arikok.
- Plans are underway to install solar PV parks with a total solar capacity of 10 MW by the end of 2013. This will be mainly achieved by the installation of solar panels on the parking lot of Reina Beatrix Airport and above other parking lots. The 10 MW target will be achieved by also installing solar panels on the roofs of a number of low-income homes, government buildings, and schools.
- Several hotels use solar panels for water heating.
- Currently, solar water heating is used by very few households.
- ELMAR has introduced new regulations, allowing distributed generation (DG) to be connected to their distribution grid for residential and commercial purposes and tariffs for the surplus energy produced by these DG units were introduced.
- Aruba produces large quantities of waste due to its population size of 100,000 and its annual number of visitors of 1,000,000. Companies have been invited to tender for the building and operation of a waste-to-energy (W2E). Incinerators will burn both old and new waste and will generate gas for combustion and subsequent power generation by the power company.
- Aruba has limited potential for use of hydropower for energy storage
- Underwater pressurized air and flywheel are being considered by WEB.



An artistic impression of the Reina Beatrix Airport parking lot with solar panels on the roof top



The increase in use of renewable energy sources over the period 2008 to 2010 and the projections to 2014

- Since 2009, Aruba has had one wind park, the Vader Piet Wind Park, operated by an IPP; the IPP sells the power for a price that is fixed for 15 years (except for corrections due to inflation).
- An additional wind park will become operational in 2013 or 2014 which will increase the average wind power contribution to approximately 30% of the country's energy mix and will make Aruba one of the countries with the highest percentage of wind power in the world.
- Several hotels use solar panels for water heating.
- Aruba has one major bio fuel producer that at the moment collects waste cooking oil from approximately 60% of the local hotels and restaurants, thereby producing yearly approximately 45,000 gallons ($\approx 1,100$ barrels) of bio fuel. The bio fuel is used by vehicles.

Curaçao

Renewable energy technologies have historically been used both in small, isolated and utility scale applications in Curaçao. In particular, wind and solar photovoltaic (PV) electricity generation as well as solar thermal systems have been used at some scale. There is still significant scope however, for increasing the penetration of these technologies and further extending the use of renewables to the utilization of hybrid systems (such as PV/wind) and

biogas (especially from organic waste within the hospitality sector) as well as ocean technologies for cooling and electricity production.

Wind: Curaçao has a history that employs the use of wind resources. With annual average wind speeds at hub height of 48 m between 9.0 and 9.5 m/s, the Tera Kòrá and Playa Kanoa sites are among the best wind resources in the world. As a consequence, Aqualectra upgraded and expanded the original windfarms (which had fallen into disrepair due to poor maintenance); the new windfarms have been operational since July 2012 and Curaçao now produces as much as 30 MW or 15 per cent of its electricity from wind power.

Biomass: Biomass energy resources are available typically as municipal solid waste (MSW) and sewerage waste, which is produced in significant quantities from the hotel and tourism sector. In 2003, a feasibility study was conducted for implementation of a commercial waste to energy plant in the island but, to date, there has been no further progress. Recently also (in 2008), CUROIL, Refeneria di Korsou, Aqualectra and Fundashon Antiano pa Energia (FAPE) started an assessment of the feasibility for commercial production of biodiesel from algae and other biomass sources but that study has so far been inconclusive. The utilization of appropriate biomass conversion technologies can produce modern energy carriers (solid, gas or liquid fuels, as well as electricity) from the available biomass resources within Curaçao.

Ocean: In 2005, Aqualectra and Ecofys started the process of designing a 3,000 ton Sea Water Air Conditioning (SWAC) project and in 2008 the project was engineered and approved. The financial crisis of that same year slowed down its development and currently, efforts are being undertaken to resume the activities.

Guyana

Potential for use of Renewable Energy Sources and Diversification

Though Guyana continues to depend on expensive and unsustainable fossil sources of energy, the country has significant endowments in renewable energy resources and is ideally suited for the development of cost effective renewable energy systems. Guyana is currently exploring the following renewable technologies:

- Hydropower
- Biomass and Bagasse-based cogeneration
- Rice Husk
- Biodiesel
- Ethanol
- Biogas

- Wind
- Solar Thermal
- Solar Photovoltaic

New technologies are becoming more economical and commercially mature, uncertainty in conventional fossil fuels and other inputs are creating “increasing risks” for future electricity costs, and “old assumptions and myths” about economies of scale in power generation are breaking down.

Hydropower:

- 67 potential sites identified in the mid 1970’s
- Total hydropower potential in the country is approximately 7,200 to 7,600 MW
- Hydropower development plans include: 165MW large Hydro-Electric Project; 330kW micro hydro project; KurupungRiver Hydroelectric Project, Region 7, KumarauFalls, 60MW; Cooperation with the Brazil on a feasibility study for Upper and Middle Mazaruni hydropower development (3,000 +1,500 MW); Northern Arc Interconnection Project MOU: evaluate the feasibility of a possible collaboration on the energy transmission system for the electric interconnection of Guyana, Suriname, French Guiana and the northern cities of Boa Vista(State of Roraima) and Macapá(State of Amapa) (the Northern Arc Countries) with support from IDB.
- Some hydropower sites which have attracted interest over the years include: Devil’s Hole:35MW to 62 MW, CuyuniRiver, Region 7; ChiungRiver: 0.3MW, Region 8; Moco-Moco:0.5 MW hydroelectric plant was commissioned in 1999 but in 2003 the area experienced heavy rainfall and landslides that put the plant out of operation, rehabilitation proposal under negotiation, Region 9; Wamakaru:Up to 3.5 MW, Region 9

Biomass:

- Guyana has approximately 16 million hectares of forest which accounts for about 80% of its land area.
- Guyana’s forest products exports range from raw and sawn timber, to plywood, moulding and furniture products all of which produce varying types of wood waste.
- In the past, wood waste was regarded as a troublesome by-product of the sawmilling operation, resulting in disposal as landfill or by burning, with both having negative environmental consequences.
- Utilization of wood waste as a source of energy can address the problems associated with its disposal while providing a source of energy in the form of heat or electricity to offset costs associated with grid-supplied electricity.
- GEA is assessing energy potential from woodwaste in Guyana.

Bagasse

- The sugar factories have traditionally burnt the bagasse generated from sugar cane in the boilers which supplied the electricity and steam for factory operations.
- Total energy value of all bagasse produced in 2012 was 1.2 million boe, but only 6% was converted to electricity for sale to the grid and factory operations.
- Skeldon sugar factory has a 30MW cogeneration facility and requires about 8MW to meet its own power demand.
- Potential for higher electricity output based on higher pressure boilers: Need for studies

Rice Husk

- Rice production attained an all-time high of 422,057 tonnes in 2012.
- By-products such as bran, broken rice and rice husk.
- Rice husk, the outer most layer of the paddy grain, is a form of biomass and accounts for about 20% of the paddy's weight.
- Unlike the other by-products, rice husk is mostly seen as a waste disposal problem for many mills and is usually burnt as a form of waste disposal resulting in environmental concerns.
- GEA is in the process of verifying the energy potential from rice husk in Guyana.

Biofuels

- A number of potential developers have expressed interest in producing biofuels(bio-ethanol and biodiesel) for export
- Potential feedstock: sugar cane, coconut oil, palm oil, sweet potatoes and other feedstock
- A commercial pilot plant was established in Region producing biodiesel from palm oil.
- Small scale production of biodiesel from coconut oil and recycled vegetable oil is also being done.
- Guyana will not be converting any traditional food producing land to biofuel production.
- Agro-Energy Policy drafted.

Anhydrous Ethanol

- Guyana's first ever bioethanol demonstration plant at Albion Estate, Region 6, was commissioned in August 2013.
- 1000 litres per day of ethanol from molasses.
- Used by the Guyana Sugar Corporation's (GuySuCo) laboratory and industrial practices and to fuel a small number of vehicles owned by the sugar company and the Ministry of Agriculture using a blend of gasoline and ethanol (10%) to create an E-10 formulation.

Biogas

- The use of methane in Guyana has been largely underdeveloped.
- There are a number of potential sites including poultry and cattle-rearing farms which need to be further explored.
- Potential exists for the use of landfill-based methane gas as a source of energy
- About 28 known biodigesters currently in operation
- Bio-Methanization plant installed at DDL: Estimated 40,941 boe

Wind

- Engineers have created a database to capture the various wind energy installations in the country: 31.35kW installed capacity identified thus far.

Solar

- Guyana: approx. 5 kWh/m²/day
- PV systems: hinterland regions, health centres, schools, communities and homes for lighting, small appliance loads, water pumping and productive cottage industries
- Solar panels: modular: Cost range: G\$1300 to G\$2500 per watt installed.
- Actively installing solar photovoltaic systems in remote hinterland communities and schools that do not have access to grid power.
- Under the Unserved Areas Electrification Programme (UAEP), Hinterland Component: 1,750 solar systems were installed in homes (65,125 watts), schools and other community buildings across 21 hinterland villages.
- GoG's Low Carbon Development Strategy to provide at least basic access to electricity to every hinterland household using solar photovoltaic systems to about 15,000 communities without grid access.
- More than 1 MW of solar photovoltaic systems installed across Guyana with an estimated 1.81 GWh energy generation per year.
- With support from the Austrian Development Cooperation (ADC) and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), installed an 8.46kW Grid-tie Photovoltaic System - demonstration of net-metering application.
- Solar water heating is also beginning to be used for domestic water heating
- Importation and installation of solar water heaters will be encouraged for both residential and commercial use. The tourism and hospitality sector will be engaged with the objective of promoting the installation of solar water heaters.



- GEA assisted in the promotion and distribution of 507 solar cooking stoves to five (5) communities, namely Shulinab(Region 9), Rupertee(Region 9), Powaikoru(Region 1), Kangaruma(Region 7) and Tuseneng(Region 8), educational and health facilities

Suriname

Potential for use of Renewable Energy Sources and Diversification

- The contribution of renewable energy to the total supply up until now has been limited to the exploitation of hydro energy to supply coastal areas with electricity. However, the Government is interested in other options, including micro-hydropower, solar energy, bioenergy and wind energy.
- The Brokopondo Overeenkomst (Brokopondo Agreement), enacted into law in 1958, speaks to an agreement between the Government of Suriname and Suralco concerning the development of the hydropower potential. This agreement comes to an end in 2032.
- Research into the use of small hydro-power plants in the interior continues to take place as part of the development of the interior.
- There is use of small solar powered units for water distribution in 11 villages.
- There is one wind turbine in northeast Galibi, which is owned and managed by a lodge owner.
- Extensive research is being undertaken by the Anton de Kom University of Suriname in the use of renewables (including waste-to-energy, solar, small hydro dams, biodiesel and wind energy) in the energy supply mix.
- Staatsolie currently is implementing a sugar cane to ethanol project. Consisting of an agriculture component and an ethanol-producing component, the project will be able to produce between 14 and 15 million litres of ethanol per day by 2016 and will be able to produce E-15 for the transportation sector. The project also will produce 25MW of power from bagasse. Additionally, the project will produce 40,000 tonnes of sugar per year to cover the domestic and export markets.
- Staatsolie also is undertaking feasibility studies on the proposed Hypojai hydropower project. This project will ensure that there is a sustainable water supply to Brokopondo. Currently communities which live there use the water for their daily needs. If the project is feasible it will generate reliable power with the second phase incorporating extra dams (check dams) that will add 168MW to the current capacity of 160 MW.
- In relation to photovoltaic systems, there have been different applications in the country. Most of them deliver energy on a small scale, for instance to power a radio station or a water pumping system.
- The Government of Suriname has expressed interest in developing model townships in the interior to bring basic infrastructure and services to the population. To make this model feasible, the Government is seeking alternative and sustainable sources of energy to supply the future demand. Some of these energy sources are already applied on a small scale and also on a commercial basis. The use of already available biomass

for biofuels (such as sugar cane, chaff, straw and organic waste) and new possibilities (such as palm oil and jatropa) are being analyzed.

- Suralco is currently in the process of undertaking feasibility studies for the generation of energy from LNG, biofuels (from waste), coal and wood for its own manufacturing purposes.

Jamaica

- Jamaica currently has one operational commercial wind farm – The Wigton Windfarm in Manchester which has a capacity of 38.7 MW. This power is sold to the Jamaica Public Service (JPS) for domestic use. This translates into approximately 55 gigawatt hours of energy, enough to power about 24,000 homes, resulting in savings of about 32,400 barrels of oil valued at US\$2.3 million, and in so doing, avoids 45,954 tonnes of carbon emissions, as wind energy is cleaner than energy derived from oil.
- There are 8 small hydro powered plants with a combined capacity of 23 MW. All 8 plants are owned by the Jamaica Public Service Company Limited
- The solar PV capacity installed is unknown but it has been estimated that there are about 20,000 solar water heating units mainly on private homes
- With respect to bioethanol, there are three ethanol dehydration plants with a combined capacity of 220 million gallons per year. There also was a full roll-out of E10 in November of 2009. E10 is made using imported anhydrous ethanol made from sugarcane feedstock.
- Jamaica currently has 350 biodigesters treating animal waste equivalent to the production of approximately 10,000 m³ of biogas and 200 Biodigester Septic Tanks treating domestic sewage equivalent to the production of approximately 2000 m³ of biogas
- The Government, with the assistance of the Brazilian Government, has embarked on a drive to develop an ethanol from sugar cane industry. The state-owned refinery, Petrojam, has partnered with Brazil's Coimex Group to rehabilitate a 40-million gallon ethanol plant that has already generated revenues of US\$120 million from exports to the United States since 2005. Total bagasse output in 2003 was approx 600,000 tonnes per annum, equivalent to approx 940,000 barrels of oil with a value of US\$37.5 million. 1 tonne of sugar cane is equivalent to about 1.2 barrels of oil.



There are various renewable energy projects that are currently in the pipeline and are expected to come on stream in the medium term. Some of these include:

- **Energy from Waste** - Jamaica has eight (8) Solid Waste Disposal sites. Approximately 1.3M tonnes of Municipal Solid Waste (MSW) is generated island-wide annually. This waste can be converted into usable energy through the use of waste-to-energy (WTE) conversion technologies. The PCJ is currently in negotiations with an investor to develop two WTE plants :
 - One plant to be sited near Riverton: to produce ~ 45 MW of electricity
 - One plant to be sited near Retirement : to produce ~ 20MW
- **Biodiesel** - Jamaica has the potential to produce and use biodiesel made from feedstocks such as WVO or indigenous crops such as castor and jatropha. The PCJ has commenced a small pilot project on biodiesel which will help to inform policy.

Overview of the Fiscal and Regulatory Barriers to Implementing Renewable Energy Technologies

In the last few years, renewable energy technologies have experienced substantial improvements in cost, performance, and reliability, making them competitive today in a range of applications. Led by wind and photovoltaic (PV) technologies, they represent the fastest growing of all energy industries (though starting from a relatively low base). The momentum for renewable energy worldwide is strong, and the prospects for these technologies virtually untapped.

The fact that today the renewable energy potential of nations is far from maximized is due in large part to a number of outstanding barriers which put renewable energy at an economic, regulatory, or institutional disadvantage relative to other forms of energy. Barriers include subsidies for conventional forms of energy, high initial capital costs coupled with lack of fuel-price risk assessment, imperfect capital markets, lack of skills or information, poor market acceptance, technology prejudice, financing risks and uncertainties, high transactions costs, and a variety of regulatory and institutional factors.

A Closer Look at the Barriers

- The higher relative costs of the technologies (despite cost reductions) in a number of applications; renewable energy systems have higher upfront capital costs than conventional alternatives, though lower operation and maintenance (O&M) costs.
- Lack of mature markets and favorable policy, regulatory, and legal frameworks to encourage the development of and investment in renewable energy.
- Subsidies for fossil fuels make it difficult for renewable energy to compete; and lack of fuel-price risk assessment.
- Inadequate institutional capacity for all aspects of renewable energy project/program design, development, and implementation, including lack of skills and knowledge around RE technologies generally.
- Imperfect capital markets; insufficient access to affordable financing for project developers, entrepreneurs, and consumers; and financing risks and uncertainties.
- Lack of awareness and understanding of the benefits, costs, and applications of renewable energy among policymakers, the local private sector, finance institutions, and prospective customers.
- Inadequate information on the renewable energy resource potential.
- Restrictions on siting and construction, transmission access, and utility interconnection.
- The small scale nature of the technologies, often coupled with the geographic dispersion and low population densities of rural customers, contributes to high transaction costs for renewable energy projects and insufficient cost recovery.
- Inadequate demonstrated models for scale- up.
- Insufficient mechanisms for international cooperation, including technology transfer, trade, and financial flows.

Snapshot of the Ten barriers ...that have been identified globally that impact the widescale use of renewable energy technologies. These are listed in the table below:

Barrier	Example
Institutional	Institutional capacity limitations (R & D, demonstration and implementation)
Market	Small size of the market, low levels of involvement of the private sector; inadequate incentives to ensure effective facilitaton of private sector involvemnt
Awareness/Information	Lack of awareness about RETs and limited access to information on RETs
Financial	Inadequate and insufficient financing arrangements (local, national and international) for RET projects
Economic	Unfavourable costs, taxes, subsidies and energy prices
Technical	Lack of access to some of the new and emerging RET technologies, inadequate maintenance facilities and lack of existing local capacity to facilitate maintenance
Capacity	Lack of skilled manpower and training facilities to facilitate the effective deployment of RETs
Social	Lack of social acceptance in some instances and local participation
Environmental	Visual pollution in some cases (wind farms, not-in-my-backyard issues emerging), lack of adequate valuation of social and environmental benefits
Policy	Energy policies that do not effectively take into account fiscal and regulatory barriers that exist that are likely to affect the deployment of renewables

Requirements for Deploying RE Technologies in the Region

Deploying RE technologies at a rapid pace in the Caribbean will require addressing the many barriers presented above, including:

- Development of supportive policy and regulatory frameworks
- Securing public sector commitment to act as leaders in the deployment of RE technologies in public sector applications such as in hospitals, schools and other government buildings
- Strengthening local capacities and entrepreneurship
- Transferring technologies
- Increasing access to affordable financing and consumer credit
- Transitioning from traditional biomass to modern use of biomass, cleaner fuels,

- Maximizing use of hydro resources (large, small, and micro) in an environmentally sustainable manner
- More efficient use of biomass residues for power generation and transport, including growth of dedicated crops
- Increasing deployment and reducing costs of solar, wind, geothermal, wave, tidal, and other renewable energy sources

A number of drivers are spurring market growth in renewable energy. Most notably, investments in technology research, development, and demonstration (RD&D), primarily by industrialized nations; supportive policy and regulatory frameworks; energy security issues; environmental and climate change concerns; and local and regional development opportunities that these technologies offer. Price spikes and supply concerns over fossil based technologies are further increasing interest in and demand for the technologies.

Overview of the Barriers to Implementing Energy Conservation and Efficiency Strategies

Globally, governments are exploiting energy efficiency as their energy resource of first choice because it is the least expensive and most readily scalable option to support sustainable economic growth, enhance national security, and reduce further damage to the climate system.

Some of the barriers to energy conservation and efficiency and the measures to overcome them are presented in the table below:

Barrier to Implementing Energy Conservation and Efficiency Strategies	Measures to Remove Barriers
Lack of information	Information centres and services; appliance labelling and consumer information
Lack of trained personnel or technical or managerial expertise	Development and delivery of training programmes
Below long-run marginal cost pricing and other price distortions	Instituting supportive legal, regulatory and policy changes
Regulatory biases or absence of regulations to support energy development	Development of relevant policies and standards
High transaction costs	Market development and commercialization; development of demand-side management programmes, support for the introduction of energy service companies
High initial costs of EE technologies coupled	Develop innovative financing mechanisms

Barrier to Implementing Energy Conservation and Efficiency Strategies	Measures to Remove Barriers
with lack of access to credit	
High user discount rates	Support for the introduction of energy service companies
Higher perceived risks of the more-efficient technology	Technology research, adaptation, and demonstration; and/or performance contracting

Guidelines towards Improving Energy Conservation and Efficiency

Indoor Lighting

- Turn off lights when not in use. Frequently switching lights on and off will not damage components.
- Turn off lights in unoccupied areas such as store rooms and sick bays.
- At night, turn off all lights not necessary for security and safety including task and other office lights.
- Reduce the number of lights to a switch in large rooms so that lighting can be turned off when certain areas are not in use.
- Remove excess lighting. Use the minimum wattage required to perform tasks and illuminate spaces safely. Low wattage bulbs (e.g. 18-watt T8 bulbs) can be used of bathrooms, store rooms, corridors, hallways and reception areas. Utilise task lighting where additional illumination is needed.

LIGHT SOURCE	EFFICIENCY (lumens/ Watt)
Standards Incandescent	5 – 20
Tungsten-Halogen (halogen)	15 – 25
Halogen Infra-red Reflecting	20 – 35
Compact Fluorescent (5 – 26 W)	20 – 55
Compact Fluorescent (27 –40 W)	50 – 90
Tubular Fluorescent	60 – 100

Light Sources and their Efficiency

- Use energy efficient light sources. These produce the greatest amount of illumination per Watt of power, thus wasting less energy. Ensure that the appropriate bulb is used for the purpose. The table below provides a comparison of the lighting/ energy efficiency of some light sources.

- For spot or task lighting, consider compact fluorescent lights (CFLs) with reflectors. The lamps range in wattage from 13W to 32W and provide a very directed light using a reflector and lens system.
- Replace incandescent bulbs with Compact Fluorescent Lamps (CFLs). Whilst incandescent lamps are cheap to buy, they consume more energy and have a shorter life than CFLs which may cost up to 14 times more than an incandescent bulb, but uses 75% less energy and lasts 10 times longer (from 1,500— 10,000 hours compared to 750—1000 hours for the incandescent). Consider the following table which shows the superior efficiency of CFLs.
- Where incandescent bulbs are already being used and it is not realistic to change all bulbs at once, consider replacing incandescent bulbs with CFLs as the former blows. CFLs can be installed in existing incandescent light fittings. Incandescent bulbs could remain in areas where lighting is used infrequently such as in storerooms etc.
- Where incandescent bulbs are used, turn off promptly after use as these bulbs generate a lot of heat and therefore can increase the load and energy consumption on the air conditioning system.
- Never put a CFL in a circuit with a dimmer unless the bulb is specifically designed to be dimmable.
- When changing to fluorescent lights, ensure that the lamps and ballast³ are compatible in voltage and current. The supplier should be able to advise you on the proper tubes for your existing ballast.
- Choose fluorescent lights with electronic ballasts, which virtually eliminate flicker, operate quietly, and maximize energy efficiency. Magnetic ballasts flicker 100 times every second, and are less energy efficient. If those currently being used have magnetic ballasts, these may be replaced with electronic types over time.

Incandescent Bulbs and the Fluorescent Equivalent

INCANDESCENT BULBS	EQUIVALENT FLUORESCENT BULBS
45 Watts	9 –11 Watts
60 Watts	13 Watts
75 Watts	15 Watts
100 Watts	20 Watts
120 Watts	24 Watts



³ A ballast is the device that regulates the electricity used by the bulb. There are 2 different types of ballasts: electronic and magnetic.

- Install occupancy sensor switches in individual offices, bathrooms, conference rooms etc. These sensors activate lights when a person is in an area and turns off lights after the person has left. These can reduce energy costs by 40%.
- Install time switches—these set the time when all lighting will actually go off in all offices.
- Use natural light whenever possible. Turn off lights near windows when daylight is adequate. Prevent radiant heat gain to the building by glazing glass windows and/ or using shading devices such as louvers and light shelves.
- Do not use halogen lamps. Although some halogens use up to 20 percent less energy than incandescent lights and last anywhere from 2,000 to 6,000 hours, they are far less efficient than CFLs. In addition halogens burn hotter than other lights, and are thus a fire hazard.
- If you have torchiere fixtures with halogen lamps, consider replacing them with compact fluorescent torchieres. Compact fluorescent torchieres use 60% to 80% less energy and can produce more light (lumens) than the halogen torchieres and are safer.



Outdoor Lighting

- Replace outdoor incandescent bulbs with High-Intensity Discharge (HID) lamps. These can save 75% to 90% of lighting energy used by incandescent lamps and fixtures.
- Replace mercury vapour and halogen lamps with high-pressure sodium lamps (the most energy efficient) for security lighting (e.g. for parking lots); floodlighting; sports arenas and playfields; and street lamps. If sodium lamps are not preferred, metal halide or cold-start compact fluorescent can be used. Incandescent sources should be avoided unless they are integrated with a control mechanism that significantly limits the time that they operate.
- Install photocells to switch outdoor lights automatically on at dusk and off at dawn.
- Turn off signage lights (i.e. advertising and display lights) during the day.
- Use colour contrast to attract attention to signage, rather than high levels of illumination. Provide reflective surfaces for lettering or other elements that need to be illuminated at night and illuminate only the lettering, not the background.
- Change out incandescent or fluorescent exit signs with Light Emitting Diodes (LED) exit signs.

- Locate outdoor lighting where it is needed. For example, locate outdoor lighting below tree canopies, not above.
- Set specific outdoor lighting, as appropriate, to automatically lower or turn off after the organization closes for the day and/or after all employees have left the premises.
- Invest in solar powered lights for outdoor lighting.

Cooling and Ventilation (accounts for between 30—50% of energy costs in buildings)

- Set the thermostat to 26oC or higher during warmer months when the work place is occupied, and 30oC or off after business hours, or turn off.
- Install programmable thermostats or time clocks as these can automatically adjust temperature settings and can thus save energy. Savings of up to 3% can be earned for each degree the thermostat is set above 25°C.
- Replace or clean a/c filters monthly, as dirty filters restrict air-flow and cause the system to use more energy. Clean filters can save about 2% of energy.
- Test ducts and repair leaks or restrictions. Leaking duct work accounts for as much as 25 % of cooling costs.
- Do not block the air conditioning vents with drapes etc.
- Use ceiling or room fans along with air conditioning (a/c), as air movement will cool the room.
- Keep outside units free from leaves or debris that may clog vents and displace air flow.
- Properly seal windows to prevent the loss of cool air.
- Keep windows and doors closed when the air conditioning unit is on to prevent intake of outdoor air which is usually warmer than indoor air. An increase in warm air indoors will cause the a/c to increase its energy consumption to maintain the pre-determined temperature.
- Ensure ceiling tiles are securely in place to reduce infiltration of unconditioned air into conditioned space.
- Cooling should start no sooner than ½ hour before the work day begins.

- Install awnings, solar film, or shade screens on east- and west-facing, sun-exposed glass areas.
- Replace old air conditioning units. Today's more energy efficient models use 30% to 50% less energy to produce the same amount of cooling as air conditioners made in the mid-1970s. Even if your air conditioner is only 10 years old, you may save 20% to 40% of your cooling energy costs by replacing it with a newer, more efficient model.

Computer Equipment, Photocopiers, Printers & Fax Machines

- Eliminate wasted energy; turn off monitors when computers are not in use, as monitors consume approximately 40% of the energy used by a computer.
- Turn off computers when not in use for 2 hours or more.
- Instead of using screensavers, programme the controlling software to render computers inactive when not in use. Screensavers use energy and some screensavers are now so complex that they consume excessive energy.
- Where possible, choose a smaller monitor. The bigger the monitor, the more energy it uses. Switching from a 17-inch monitor to a 14-inch monitor save energy by as much as 35%.
- Use monitors that have Liquid Crystal Display (LCD) panels as they use less energy compared to conventional Cathode Ray Tube (CRT) monitors.
- Consider the use of flat panel monitors as they use only a 1/3 of the power of conventional monitors and also saves space. Also, flat-panel monitors offer less glare and eyestrain with brighter/crisper images, and that they emit very little radiation. On the downside, flat panel monitors are more expensive than CRT monitors.
- Consider the use of laptops as they consume 90% less energy than regular workstations.
- Install local area networks (LAN) as they reduce energy costs through the sharing of computer resources.
- Install and use a LAN or printer-sharing switch rather than buying one printer per worker.
- Invest in "Uninterruptible Power Supplies," (also known as UPS which combine surge protectors and battery packs) as computer protection during power surges, low power supply or power cuts.

- Unplug appliances when not in use. Plug appliances into a power strip, which can be switched off, or use appliances that produces low standby losses. These measures will reduce the effects of leaking electricity.
- Eliminate wasted energy, turn off office equipment or set it to "power down" when not in use. Setting computers, monitors, and copiers to use sleep-mode when not in use can cut energy costs by approximately 40%.
- Turn equipment off at the end of the workday.
- Purchase photocopiers, printers, fax machines and computers that are equipped with energy saving features. These models use about 50% less energy than regular models. For example, the ENERGY STAR logo indicates the presence of energy saving features in these machines.
- Programme/enable the energy savings options on existing office equipment
- Purchase the right sized copier to fit the copying needs of the office.
- If appropriate, use ink jet printers - they consume 90% less energy than laser printers.

Food Service & Refrigeration Equipment

- When upgrading a kitchen, consider the following:
 - Infrared fryers
 - Convention ovens (including steamer models)
 - Microwave ovens
 - Specialized equipment (designed to cook specific foods efficiently)
- Cook with the most efficient appliance possible for the food being prepared.
- In general, the higher on the following list, the less energy the appliance uses
 - Microwave
 - Slow Cookers ("crockpots")
 - Fryer
 - Toaster Oven
 - Gas Oven
 - Electric Convection Oven
 - Electric Oven
- Use pressure cookers and microwave ovens whenever it is convenient to do so. They can save energy by significantly reducing cooking time.

- When using cooking equipment:
 - Turn equipment off when not in use
 - Use a temperature no higher than necessary
 - Match the equipment to the job
 - Cook as efficiently as possible – this includes adjusting flames on ranges to just touch the bottom of cookware, avoiding unnecessary oven door openings, cooking foods with the same requirements simultaneously, and cooking in volume.
- When purchasing a gas oven or range, look for one with an automatic, electric ignition system. An electric ignition saves gas—because a pilot light is not burning continuously.
- Purchase energy efficiency exhaust hoods as they provide significant savings because they use outside air rather than inside conditioned air for ventilation.
- Make sure your refrigerator door seals are airtight. Test them by closing the door over a clean piece of paper so it is half in and half out of the refrigerator. If you can pull the paper out easily, the latch may need adjustment or the seal may need replacing. Purchase refrigerators with automatic moisture control. Models with this feature have been engineered to prevent moisture accumulation on the cabinet exterior without the addition of a heater. This is not the same thing as an "anti-sweat" heater. Models with an anti-sweat heater will consume 5% to 10% more energy than models without this feature.
- Set the refrigerator and freezer at the settings designated by the manufacturer to preserve food quality and freshness. Recommended temperatures are 2.78°C to 4.4°C for the fresh food compartment of the refrigerator and -15°C for the freezer section. If you have a separate freezer for long-term storage, it should be kept at -17.7°C.
- Regularly defrost 'manual-defrost' refrigerators and freezers; frost build-up increases the amount of energy needed to keep the motor running. Don't allow frost to build up more than one-quarter of an inch.

Building Design

- Use “green design” features when renovating or building new structures. Green or sustainable building design encompasses design strategies, materials choices and construction methods that focus on the efficient use of resources over the full life cycle of a building and the creation of spaces that are healthy and comfortable for occupants. The Energy Efficiency Building Code, a voluntary code, developed by the Jamaica Bureau of Standards can be utilized when constructing new building.

- Encourage the use of day-lighting and natural lighting in design. In almost all cases where lighting is needed on a regular basis during the day, day-lighting can be an effective solution for at least some of the lighting requirements. Day-lighting should be considered in buildings such as offices, laboratories, schools, food service facilities, etc. In existing buildings, day-lighting potential is greatest close to perimeter window walls.
- Day-lighting should be integrated with electric lighting.
- Paint walls and roofs in white or light colours as white absorbs less heat than darker colours.
- Combine architectural features and shading so that a minimum of the building envelope is exposed to the sun. Design landscaping around the building and over parking areas so that no parking area is exposed to the sun. This will not only reduce the heat build-up in parked vehicles, but will reduce the temperature of air blowing against the building by 6 to 8 degrees.
- Install solar hot water heaters on the roof. Ensure that the building design includes adequate support for the dead weight load and the wind stress, and all conduits for pipes or wires.

Case Studies on the Fiscal and Regulatory Barriers to Advancing Renewable Energy Technologies

Guyana

Electricity - Regulatory Barriers

The regulatory barriers to implementation of renewable energy technologies are:

- Lack of a modern energy plan that integrates renewable power generation into a Sustainable Energy Policy for Guyana: Though there is some degree to which alternate energy is captured within the LCDS, there is a lack of comprehensive policy that takes account of modern advancements in renewable energy technologies and options, as well as the current state of the Guyanese and global economies.
- Lack of a long-term strategy for grid expansion that seeks to make timely and deliberate technological enhancements to the existing grid so as to facilitate the systematic addition of renewables: These are major infrastructure projects which cannot be carried out without planning security and requires a paradigm shift from the current method of forecasting which is limited to five year rolling plans.
- Lack of spatial planning for RE systems: The planning system's focus is expected to be on provision of guidance on the locations where particular renewables are most appropriate as well as the shaping of criteria for determining the project applications that are in keeping with the national sustainable energy strategy; this will serve, in particular, to reduce transaction costs associated with project siting and environmental permitting.
- Need for additional institutional capacity for project evaluation and approval: There is a lack of expertise for dealing with renewable energy issues within the respective government ministries and agencies, which leads to confusion, delays or unmotivated denials of approvals. This has served to limit the opportunity for diversification and RE integration continue to focus on utility scale hydropower and off grid solar PV.
- Weak regulation of the electricity sector: Whilst many Caribbean countries that have made progress in the regulation of their electricity sector have a regulatory agency that is empowered to set service standards and tariffs, in Guyana, the regulator (PUC) seems to have considerable legal, personnel and financial constraints, all of which limit its ability to fulfill its role.

Electricity – Fiscal Barriers

- Lack of competitive pricing for renewable energy feeding into an archaic, inefficient grid: Renewable energy power feeding into the GPL grid is unlikely to receive “full credit” for the value of the electricity generated as: (i) current fossil based prices are “artificially low” and will serve as a distorted baseline; and (ii) contribution of renewables to generation reliability and fuel savings are neither accounted nor compensated.
- Transaction costs are typically high, especially for small, grid scale renewable energy projects: Many projects, such as wind, waste to energy, biomass to energy, etc. will likely require information that may not be readily available or they may require additional time or technical personnel to assess and verify the bankability thereof. The absence of a recent assessment of renewable resources within Guyana as well as the burdensome utility interconnection requirement will add to the transaction costs.

Regulatory Barriers Specific to Large Renewable Energy Systems

- Administrative procedures for the addition of utility scale RE generation to the grid at best lacks transparency and is rather ambiguous; in the absence of a legal framework that delineates the “rules of engagement” for addition of utility scale renewables to the grid, the utility will continue to negotiate Power Purchase Agreements (PPA) on an ad hoc basis, which makes it difficult for potential project developers to plan and finance projects on the basis of transparent and consistent rules.

Fiscal Barriers Specific to Large Renewable Energy Systems

- There is a lack of institutional incentives for renewables that deliver favourable Levelized Cost of Electricity (LCOE) to the country; without reliable information on the relative costs and benefits of the available renewable energy technologies, it is difficult, if not impossible, for the government to accurately assess which technologies are the most appropriate for the various circumstances in Guyana and decision makers may therefore not fully understand the opportunities. Consequently, fiscal incentives (when given) are on an ad hoc basis and require “political approval”.

Regulatory Barriers Specific to Micro and Small Renewable Energy Systems

- There is neither legislation nor mechanism for grid connection and access: Within the electricity sector, interconnection regulations such as Net Metering and Net Billing provide additional modes of encouraging micro scale renewable energy investments, which cumulatively have the potential to rival large scale investor led projects. Interconnection regulations for customer generated RE is absent in Guyana and have the potential to provide significant stability and reliability to the grid.

Fiscal Barriers Specific to Micro and Small Renewable Energy Systems

- Lack of incentives for third party financing of building integrated RE technologies: The development of building integrated RE systems are incentivized through recent Customs and Value added Tax (VAT) Acts that provide exemption for some small scale RE technologies. But the more integration of RE technologies, such as solar PV, hybrid PV, and solar thermal systems for cooling and water heating, may add 10 – 20 per cent to building costs. Meanwhile, there is very little or no cognizance among mortgage banks and insurance companies for enhanced lifecycle of buildings with RE technologies compared to the BAU scenario and the usual formulae are applied to the calculation of loans and insurance premiums. In cognizance of the macroeconomic benefits of distributed RE applications to Guyana, it may be necessary to consider incentivizing the financial sector; the traditional approach of incentivizing end users through tariff and tax exemptions is, in cases, not sufficient to reduce the cost barrier for RE technologies.

Regulatory Barriers Specific to “Avoided Generation” Systems

- Low qualification and the lack of reliable certification schemes for installers: A typical barrier that continues to persist is also the lack of trained and competent installers for avoided generation systems, such as solar water heaters (SWH), in most markets. This is particularly relevant for single-family houses, where installers can often act as the decision-maker and may motivate potential users to buy “avoided generation” technologies. If they are not specifically trained, they may discourage consumers or even provide a poor installation, with a negative impact on the functionality of the system and on the image of the technology.

Fiscal Barriers Specific to “Avoided Generation” Systems

- Split incentives happen when those responsible for paying energy bills are different than those making capital investment decisions: Many “avoided generation” systems, such as solar water heaters are ideally suited to hospitals, hotels and apartment buildings. But frequently, the people who make the investment happen (substitute or replace grid based energy services with off grid alternatives) are not the ones who realize the electricity savings. In Guyana therefore, building design and the choice of energy technologies are influenced by factors that are deemed more expedient to the developer and there is neither the requirement nor incentive for project developers to include building operating and maintenance cost in bid tenders.

Regulatory Barriers Affecting Renewable Energy Vehicle Technologies

- Lack of a modern energy plan that integrates renewable fuel production, marketing and distribution into a Sustainable Energy Policy for Guyana: Though there is some degree to which biofuel options are captured within the LCDS, there is a lack of comprehensive policy that takes account of modern advancements in renewable energy vehicle technologies and options for electric vehicle (EV), hybrid electric vehicle (HEV) and flexi fuel vehicle (FFV) use.
- Renewable energy vehicles (such as EV, HEV and FFV) are not a priority within the Guyana energy framework: Renewable energy options more targeted towards the direct replacement of liquid fossil fuels by bioethanol and biodiesel blends.
- Price control mechanisms are utilized by government as a strategy to contain transportation cost for goods and people: This degree of subsidy is antagonistic toward the promotion of renewable fuels and vehicle technologies but was central to the National Development Strategy.
- The Government of Guyana, under the GRA Act, provides tariff exemption for the importation of a number of conventional vehicles; this serves to make the enhance market distortions toward renewable energy vehicle technologies and also provides a signal to the market regarding government's vehicle import priorities.

Fiscal Barriers Affecting Renewable Energy Vehicle Technologies

- Lack of competitive pricing: Most renewable energy vehicles are manufactured on assembly lines, where mass production can greatly reduce costs. But the global infrastructure for fuel production, distribution and supply is based on fossil vehicles and renewable vehicle technologies are, on average, 30 per cent more expensive than their conventional counterparts; Guyana does not provide incentives for renewable energy vehicles.
- The Guyana transportation sector is currently served by a very large, reliable petroleum liquid fuel infrastructure: If alternative low-carbon fuels are to displace petroleum fuels, they must provide similar levels of cost, convenience, and reliability, which will require significant investment in public and domestic delivery infrastructure. The mainstreaming of renewable energy vehicles will depend heavily on the availability of infrastructure to support their energy requirements, which may require government to use creative incentives to attract investments toward same.

Regulatory Barriers Specific to Renewable Energy Use in Domestic Transport

- Lack of information to make informed choices on domestic vehicle choices; consumers are essentially limited by the available technology options as well as the available infrastructure for fuel distribution. Both are creations of the motor vehicle regulatory

environment within Guyana, which has experienced very little change over the past three decades.

Fiscal Barriers Specific to Renewable Energy Use in Domestic Transport

- There are no fiscal incentives for the purchase of renewable energy vehicles (EV, HEV or FFV); simultaneously, there are Import Duty and VAT exemptions for the importation of conventional petrol or diesel powered vehicles that are more than four years old.

Regulatory Barriers Specific to Renewable Energy Use in Public Transport

- Lack of information to make informed choices on vehicle technologies for the public transport sector; in the case of fleet vehicles purchases (unlike the case of domestic vehicles), decision makers are less limited by the in country technology options but are nonetheless, limited by the available information of applicable options as well as the available infrastructure for fuel distribution.

Fiscal Barriers Specific to Renewable Energy Use in Public Transport

- Lack of incentive for investment in renewable energy vehicle technologies for the public transport sector; the public bus and minibus systems constitute aging vehicle fleets of typically more than ten years old and operate on marginal profits as government regulators significantly limit their ability to charge “market driven” tariff rates in an effort to keep public transport affordable. There are nonetheless significant opportunities for switching from conventional to renewable diesel, whenever sufficient supplies of the latter become available.

Regulatory Barriers Specific to Renewable Energy Use in Maritime Transport

- There is very little or no regulatory push for the integration of biodiesel use into the fuel mix for ferries, river boats and other water based freight vessels; so far, biodiesel use in Guyana have been limited to pilot demonstrations in a number of road based vehicles (light trucks and vans) as well as farm and production equipment that are owned by the IAST.

Fiscal Barriers Specific to Renewable Energy Use in Maritime Transport

- Despite the opportunities for biodiesel use, there are no incentives for the use of renewable energy fuels within the maritime industry; simultaneously, duty exemptions exist for the purchase of conventional diesel powered outboard engines (of 75 hp or less), which have the capability of using biodiesel without modification.

Belize

Electricity - Regulatory Barriers

The regulatory barriers to implementation of renewable energy technologies are:

- **Lack of integrated energy planning:** The MESTPU was established to mainstream the coordination of energy policy development and planning but there is no clear regulation or structure within which the planning process is embodied. The result is that despite the recommendation for broad based energy planning through an Energy Steering Committee and the anticipated coordinating role of the Ministry of Energy, Science, Technology and Public Utilities, there continues to be little broad based energy planning within Belize. Energy planning related to the electricity sector continues to focus on the least cost expansion of generation capacity that increases access to electricity whilst keeping the tariff affordable and is the responsibility of a state owned electric utility (BEL). Given Belize's long-standing participation and membership in the Caribbean Community (CARICOM), it has pursued deeper integration within CARICOM than it has done within Central America. Thus, Belize is part of the Caribbean Renewable Energy Development Project (CREDP) and the Caribbean Energy Information System (CEIS) but does not participate actively in the Sistema de Interconexión Eléctrica de los Países de América Central (SIEPAC) – translated as the Central American Electrical Interconnection System – or ALURE, a cooperation programme between the European Union and Latin America in the energy sector; a critical issue stems from the fact that there has been no clear assessment nor judicious decisions regarding the participation of Belize within SIEPAC and how this will influence the opportunities for large scale generation, which would have otherwise suffered from a lack of scale.
- **Lack of baseline data:** It has been 10 months since the constitution of the MESTPU and much of its ability to assess and plan is being stymied by a lack of historic data on energy consumption in general, and within the transport sector in particular. This limits the ability to set targets and to measure the achievement of indicators related to energy use as well as to make projections for judicious planning.
- **Lack of spatial planning for RE systems:** The planning system should focus on the provision of guidance towards locations where particular renewable energy technologies, such as biomass production and wind generation, are most likely to be appropriate as well as shaping the criteria to be taken into account in the determination of project applications. This will serve to reduce the transaction costs associated with project siting and environmental permitting.

- Lack of institutional capacity for project evaluation and approval: There is a limited expertise for addressing renewable energy issues within government ministries and agencies, which limits the approval process. This has served to limit the opportunity for diversification and RE integration continue to focus on utility scale hydropower and off grid solar PV despite the massive opportunities for other sources.
- Weak regulation of the electricity sector: Whilst many Caribbean countries that have made progress in the regulation of their electricity sector have a regulatory agency that is empowered to set service standards and tariffs, in Belize, the regulator (PUC) seems to have legal, personnel and financial constraints, all of which limit its ability to fulfil its role. Moreover, although the regulator is limited in its role it serves to make recommendations to the Minister on matters related to the operation of the electric and water utility.
- Absence of systematic administrative procedures for the addition of utility scale RE generation to the grid: In the absence of a legal framework that delineates the rules of engagement for addition of utility scale renewables to the grid, investors will continue to require individual licenses from the Government and will continue to negotiate Power Purchase Agreements (PPA) with the utility (BEL) on an ad hoc basis, which makes it difficult for potential project developers to plan and finance projects on the basis of open and consistent rules.
- There is neither legislation nor mechanism for grid connection and access by customer generators: Within the electricity sector, interconnection regulations such as Net Metering and Net Billing provide additional modes of encouraging micro scale renewable energy investments, which cumulatively have the potential to rival large scale investor led projects. Interconnection regulations for customer generated RE is absent in Belize despite having the potential to reduce and stabilize demand from the CFE grid.
- Low qualification and the lack of reliable certification schemes for small scale RE installers: There are few trained and competent installers for small RE and avoided generation systems, such as solar PV and solar water heaters (SWH) in the Belize market. This is particularly relevant for single-family houses, where installers can often act as the decision-maker and may motivate potential users to buy sustainable energy technologies.

Electricity - Fiscal Barriers

- Lack of competitive pricing for renewable energy feeding into the grid: Renewable energy power feeding into the BEL grid is unlikely to receive full credit for the value of the electricity generated as: (i) current fossil based prices are artificially low and will serve as a distorted baseline; and (ii) contribution of renewables to generation reliability and fuel savings are neither accounted nor reasonably compensated.
- Transaction costs are typically high, especially for small, grid scale renewable energy projects: Many projects, such as wind, waste to energy and biomass to energy will likely require information that may not be readily available or they may require additional time or technical personnel to assess and verify the bankability thereof. In particular, the cumbersome negotiations for securing Power Purchase Agreements (PPA) often times add to the transaction costs.
- There are limited institutional incentives for renewable investments that deliver macroeconomic benefits to the country: Investment incentives that have been designed for the manufacturing sector are being applied to energy investors under similar conditions and consequently, there is no package of realistic fiscal incentives that are tailored and applicable to the renewables industry. The consequence is that investors seek appropriate incentives on case by case through the application for waivers, through the Cabinet.
- Absence of incentives for RE technologies: The purchase of small RE technologies and their integration into new building construction is not incentivized as there is no provision for Duty and GST exemption for small scale RE technologies. This is especially important in an environment where the integration of RE technologies, such as solar PV, hybrid PV, and solar thermal systems for cooling and water heating, may add 10 – 20 per cent to new building costs and simultaneously, there is very little or no cognizance among mortgage banks and insurance companies for the enhanced lifecycle of buildings with RE technologies compared to the BAU scenario. Consequently, the usual formulae are applied to the calculation of loans with the consequence that the additional investment that is required for RE is prohibitive.

Transport – Regulatory Barriers

The following barriers apply to the use of renewable fuels and vehicle technologies within the transport sector.

- Absence of a Transport Policy that integrates renewable fuel production, marketing and distribution into the current National Energy Policy for Belize: Though there is some degree to which biofuel options are captured within the NEP, there is a lack of comprehensive sub policy on transport that takes account of modern advancements in renewable energy vehicle technologies, such as flexi fuel vehicle (FFV), and options for electric vehicle (EV) and hybrid electric vehicle (HEV) use.
- Renewable energy vehicles, electric and hybrid-electric vehicles are not a priority within the Belize energy framework: Renewable energy options more targeted towards the direct replacement of liquid fossil fuels by bioethanol and biodiesel blends and targets within the MESTPU Strategic Plan (2012 2033).
- Lack of reliable biofuel supply: Consumers are limited also by the lack of reliable sources of biofuel stock. There is neither the availability of biofuel blends, which can be suitably integrated into the existing fuel supply chain, nor pure biofuels (biodiesel or bioethanol) that can be used directly in FFVs. In fact, there are regulatory barriers within Belize that prohibit the active participation of the private sector in the agriculture, in particular bio energy, sector (Sugar Cane Control Industry Act, 2000). Despite the promotion of biofuels (targeting the transport sector) within the NEP and the MESTPU Strategic Plan, there has been no clear articulation of regulation change to facilitate reliable production. Simultaneously, the use of sugar lands in Belize remains inefficient and methodologies that optimize product yield has the potential to either produce additional sugarcane for bioethanol or provide acreage for dedicated biofuel crop production.
- The Belize transportation sector is currently served by a very large, reliable infrastructure for petroleum based liquid fuels: If low-carbon, renewable fuels are to displace petroleum fuels, they must provide similar levels of cost, convenience, and reliability. The mainstreaming of renewable energy vehicles will depend heavily on the availability of infrastructure to support their energy requirements and will require government to introduce appropriate regulations and legislation for the marketing and distribution of renewable fuels.
- Lack of information to make informed choices on domestic vehicle choices: Consumers are essentially limited by the available vehicle technology options within the country as

well as the available infrastructure for fuel distribution. Both are creations of the motor vehicle regulatory environment within Belize, which has experienced very little change over the past three decades.

- Lack of plans for the integration of renewable energy vehicle technologies into the public transport sector: Public transport planning in Belize is limited to the provision of licenses to public vehicle operators. The availability of information on suitable vehicle technology options as well as the required infrastructure for their energy supply is lacking. There is very little synergy between the MESTPU and the MTNEMO, which has served to restrict the exploration of options for the sector.
- There is very little regulatory push for the integration of biodiesel use into the fuel mix for water based freight and fishing vessels; so far, biodiesel use in Belize have been limited to pilot demonstrations in a number of road based vehicles (light trucks and vans) as well as farm and production equipment, especially within small, rural communities.

Transport – Fiscal Barriers

- Lack of competitive pricing: Belize does not provide incentives, such as duty waivers, for import of renewable energy vehicles. This serves to distort the markets in favour of conventional vehicles and the value added benefits of renewable energy vehicles are not compensated.
- Lack of incentives to encourage biomass production for the biofuel industry: Many farmers continue to over focus on the production of traditional agricultural crops, including sugarcane, despite the relatively low yields that stem from under investment in the sector. There is scope to offer incentives schemes to farmers for “crop switching” that produces “energy crops”, such as *Arundo donax*, that can be efficiently converted into biofuels through modern thermochemical processes.
- There are no fiscal incentives for the purchase of renewable energy, electric and hybrid electric vehicle technologies: The current structure of customs duties and tariffs for vehicles were formulated over thirty years ago for the importation of conventional petrol or diesel powered vehicles but have not been revised to accommodate the current paradigm in vehicle technologies and the energy strategy for the country.
- Absence of incentive for investment in renewable energy vehicle technologies for the public transport sector: The public bus and minibus systems constitute aging vehicle

fleets of typically more than ten years and operate on marginal profits in an effort to keep public transport affordable. This limits the ability and willingness of operators to invest in new vehicle technologies. There are nonetheless significant opportunities for switching from conventional to renewable diesel, whenever sufficient supplies of the latter become available.

- Despite the opportunities for biodiesel use, there are no incentives for the use of renewable energy fuels within the maritime industry: Simultaneously, duty exemptions exist for the purchase of conventional diesel powered outboard engines.

Jamaica

A report entitled “The Renewable Energies Potential in Jamaica” (2005) identified several barriers to the expansion of renewable energy use in Jamaica, as follows:

- Time-consuming administrative procedures related to RE project development
- Lack of economically sound contractual arrangements
- Imprecise legal formulations
- Inadequate financial and fiscal incentives (e.g. duty and GCT exemptions or property tax rebates)
- Lack of dedicated grants or soft-loans for RE exploration
- Inadequate up-to-date on-site pre-feasibility assessments
- JPSCo’s system losses (technical and non-technical) currently exceed the total energy produced by renewable energy providers, effectively raising the price of electricity to paying consumers. This issue will effectively raise the price consumers pay to JPSCo for each kilowatt-hour of renewable energy sold.
- Lack of penalties for not meeting renewable energy targets in the National Energy Policy
- Lack of building code enforcement for items such as solar water heaters
- Lack of uniform net-metering and interconnection standards for small-scale power generation units (e.g. solar photovoltaic systems)

Another barrier includes the Jamaica Public Service Company Ltd. (JPSCo) License which gives this company exclusive rights to transmit, distribute and supply electricity throughout Jamaica, for a twenty (20) year period, based on the All Island Electricity License (2001). This National Renewable Energy Policy is designed to break down these barriers and create an enabling framework for the development of the sector and for the deployment of RE technologies.

Notwithstanding there has been an increase in the percentage of renewables in the energy mix moving from 6% in 2008 to 9% in the 2009 and in 2012 to 11% of the energy mix due primarily

to the development and implementation of various programmes such as the full roll out of E10 for use in motor vehicles in the transport sector.

Module 3 – Removing the Barriers to Advance the Introduction of Energy Efficiency and Renewable Energy Strategies and Technologies

Removing the Barriers – Towards Advancing the Renewable Energy Sector – Policies and Strategies to Promote Renewable Energy Development and Deployment

The need for enacting policies to support renewable energy is often attributed to a variety of “barriers” or conditions that prevent investments from occurring. Often the result of barriers is to put renewable energy at an economic, regulatory, or institutional disadvantage relative to other forms of energy supply.

Many of these barriers are considered to be “market distortions” that unfairly discriminate against renewable energy, while others have the effect of increasing the costs of renewable energy relative to the alternatives. Barriers are often quite situation-specific in any given region or country.

Policies and strategies whose specific goal is to promote renewable energy fall into three main categories:

- Price- setting and quantity-forcing policies, which mandate prices or quantities
- Investment cost reduction policies, which provide incentives in the form of lower investment costs
- Public investments and market facilitation activities, which offer a wide range of public policies that reduce market barriers and facilitate or accelerate renewable energy markets

Price-Setting and Quantity-Forcing Policies

Price-setting policies reduce cost- and pricing-related barriers by establishing favourable pricing regimes for renewable energy relative to other sources of power generation. The quantity of investment obtained under such regimes is unspecified, but prices are known in advance. Quantity-forcing policies do the opposite; they mandate a certain percentage or absolute quantity of generation to be supplied from renewable energy, at unspecified prices. Often, price-setting or quantity-forcing policies occur in parallel with other policies, such as investment cost reduction policies.

The two main price-setting policies are the:

- Public Utility Regulatory Policies Act (PURPA) legislation in the United States
- “Electricity feed-in laws”

The two main quantity-forcing policies are the:

- Competitively-bid renewable-resource obligations
- Renewable portfolio standards

U.S. Public Utility Regulatory Policies Act - (PURPA). PURPA was enacted in 1978 in part to encourage electric power production by small power producers using renewable resources to reduce U.S. dependence on foreign oil. The policy required utilities to purchase power from small renewable generators and co-generators, known as “qualifying facilities,” through long-term (10-year) contracts at prices approximating the “avoided costs” of the utilities. These avoided costs represented the marginal costs to the utilities of building new generation facilities, which could be avoided by purchasing power from the qualifying facilities instead. Avoided cost calculations typically assumed an aggressive schedule of escalating future energy prices, making contract prices to qualifying facilities quite attractive.

Electricity Feed-in Laws - Electricity feed-in laws set a fixed price for utility purchases of renewable energy. For example, renewable energy producers could sell their power to utilities at a determined percentage of the retail market price. The utilities are oftentimes obligated to purchase the power from the supplier. Feed-in law tend to lend themselves to a rapid increase in installed capacity and development of commercial renewable energy markets.

Competitively-bid renewable-resource obligations – Here, power producers bid on providing a fixed quantity of renewable power, with the lowest-price bidder winning the contract. With each successive bidding round (there were four total), bidders reduced prices relative to the last round. One of the lessons that could be drawn from the UK experience is that competitively determined subsidies can lead to rapidly declining prices for renewable energy. However, there is a flip side to this as the process can encourage competing projects to bid below cost in order to capture contracts, with the result that successful bidders become unable to meet the terms of the bid or end up insolvent.

Renewable energy portfolio standards (RPS) - An RPS requires that a minimum percentage of generation sold or capacity installed be provided by renewable energy. Obligated utilities are required to ensure that the target is met, either through their own generation, power purchases from other producers, or direct sales from third-parties to the utility’s customers.

Typically, RPS obligations are placed on the final retailers of power, who must purchase either a portion of renewable power or the equivalent amount of green certificates (see below). Two types of standards have emerged: capacity-based standards which set a fixed amount of capacity by a given date, while generation-based standards mandate a given percentage of electricity generation that must come from renewable energy.

Renewable Energy (Green) Certificates - Renewable energy (green) certificates are emerging as a way for utilities and customers to trade renewable energy production and/or consumption credits in order to meet obligations under RPS and similar policies. Standardized certificates provide evidence of renewable energy production, and are coupled with institutions and rules for trading that separate renewable attributes from the associated physical energy. This enables a “paper” market for renewable energy to be created independent of actual electricity sales and flows. Green certificate markets are emerging in several countries, allowing producers or purchasers of renewable energy who earn green certificates to sell those certificates to those who need to meet obligations but haven’t generated or purchased the renewable power themselves. Those without obligations, but wishing to voluntarily support green power for philosophical or public-relations reasons may also purchase certificates.

Investment Cost Reduction Policies

A number of policies are designed to provide incentives for voluntary investments in renewable energy by reducing the costs of such investments. These policies can be characterized as falling in five broad categories, policies that:

- Reduce capital costs up front (via subsidies and rebates)
- Reduce capital costs after purchase (via tax relief)
- Offset costs through a stream of payments based on power production (via production tax credits)
- Provide concessionary loans and other financial assistance,
- Reduce capital and installation costs through economies of bulk procurement

Subsidies and Rebates - Reduction in the initial capital outlay by consumers for renewable energy systems can be accomplished through direct subsidies, or rebates. These subsidies are used to “buy down” the initial capital cost of the system, so that the consumer sees a lower price. In the United States for example, at least nineteen states offer rebate programs at the state, local, and/or utility level to promote the installation of renewable energy equipment. The majority of the programs are available from state agencies and municipally-owned utilities and support solar water heating and/or photovoltaic systems, though some include geothermal heat pumps, small wind generators, passive solar, biomass, and fuel cells. Homes and businesses are usually eligible, although some programs target industry and public institutions as well. In some cases, rebate programs are combined with low or no-interest loans.

Tax Relief - Tax relief policies can include:

Investment tax credits for renewable energy which are usually offered for businesses and residences.

Accelerated depreciation which allows renewable energy investors to receive the tax benefits sooner than under standard depreciation rules. The effect of accelerated depreciation is similar to that of investment tax credits. In the United States for example, businesses can recover investments in solar, wind, and geothermal property by depreciating them over a period of five years, rather than the 15- to 20-year depreciation lives of conventional power investments. India's accelerated depreciation policy allowed 100% depreciation in the first year of operation, helping spur the largest wind power industry among developing countries. However, this policy led to large investments without sufficient regard to long-term operating performance and maintenance, resulting in capacity factors lower than for wind power installations elsewhere. This led many to conclude that production-based incentives are preferable to investment tax credits and accelerated depreciation, although Germany's investment tax credits accompanied by wind turbine technical standards and certification requirements avoided the problems found in India.

Production Tax Credits provides the investor or owner of qualifying property with an annual tax credit based on the amount of electricity generated by that facility. By rewarding production, these tax credits encourage improved operating performance. A production tax credit in Denmark provides DK 0.10/kWh (US 1.5 cents/kWh) for wind power, but few other countries have adopted similar credits. In the United States the Renewable Electricity Production Credit (PTC) provides a per-kWh tax credit for electricity generated by qualified wind, closed-loop biomass, or poultry waste resources. Federal tax credits of 1.5 cents/kWh (adjusted annually for inflation) are provided for the first ten years of operation for all qualifying plants.

Property Tax Incentives for renewable energy are implemented in one of three ways: (1) renewable energy property is partially or fully excluded from property tax assessment, (2) renewable energy property value is capped at the value of an equivalent conventional energy system providing the same service, and (3) tax credits are awarded to offset property taxes.

Personal Income Tax Incentives are credits against personal income taxes made available for purchase of and/or conversion to eligible renewable energy systems and renewable fuels. In some cases, taxpayers can deduct the interest paid on loans for renewable energy equipment.

Sales Tax Incentives are policies that provide retail sales tax exemptions for eligible renewable energy systems and renewable fuels

Other Tax Policies - A variety of other tax policies exist, such as income tax exemptions on income from renewable power production, excise duty and sales tax exemptions on equipment purchased, and reduced or zero import tax duties on assembled renewable energy equipment or on components. India, for example, has allowed five-year tax exemptions on income from sales of wind power.

Grants - Many countries have offered grants for renewable energy purchases.

Loans - Loan programs offer financing for the purchase of renewable energy equipment. Loans can be market-rate, low-interest (below market rate), or forgivable. Funding comes from a variety of sources, including municipal bonds, revolving funds, development partners (PetroCaribe fund is an example). Financing may be for a fraction to 100% of a project. Some loan programs have minimum or maximum limits, while others are open-ended. In some developing countries, notably India, China, and Sri Lanka, multilateral loans by lenders such as the World Bank have provided financing for renewable energy, usually in conjunction with commercial lending. One of the most prominent examples is the India Renewable Energy Development Agency (IREDA), which was formed in 1987 to provide assistance in obtaining international multilateral agency loans and in helping private power investors obtain commercial loans.

Public Investments and Market Facilitation Activities

Public Benefit Funds - In the United States for example, public funds for renewable energy development are raised through a System Benefits Charge (SBC), which is a per-kWh levy on electric power consumption. Similar levies exist in some European countries for fossil-fuel-based generation. In general, the funds serve a variety of purposes, such as paying for the difference between the cost of renewables and traditional generating facilities, reducing the cost of loans for renewable facilities, providing energy efficiency services, funding public education on energy-related issues, providing low-income energy assistance, and supporting research and development.

Construction and design policies are building-code standards for renewable energy technologies such as PV installations, design standards evaluated on life-cycle cost basis, and performance requirements.

Equipment standards and contractor certification – can be developed to ensure uniform quality of equipment and installation, increasing the likelihood of positive returns from renewable energy installations. Contractor licensing requirements ensure that contractors have the necessary experience and knowledge to properly install systems. Equipment certifications ensure that equipment meets certain minimum standards of performance or safety.

Industrial recruitment - Industrial recruitment policies use financial incentives such as tax credits, grants, and government procurement commitments to attract renewable energy equipment manufacturers to locate in a particular area. These incentives are designed to establish RE industries, create local jobs, strengthen the local economy and tax base, and improve the economics of local renewable development initiatives.

Government Procurement policies can promote sustained and orderly commercial development of renewable energy. Governmental purchase agreements can reduce uncertainty and spur market development through long-term contracts, pre-approved purchasing agreements, and volume purchases. Government purchases of renewable energy technologies in early market stages can help overcome institutional barriers to commercialization, encourage the development of appropriate infrastructure, and provide a “market path” for technologies that require integrated technical, infrastructure, and regulatory changes.

Solar and Wind Access Laws - Renewable access laws address access, easements, and covenants. Access laws provide a property owner the right to continued access to a renewable resource. Easements provide a privilege to have continued access to wind or sunlight, even though development or features of another person's property could reduce that access. Easements are often voluntary contracts, and may be transferred with the property title. Covenant laws prohibit neighbourhood covenants from explicitly restricting the installation or use of renewable equipment. Policy mechanisms include access ordinances, development guidelines addressing street orientation, zoning ordinances with building height restrictions, and renewable permits.

Power Sector Restructuring Policies that can Influence Renewable Energy Development

Power sector restructuring is having a profound effect on electric power technologies, costs, prices, institutions, and regulatory frameworks. There are five key trends underway that continue to influence renewable energy development, both positively and negatively.

Competitive Wholesale Power Markets and Removal of Price Regulation on Generation - Power generation is usually one of the first aspects of utility systems to be deregulated. The trend is away from utilities monopolies towards open competition, where power contracts are signed between buyers and sellers in wholesale “power markets”. Distribution utilities and industrial customers gain more choices in obtaining wholesale power. Such markets may often begin with independent-power-producer (IPP) frameworks. As wholesale electricity becomes

more of a competitive market commodity, price becomes relatively more important than other factors in determining a buyer's choice of electricity supplier.

The potential effects of competitive wholesale markets and IPPs on renewable energy are significant. Wholesale power markets allow IPPs to bypass the biases against renewables that traditional utility monopolies have had. In some countries, IPP frameworks have been explicitly enacted to support renewable energy. Examples are Sri Lanka and Thailand, where utility monopolies were broken and renewable energy IPPs can sell power to the grid. However, other effects of wholesale competition may stifle renewable energy development. As low-cost combined-cycle gas turbines begin to dominate new generation, renewable energy has difficulty competing on the basis of price alone.

Self-Generation By End-Users and Distributed Generation Technologies - independent power producers may be the end-users themselves rather than just dedicated generation companies. With the advent of IPP frameworks, utility buy-back schemes (including net metering), and cogeneration technology options, more and more end-users, from large industrial customers to small residential users, are generating their own electricity. Their self-generation offsets purchased power and they may even sell surplus power back to the grid. Traditionally, regulated monopoly utilities have enjoyed economic advantages from large power plants and increasing economies of scale. These advantages are eroding due to new distributed generation technologies that are cost-competitive and even more efficient at increasingly smaller scales. In fact, newer technologies reduce investment risks and costs at smaller scales by providing modular and rapid capacity increments.

Renewable energy is well suited to self-generation, but faces competition from other distributed generation technologies, especially those based on natural gas. Gas has become the fuel of choice for small self-producers because of short construction lead times, low fuel and maintenance costs, and modular small-scale technology. However, with restructuring, a host of distributed generation policies, including net metering, become possible (see the section on distributed generation policies). These policies often spur renewable energy investments. On the other hand, self-generators may be penalized by utility-wide surcharges that accompany restructuring, such as those for stranded generation assets (called "non-bypassable competitive transition charges" in the US). Self-generators who use renewable energy must still pay these charges, based on the amount of electricity they would have purchased from the grid, even if actual grid consumption is small.

Privatization and/or Commercialization of Utilities - In many countries, utilities, historically government-owned and operated, are becoming private for-profit entities that must act like

commercial corporations. Even if utilities remain state-owned, they are becoming “commercialized”—losing state subsidies and becoming subject to the same tax laws and accounting rules as private firms. In both cases, staffing may be reduced and management must make independent decisions on the basis of profitability. The effects of privatization and commercialization on renewable energy are difficult to judge. The environmental effects of privatization can be positive or negative, depending on such factors as the strength of the regulatory body and the political and environmental policy situation in a country. Private utilities are more likely to focus more on costs and less on public benefits, unless specific public mandates exist. On the positive side, privatization may promote capital-intensive renewable energy by providing a new source of finance—capital from private debt and equity markets. However, the transition from public to private may shorten time horizons, increase borrowing costs, and increase requirements for high rates of return. All of these factors would limit investments in capital-intensive renewable energy projects, in favour of lower-capital-cost, higher-operating-cost fossil-fuel technologies.

Unbundling of Generation, Transmission and Distribution - Utilities have traditionally been vertically integrated, including generation, transmission and distribution functions. Under some restructuring programs, each of these functions is being “unbundled” into different commercial entities, some retaining a regulated monopoly status (particularly distribution utilities) and others starting to face competition (particularly generators). Unbundling can provide greater consumer incentives to self-generate using renewable energy. If retail tariffs are “unbundled” as well, so that generation, transmission and distribution costs are separated, customers have more incentive to self-generate, thereby avoiding transmission and distribution charges.

In addition, open-access transmission policies that go along with unbundling have been explicitly targeted to promote renewable energy in some countries. In India, open-access policies helped catalyze the wind industry there, by allowing firms to produce wind power in remote regions with good wind resources and then “wheel” the power over the transmission system to their own facilities or to third parties. Brazil enacted a 50% reduction of transmission wheeling fees for renewable energy producers, which has been credited for promoting a booming small hydro industry there.

Competitive Retail Power Markets and “Green Power” Sales - Competition at the retail level means that individual consumers are free to select their power supplier from among all those operating in a given market. Competitive retail power markets have allowed the emergence of “green power” suppliers who offer to sell renewable energy, usually at a premium. As green power sales grow, these suppliers are forced to investment in new renewable energy capacity to meet demand, or buy power from other renewable energy producers. Green power markets

have begun to flourish where retail competition is allowed, but often only in conjunction with other renewable energy promotion policies. The Netherlands is perhaps the best-known example. Following restructuring in 2001, one million green power customers signed up within the first year. However, incentives played a role; a large tax on fossil-fuel-generated electricity, from which green power sales were exempt, made green power economically competitive with conventional power. In the U.S., green power markets are emerging in several states in response to state incentives and aggressive marketing campaigns by green power suppliers. At least 30 US states have green pricing programs. Four states have mandatory green power policies that require utilities to offer customers opportunities to support renewable energy. California became one of the largest markets, with over 200,000 customers, but this was aided by a 1 cent/kWh subsidy to green power, paid for by a system benefits charge.

Distributed Generation Policies that can Influence Renewable Energy

Development

Distributed generation avoids some of the costs of transmission and distribution infrastructure and power losses, which together can total up to half of delivered power costs. Whilst policies to promote distributed generation—including net metering, real-time pricing, and interconnection regulations do not apply only to renewable energy, they can strongly influence renewable energy investments.

Net metering allows a two-way flow of electricity between the electricity distribution grid and customers with their own generation. When a customer consumes more power than it generates, power flows from the grid and the meter runs forward. When a customer installation generates more power than it consumes, power flows into the grid and the meter runs backward. The customer pays only for the net amount of electricity used in each billing period, and is sometimes allowed to carryover net electricity generated from month to month. Net metering allows customers to receive retail prices for the excess electricity they generate at any given time. This encourages customers to invest in renewable energy because the retail price received for power is usually much greater than it would be if net metering were not allowed and customers had to sell excess power to the utility at wholesale rates or avoided costs. Electricity providers may also benefit from net metering programs, particularly with customer-sited PV which produces electricity during peak periods. Such peak power can offset the need for new central generation and improve system load factors. **(Case Study – Jamaica)**

Real-Time Pricing, also known as dynamic pricing, is a utility rate structure in which the per-kWh charge varies each hour based on the utility's real-time production costs. Because peaking plants are more expensive to run than baseload plants, retail electricity rates are higher during peak times than during shoulder and off-peak times under real-time pricing. When used in

conjunction with net metering, customers receive higher peak rates when selling power into the grid at peak times. At off-peak times the customer is likely purchasing power from the grid, but at the lower off-peak rate. Photovoltaic power is often a good candidate for real-time pricing, especially if maximum solar radiation occurs at peak- demand times of day when power purchase prices are higher. Real-time metering equipment is necessary, which adds complexity and expense to metering hardware and administration.

Module 4: Developing Energy Efficiency and Renewable Energy Policies and Action Plans – Advancing the EE and RE Agenda of Countries

Like any policy, national energy efficiency (EE) and renewable energy (RE) policies should provide the rationale for the policy, describe the context for the development of the policy, articulate the vision and goals and include strategies to achieve those goals. The policies should also present a monitoring and evaluation framework which would include the selection of indicators and the identification of targets and the monitoring protocol. Indicators are the building blocks of policy monitoring and evaluation. Once these are decided, targets should be set in collaboration with the key implementation partners.

Key Elements of National Renewable Energy Policies

Key elements that should be included in national renewable policies are described below.

Rationale for Policy

The rationale for a national renewable energy policy should articulate the country's need for the development of a renewable energy sector and clearly state how the policy supports specific aspects of the country's national energy policy as well as national and sectoral development plans. For example, if there are renewable energy targets in the national policy, the renewable energy policy should indicate how that target would be met.

The rationale should also include the benefits of developing the renewable energy sector. As described in Module 1, these benefits include the following:

- Less air pollution due to using a cleaner energy source
- Reduced greenhouse gas emissions associated with electricity generation
- Greater energy security by displacing fossil fuels with more sustainable and locally available sources of energy
- Improvements in balance of trade due to the displacement of imported oil
- More affordable energy to consumers
- Potential for increased employment opportunities and economic diversification

A Profile of Renewable Energy Sector

The policy should include a description of the existing renewable energy sector in the country to provide a baseline for the development of strategies and to establish indicators and targets. The profile should include:

- Examples of existing renewable energy facilities with an indication of their current status – including the amount of energy generated
- Existing legislation or regulations that impact the renewable energy sector
- Current or planned renewable energy projects
- Any existing or proposed Government or private sector renewable energy initiative – including incentives to encourage the development of renewable energy
- The amount of energy that is generated annually from renewable sources – and the percentage of the total annual energy use of the country

Scope for the Development of the Renewable Energy Sector

While there may be renewable energy options that are common to all Caribbean countries such as solar, each country must determine which renewable sources it should focus on developing in the short term and which should be the focus for more long-term research and future investment. To inform his decision, research should be undertaken to inform which renewable energy focus area will be pursued. This research could include an examination of existing national and regional studies and reports as well as examples of international case studies from similar countries.

Possible renewable sources of energy include:

- | | |
|---|--------------------|
| • Hydro | • Landfill gas |
| • Wind | • Sewage gas |
| • Solar | • Geothermal |
| • Bagasse – sugar co-generation | • Ocean/wave/tidal |
| • Co-generation | • Fuel cells |
| • Waste energy from waste food and agricultural wet waste | • Biofuels |

SWOT Analysis

A SWOT analysis of the renewable energy sector should be conducted to inform the policy and the main elements included in the policy document. For the development of renewable energy sector, the identification of strengths and weaknesses (including existing barriers) represents the internal assessment of the sector while the consideration of opportunities and threats represents the analysis of the impact of the external environment on the sector. The SWOT analysis and the profile of the renewable energy sector form the basis for identifying goals and strategies that will be employed in the development of the sector. Some issues to be considered in the SWOT analysis are shown in the table below. Country-specific details related to these issues should be identified in the analysis.

Strengths	Weaknesses
<ul style="list-style-type: none"> Identified indigenous sources of energy available for development Existence of national energy policy Existence of national development plan Experience with certain sources of renewable energy Existence of any institutions that promote RE 	<ul style="list-style-type: none"> Deficiencies in technical and R&D capacity in RE Low levels of awareness of RE Limited regulatory framework for promoting the use of renewables (e.g. lack of proper tax incentives/disincentives; net metering; feeding tariffs, net wheeling) Deficiencies in national policies and regulations Deficiencies ability to draft new legislation
Opportunities	Threats
<ul style="list-style-type: none"> Current private sector interest towards investment in RE Access to information and expertise in RE Global thrust towards development of RE as sustainable forms of energy Support for RE developments from IDPs Current high price of electricity Benefits from trading carbon credits through participation in the Clean Development Mechanism by implementing RE projects 	<ul style="list-style-type: none"> Fluctuating (relative price of oil) oil prices (if oil prices fall low there could be loss of interest in RE) Advanced technologies for accessing conventional sources of energy Prohibitive costs of existing renewable energy technologies Natural hazards Theft



A source of information on renewable energy is the Caribbean Information Platform on renewable Energy: <http://cipore.org/home/>

The Strategic Framework

The policy’s strategic framework will include the vision and goals for the renewable energy sector – and suggested strategies for accomplishing the goals. The framework should also include the organisations which will be responsible for guiding, developing and implementing the strategies.

The goals should address the economic, infrastructural and planning conditions that would support the development of RE; fiscal and financial policy instruments to encourage RE; legislation and regulations; technical capacity; and research and development for RE.

Some incentives to encourage the development of RE are shown in the table below.

Area for RE Development Focus	Financial Measures <i>(Subsidies, loans, grants, fiscal measures)</i>	Non-Financial Measures
RD&D (Research, Development and Demonstration) and innovation	Fixed government RD&D subsidies Grants for demonstration, development, test facilities, etc. Zero (or low) interest loans	Technical cooperation
Investments	Fixed government investment subsidy Bidding system on the investment Subsidy/grant Subsidy on switching to renewable energy production or on the replacement of old renewable energy installations Zero (or low) interest loans Tax advantage for renewable energy investments Tax advantage on (interest on) loans for renewable energy investments	Negotiated agreements between producers and government
Production	Feed-in tariffs at a fixed level set by the authorities Bidding system on the feed-in tariffs necessary to operate on a profitable base Tax advantage on the income generated by renewable energy	Quota obligation on production
Consumption	Tax advantage on the consumption of renewable energy	Quota obligation on consumption

Strategies

Some general strategies to promote renewable energy include the following:

- Create an economic, infrastructural and planning environment conducive to the sustainable development of all renewable energy resources
- Create the enabling environment that facilitates the introduction of key policy instruments (financial and fiscal) for the promotion of renewable energy
- Create the legislative and regulatory environment, responsive to growth and development in the renewable energy sector
- Enhance technical capacity and public awareness of renewable energy through effective support of training programmes, information dissemination strategies and ongoing government communication
- Promote research & development and innovation in existing and emerging renewable energy technologies (RETs)

Key elements of National Energy Efficiency Policies

Key elements that should be included in national energy efficiency policies are described below.

Rationale for Policy

The rationale for a national energy efficiency policy should articulate the vital importance of increasing energy efficiency throughout all aspects of country's operations and state how the policy supports specific aspects of the country's national energy policy as well as national and sectoral development plans.

The rationale should also include the benefits of increasing energy efficiency. As described in Module 1, these benefits include the following:

- Increased energy security due to reduced dependence on imported oil
- Reduction demand for foreign currency to make payments for oil purchases
- Improvements in energy use in the transportation, manufacturing, building, and other economic sectors.
- Improved air quality
- Reduced greenhouse gas emissions
- Deferred need to invest in new infrastructure
- Waste reduction
- Freeing up of capital and hedging of fuel risks
- Enhanced competitiveness

A Profile of National Energy Use

The policy should include a description of the country's current energy use to provide a baseline for the development of strategies and to establish indicators and targets. The profile should include:

- Energy use by different economic sectors – the amount of energy used and the source of energy
- Description of the main energy users
- Current and planned energy conservation and efficiency initiatives
- Any major policy directives or government initiatives promoting energy efficiency
- Existing legislation or regulations that affect efforts to increase energy efficiency

Scope for Increasing Energy Efficiency

Improvements in energy efficiency can play a significant role in addressing energy security, environmental and economic objectives. A policy on energy efficiency should examine a number of issues and determine the areas for priority actions. The policy should address: public sector, private sector (households, industrial, commercial and tourism), electricity generation, transport, codes and standards, the energy efficiency market, environmental impacts, the

institutional framework and technical capacity development. An examination of international best practice (especially in geographically or economically similar countries) can provide guidance on strategies that can be employed.

SWOT Analysis

A SWOT analysis of the energy sector should be conducted to inform the policy and the main elements included in the policy document. This analysis should be conducted to identify elements of the national energy picture which are particularly appropriate to increasing energy efficiency in the public and private spheres – on both small and large scales. The SWOT analysis and the profile of the energy sector form the basis for identifying goals and strategies that will be employed in increasing energy efficiency. Some issues to be considered in the SWOT analysis are shown in the table below. Country-specific details related to these issues should be identified in the analysis.

Strengths	Weaknesses
Developed power supply and distribution system Existence of national energy policy Existence of national development plan Existence of any initiatives that promote EE	Deficiencies in technical and R&D capacity in EE Low levels of appreciation of need for EE Deficiencies in national policies and regulations Deficiencies ability to draft new legislation Old/aging electricity generation plants
Opportunities	Threats
Current private sector interest towards investment in EE Current high price of electricity Replacing old low-functioning electricity-generating plants with new efficient plants Access to Clean Development Mechanism through EE projects	Fluctuating (relative price of oil) oil prices (if oil prices fall low there could be less incentive to give priority to EE) High costs of more energy efficient technologies Theft

The Strategic Framework

The policy’s strategic framework will include the vision and goals for increasing energy efficiency – and suggested strategies for accomplishing the goals. The framework should also include the organisations which will be responsible for guiding, developing and implementing the strategies.

The goals should address adoption of EE practices by households and businesses; reducing and/or eliminating barriers to the uptake of energy efficiency projects and technologies; and improving the efficiency of electricity-generating plants

Strategies

Some general strategies to promote energy efficiency include the following:

- Promote demand-side energy conservation with emphasis on priority sectors such as mining, manufacturing and tourism
- Optimize energy supply
- Build capacity for uptake of energy efficiency plans and programmes including short- and medium-term financing needs
- Understand demand and supply aspects of energy efficiency
- Understand the legal and institutional frameworks that remove market distortions that favour conventional sources of energy
- Implement regulatory interventions which are required to implement norms and certification programmes etc.

Renewable Energy Indicators and Targets

Some example indicators for the renewable energy sector are shown in the table below. The table provides a suggested format which could be included in a policy document.

Indicators and Targets – Renewable Energy Policy

Proposed Indicator	Baseline	Targets		
	2013	2016	2020	2030
Percentage of energy from renewable energy sources in the energy supply mix				
GWh of electricity generated from renewable energy facilities				
% BOE avoided via net metering				
Percentage of workforce employed in the renewable energy sector				
Investments in renewable energy as a % of total investments				
BOE displaced by RE projects				
Contribution of the renewable energy sector to GDP				
Area of land used by renewable energy projects as a percentage of total land use				
Avoided GHG emissions (tonnes) due to RE				
% of RE projects benefitting from carbon credits				
Per capita installed capacity of solar water heaters				
Share of renewables in electricity generating capacity				
Share of renewables in gross electricity consumption				

Proposed Indicator	Baseline	Targets		
	2013	2016	2020	2030
Share of biofuels in road transport energy consumption				

Energy Efficiency Indicators and Targets

Some example indicators for an energy policy are shown in the table below. The table provides a suggested format which could be included in the policy document.

Proposed Indicator	Baseline	Targets		
	2013	2016	2015	2030
Primary energy intensity				
Final energy intensity (at ppp)				
CO ₂ emissions per capita				
Energy intensity of mining				
Energy intensity of manufacturing sector				
CO ₂ emissions of industry				
Energy intensity of transport to GDP (ppp)				
CO ₂ intensity of transport to GDP (ppp)				
Average electricity consumption of households per capita				
Households consumption for electrical appliances and lighting				
Efficiency of total electricity generation				
Rate of electricity transmission-distribution losses				

Developing Individual Country Policies

A national renewable energy or energy efficiency policy should be developed only after the country has an overarching national energy policy – and should explicitly support the larger policy by addressing specific energy goals. The policies should then include the key elements outlined above.

As with the development of any national policy, top-level leadership is important and the policy document should include a statement from a key government leader indicating commitment to the policy. Also, stakeholder involvement is critical. Key stakeholders from government ministries with responsibility for energy, environment, finance, transportation, tourism and agriculture (among others) should be involved in the development of the goals, strategies, indicators and targets. Other stakeholders include academia, civil society (including

environmental non-governmental organizations and professional associations) and the private sector.

Developing Individual Country Action Plans

A national policy provides the broad strategic framework for accomplishing goals within a medium to long term. These goals are achieved through implementing short-term (1-3 year) action plans which are developed throughout the course of the policy period. For each goal outlined in the policy, key projects/initiatives will be developed and implemented towards contributing to the achievement of that goal.

The action plan sets out targets to be achieved at the end of the period and identifies key projects and initiatives that will be implemented or initiated during this time to achieve these targets. Therefore, in following the action plan, strategies identified in the policy will be operationalized by the associated implementing agencies and partners through the incorporation of specific actions in the Strategic and Operational Plans of these entities. These organization-level plans will provide detailed information on specific actions to be undertaken, the implementing agencies and partners, timelines and costs.

In addition, the roles of the private sector and civil society will be presented, for they too have an important part to play in ensuring that the goals of the policy are met. It is well-recognized that the private sector is a country's engine of economic development and they must be involved in the requisite activities.

For each policy goal, the action plan should include the following for each project or initiative:

- Responsible Agencies/Organizations
- Strategies Addressed – the strategies identified in the policy that this project is implementing
- Other policy goal(s) addressed – other goals in the policy to which this project is contributing (in addition to the primary goal to which the project is geared)
- Timeline
- Cost
- Expected Outcomes
- Performance Measurement

A sample template is shown below.

Action/ Initiative	Responsible Agencies	Contribu- tion to Other Goals	Strategies Addressed	Timeline	Cost	Expected Outcomes	Performance Measurement
Goal 1:							
Goal 2:							

EXERCISE

For your country, complete the steps towards the development of a national renewable energy policy or a national energy efficiency policy using the outline below.

NAME OF POLICY: _____

SWOT Analysis

STRENGTHS	WEAKNESSES
OPPORTUNITIES	THREATS

VISION: _____

GOALS AND STRATEGIES

Goal 1: _____

Strategies:

1. _____

2. _____

3. _____

4. _____

5. _____

Goal 2: _____

Strategies:

1. _____

2. _____

3. _____

4. _____

5. _____

Goal 3: _____

Strategies:

1. _____

2. _____

3. _____

4. _____

5. _____

Goal 4: _____

Strategies:

1. _____

2. _____

3. _____

4. _____

5. _____

Goal 5: _____

Strategies:

1. _____

2. _____

3. _____

4. _____

5. _____

ACTION PLAN

Action/ Initiative	Responsible Agencies	Goals ⁴	Strategies Addressed	Timeline	Expected Outcomes	Performance Measurement

⁴ Indicate all goals supported by this action and highlight the primary goal among these to which this action contributes.

Action/ Initiative	Responsible Agencies	Goals ⁴	Strategies Addressed	Timeline	Expected Outcomes	Performance Measurement

Action/ Initiative	Responsible Agencies	Goals ⁴	Strategies Addressed	Timeline	Expected Outcomes	Performance Measurement

Module 5: Train the Trainer

The course is designed to serve as a train-the-trainer model with the expectation that participants will develop skills to serve as resource persons to conduct similar awareness raising and skill development sessions with their colleagues.

The goals of this model are to:

- Prepare participants to use Training Manual as a Resource Guide for undertaking their day to day work
- Enable participants to facilitate effectively when they are using the manual or accompanying PowerPoint Presentations to inform their staff of renewable energy and energy efficiency issues or to explain the policies or plans being developed
- Develop participants' skills in delivery of a presentation or course. The facilitators will demonstrate various tips to help with making a presentation or course more dynamic

Tips to Implement the Course as a Train-the-Trainer Model

- At the very beginning of the workshop advise participants that the training session will be a model that will illustrate elements they can use in their own organizations.
- At the end of the course, review these training aspects of the course.
- Be aware of time management – strike a balance between allowing discussion from a wide cross section of persons and keeping the planned agenda on track
- Utilize a mixture of facilitation and learning techniques, for example:
 - Lectures or short lectures from guest speakers
 - Discussions
 - Individual work
 - Small group exercises (enhancing participants' skills in group dynamics)
 - Field trips where applicable (such as to a renewable energy installation or best practice energy efficient plant)
- Involve each participant and allow participants to share their experiences and knowledge as in focus group meetings
- Provide a variety of resource materials – including current relevant news articles
- Encourage groups and individuals to make formal presentations about their policy or action plan. This will demonstrate how they can present the policy or plan to other stakeholders. Conduct an analysis of the presentations, pointing out areas of strengths and weaknesses and provide tips and suggestions for the future. This analysis will help to enhance participants' skills in distilling key information to create PowerPoint presentations, and delivering presentations – including interacting with their audience.

Facilitation Skills



Tips for the Facilitators

- Gain as much understanding about the group you are facilitating in advance of the session as is possible (numbers, work done to date, issues and concerns).
- As a facilitator you must have a very clear understanding of what needs to be accomplished by the end of the session and the means you will use to guide the group to this end.
- Be flexible. Plan your process in advance, but be ready to change or adapt to meet the needs of the group.
- Don't make the process too complex. You do not want the process to get in the way of learning and discussion. The larger the group, the simpler the process should be.
- Don't try to cram too much activity into the time you have. Allow time for meaningful discussion. Often, the sharing of ideas and discussion has the most value for participants.
- There is a balance to strike between giving people time to express themselves and keeping the process on track.

Exploring Facilitator Styles

Facilitators are guides, not participants. They ask open-ended questions designed to elicit the utmost in creativity and insight. They assume every contribution has an insight behind it and in fact, it is the task of the facilitator and the group to gain that insight for the collective good.

Facilitators do not give answers, but ask question after question to draw out wisdom, clarify it, build on it with other insights, and help the group forge out a concrete consensus to which the whole group can commit itself. They sometimes ask intentionally naïve questions, intending to get at the roots of apparent disagreement, thereby revealing a difference in understanding or values and providing a basis for resolution. They assume that every participant has an important perspective to contribute and draw out naturally quiet people even if that requires asking naturally dominant people to listen more often than is their habit. They promote clarity by enabling participants to contribute to their wisdom in short, succinct phrases which convey concise images.

Facilitators prepare extensively. They then set a clear context for the task at hand, requesting data from participants on their anticipations, regarding desired results from the group's interaction. They have clearly in mind the objective of the interaction, the time allotted to consideration and the needed impact on participants. In many interactions, one experiential objective is for the group to conclude that it already has the power and authority to implement its decisions. Facilitators familiarize themselves with the community organization's history, current external operating environment, and internal working atmosphere.

Facilitators are concerned both with process and results. They keep the interaction moving toward a decision. When there is no consensus in a critical arena, they facilitate a decision about the process necessary to produce consensus. Consensus within the group becomes the building factor, not presumed right or wrong. They assume that reality will reveal itself in due time as the group continues its work. They believe that not every issue has to be sorted out at the instant of its being raised.

Facilitators are reflective human beings. They regularly make time for the group to reflect on the significance of their work. They demonstrate and elicit humour which releases tension and provides relief from intensive work. They facilitate intuitive leaps which spark creativity, a highly motivating force which produces commitment. They require clear conclusions regarding decisions made and ensure objective documentation of the group's work for every participant, thereby paving the way for implementation.

Qualities of a good facilitator

- Trust in others and their capacities (both co-facilitators and participants)
- Good listening skills
- Good presenting skills
- Confidence without arrogance
- Ability to create an atmosphere of confidence among participants
- Respect for the opinion of others (not imposing ideas)
- Flexibility in changing methods and sequences as needed
- Knowledge of group process, including the ability to sense the group's mood at any given time and adjust the programme accordingly
- Familiarity with the culture, needs, strengths, and limitations of participants, and respect for individual differences
- Organisation: equipment, supplies, time schedule
- Ability to strike the delicate balance between being directive and non-directive, and to know when each stance is needed at different points during the workshop

In addition to these qualities, facilitators also should have relevant knowledge and experience in evaluation planning and implementation, and/or a good understanding of typical barriers and benefits of treatment evaluation. Formal scientific training is advantageous for certain types of evaluation, but is no guarantee of good facilitation.



Good Facilitating Behaviour

Setting the Stage

- Set up a space in a design functional for the requirements of the event. In a participatory planning session, people should be seated so they can see one another and track the “group memory.”
- The space should communicate that something important is going to happen here.
- Décor such as wall charts, quotations, meeting groundrules, plants and art objects can help set the tone and remind the group of its task or purpose.
- State clearly the purpose and expected outcomes of the meeting and ensure that the group understands and concurs.
- Propose a process for achieving the purpose of the meeting and get the group’s agreement on this. It may help later in the meeting. E.g. “remember, we said we would brainstorm alternatives before beginning to evaluate them.”
- Outline the proposed timeline for the meeting and ask for the group’s assistance in staying on track. Stick to it, or ask the group to make changes as the need arises.

Encouraging Participation

- Encourage participation by each individual present. Every person’s involvement is critical to the success of the meeting.
- Encourage participation for the entire time. Coming and going by some participants can be distracting.
- Don’t over-dominate the discussion. Contextual overview, procedural guidelines, and clarifying questions and statements are sufficient. The facilitator stays focused on the process, allowing the participants to contribute 100% of the content of the meeting.
- Don’t be afraid of silence. People need thinking time, especially for more complex or critical matters.
- Do ask for quality and informed participation: ask for details and examples, encourage the group to avoid generalizations; encourage people to be comprehensive, look at all angles and probe into the depths of the issue; encourage creativity and innovative thinking; and encourage honest, open and helpful dialogue.

Enabling the Flow

- Be attentive to the pace: keep it lively during brainstorming, slow it down for more reflective, pondering questions.
- Be positive and encouraging: model affirmation by honoring all individual and group work.

- Have fun and enable the group to enjoy being together: enliven with humour, affirmation and authentic enthusiasm.
- Create and work with the “group memory,” a written record of the group’s work that is available for all to see, to ensure that ideas are visible to the group, and to reflect the consensus as it develops.
- Use body language – to show attentiveness, to bring into the process people who are not participating, to bring the group’s attention back to the “group memory,” etc.
- Help the group maintain its focus: review where you are in the process (“where we’ve been and where we’re going”); repeat the focus question; re-issue instructions, etc.

Dealing with Problem Participation

- Avoid allowing one or two people to dominate the discussion; ask that they summarize for the “group memory” and move on to someone else.
- Affirm multiple and diverse points of view; ensure that they are recognized as significant.
- Don’t answer questions the group should answer for themselves. Give the question back to them so they can own the decisions.
- Don’t be defensive. If someone in the group questions the way you are conducting the meeting, ask the group if they are still comfortable with the decisions made at the beginning or would they like to make some changes.
- Take time to make meeting or team ground rules at the beginning, and enable the group to hold itself accountable for following them; call attention to their disregard by certain participants if necessary, in order to change behaviours.
- Accept/legitimize/deal with or defer: this is a general method of dealing with problem participation.
 - Accept the criticism or the feeling that has been expressed;
 - Acknowledge that it may have legitimacy;
 - Stop and deal with the issue if possible and relevant to the meeting; or
 - Defer it to a later time, e.g., “can we wait until the end of the meeting, and if your issue has not been addressed, we’ll deal with it at that time?”
- Don’t let your leadership prejudice or bias the group’s thinking. If you are attached to a particular outcome for the meeting, don’t facilitate. The final product should not reflect your thinking. If there are pre-determined outcomes or boundaries within which decisions must fit, make that clear at the beginning; otherwise your facilitation will be suspected of manipulating the group’s work.

Training Methods and Materials



Training is a highly specialized skill. Each trainer uses his or her own experience, talents, and style to implement the workshop. Training methods and materials are the techniques and resources the trainer uses to implement the workshop and transfer new knowledge, skills, and attitudes to participants.

Teaching Methods – General Tips

- When choosing teaching methods for a particular lesson, consider the following questions:
 - Is the method suitable for the objective?
 - Does the method require more background knowledge or skills than the participants possess?
 - How much time does it take to prepare? To use? Is that time available?
 - How much space does it take? Is that space available?
 - Is the method appropriate for the size of the learning group?
 - What kind of teaching materials does it require? Are they available?
 - Does the method require special skills to use? Does the trainer possess these skills?

Teaching Methods for Knowledge

- Teach only those facts which the participants need to know
- Get the participants' attention - explain why they need to know the topic. Tell a story that shows why it is important

- Give a summary. Explain the main themes you are going to cover
- Present the facts and information
- Use handouts and manuals to reinforce the lecture or lecturette. Participants learn more by listening and actively participating than by taking detailed written notes
- Ask participants to tell stories about how the facts will be used
- When possible, use audio-visual aids
- Plan an exercise for participants to practice the knowledge they learned

Training Methods for Skills

- Name the skill
- Tell why it is important
- Explain when to use it
- Describe the steps involved in performing the skill
- Demonstrate the skill
 - The demonstration must use effective methods which are applicable to the work environments of the participants
 - Use only equipment which is available to participants in the field
 - All participants must be able to see what you are doing
 - Explain what you are doing (a written handout with pictures will help reinforce the explanation)
- Arrange practice sessions - This is the most important part of teaching skills
 - Take time to practice
 - All participants must practice the skill
 - Each participant must receive feedback from the trainer/facilitator

Types of Training Materials

Written materials are useful when teaching knowledge. They may already be available at the appropriate learning level or the trainer may have to develop new materials.

- Things to consider when developing and using written materials:
 - They contain only the knowledge that participants need to know.
 - They are clear.
 - Layout is very important. Keep pages looking 'clean' and uncluttered.
 - Use language and diagrams appropriate to participants' level of knowledge. For example, only use graphs if participants can read a graph.

Audio-visual materials are useful for teaching knowledge and skills. Examples of audio-visual materials

- black board
- flip charts
- charts and diagrams
- models
- photographs
- overheads
- slides
- videos

- Things to consider when choosing audio-visual materials:
 - How does the material enhance active learning?
 - Is the material appropriate to the knowledge level of the participants?
 - How will the trainer use the material?
 - Is the material available for the training?
 - Will all the participants be able to see and/or hear the material?
 - Does the method require any supplemental materials? Are the supplemental materials available? (For example, to show a film you need a screen or blank white wall; to use a flip chart you may want to use different color markers.)
 - Are the facilities appropriate for use of the material?

The trainer will implement the workshop by choosing training methods and materials which are suited to the objectives of the lesson and which require active participation of the persons attending the workshop.