CLIMATE CHANGE TECHNOLOGY NEEDS ASSESSMENT FOR SAINT LUCIA

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1. INTRODUCTION

In 1992, at the United Nations Conference on Environment and Development (UNCED), the world community agreed to the United Nations Framework Convention on Climate Change (UNFCCC) to promote international cooperation in combating the problems associated with a changing global climate. In 1997 the Kyoto Protocol to the UNFCCC was agreed on, with the Protocol to come into force when countries, accounting for 55% of global emissions, ratified the instrument. Article 4.5 of the UNFCCC promotes the development and transfer of environmentally sound technologies to developing countries[1] as a means for enabling the international community to fulfill the requirements of the convention. In Marrakech in 2001 the UNFCCC Conference of Parties, the highest decision making body of the convention, agreed upon Decision 4/CP7[2] as a framework for international and national action for the development and transfer of technologies.

One element of the technology transfer framework is the preparation of technology needs assessments[3]. Climate change technology needs assessments are intended to assist developing countries in identifying priority environmentally sustainable technologies that can be considered as a part of the response to the mitigation of climate change[4] or as adaptation to climate change[5].

This report is intended to provide a technology needs assessment for Saint Lucia indicating the priority environmentally sustainable climate change technology needs for Saint Lucia. In line with the guidance provided in 4/CP7, it is expected that the results of the technology needs assessment will be made available in national communications and other related national reports.

[1] Termed non-annex 1 countries under the UNFCCC.
[2] The text of UNFCCC Decision 4/CP7 is provided as Appendix1.
[3] Other elements of the framework are technology information, enabling environments, capacity building, and mechanisms for technology transfer.
[4] See section 3 below.
[5] See section 3 below.

2. METHODOLOGY

Various methodologies have been developed for the conduct of climate change technology needs assessments. These include approaches developed by the Climate Technology Initiative[6] and by the United Nations Environment Programme[7]. These methodologies have certain basic common characteristics and steps, and emphasize consultative processes aimed at enabling stakeholder involvement in defining priority technology needs, the establishment of criteria for selecting priority technologies, and the linking of climate change technology needs with wider development needs and objectives. Both methodological approaches have been utilized within the UNFCCC process. Further, both emphasize the need for flexible use of the guidelines to suit particular national circumstances.

As noted above, the identification of technology needs for responding to global climate change should occur within the context of wider national development goals. Given the existing challenges that already confront efforts to achieve sustainable development in developing countries and the uncertainties as to the pace and nature of climate change, efforts for adapting to climate change as well as for reducing greenhouse gas emissions should be related to other non-climate change concerns such as economic development, health and environmental protection. A draft framework for technology needs assessments for adaptation to climate change in the Caribbean has been prepared at a UNDP sponsored workshop in Trinidad in 2003 which seeks to ensure a close linkage between the priority technology needs identified and national development priorities. Appendix 2 provides a schematic of the draft framework for technology needs assessment for adaptation to climate change developed for the Caribbean.

For the implementation of the technology needs assessment in Saint Lucia, the various methodological tools have provided important guidance within the context of logistical, data and other constraints. Specifically, in accordance with the terms of reference of the assignment, activities have included:

- a review of available climate change related documentation, including the Initial National Communication of St Lucia, with a view to

[6] Methods for Climate Change Technology Transfer Needs Assessments and Implementing Activities: Developing and Transition Country Approaches and Experiences. Climate Technology Initiative. March 2002.

[7] A UNDP/GEF Handbook on methodologies for technology needs assessments. Final draft August 2003.UNDP.

identifying environmentally sustainable technology needs for enabling the country to adapt to and mitigate against global climate change,

- consultations with key stakeholders in public and private sectors with regard to the priority adaptation and mitigation areas for climate change technology (transfer and development), so as to enable Saint Lucia to identify priority technology need areas for submission to the UNFCCC, and
- Preparation of a report on climate change technology needs for Saint Lucia, indicating the priority environmentally sustainable climate change technology needs based on the processes outlined above.

3. DEFINITIONS

Given the uncertainties that surround climate change it is important to use accepted definitions for some of the terms used in this report.

Climate change is defined in the UNFCCC as "a change which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability..". This definition distinguishes between natural changes in climate and those arising from human activity. The effect of these activities is a change in the chemical composition of the Earth's atmosphere.

The Intergovernmental Panel on Climate Change[8] (IPCC) has defined ***technology*** as "a piece of equipment, technique, practical knowledge or skills for performing a particular activity" and ***technology transfer*** as "..processes covering the exchange of knowledge, money and goods amongst different stakeholders that lead to the spreading of technology for adapting to or mitigating climate change"[9]. Technologies may be "soft" such as training and information technology, or "hard" such as wind energy and certain coastal protection technologies. The transfer of technology may be via various means including private sector acquisition, government ownership, and concessionary arrangements. Technology needs are dynamic and change with time so that a needs assessment necessarily reflects the situation at a particular time. The acquisition or transfer of a particular technology may in itself affect subsequent technology needs.

[8] The IPCC was established in 1988 as a joint initiative of the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) to provide scientific and technical

[9] Methodological and Technological Issues in Technology Transfer. IPCC. 2000. Cambridge University Press.

The IPCC report on Methodological and Technological Issues in Technology Transfer defines ***adaptation*** to climate change as an "adjustment in natural or human systems in response to actual or expected climate stimuli or their effects, that moderates harm or exploits beneficial opportunities"[10]. This recognizes that adaptation activities may be reactive and/or proactive, and that it is possible that there may also be beneficial opportunities arising from climate change[11]. It is important that adaptation not be seen as a separate and distinct set of activities since in many instances adaptation will involve incorporating knowledge of and concerns for climate change into existing and planned programmes and activities. As the IPCC has pointed out, "a key misconception is that adaptation is a task carried out by governments. Insofar as governments have property and are responsible for carrying out a variety of activities, they will be required to take adaptive actions. Most adaptations, however, will be carried out by individual stakeholders and communities…. Therefore, the government's primary role is to facilitate and steer this process…"[12].

From the standpoint of operationalizing adaptation, there is general acceptance of the need to link, or integrate, measures for adapting to climate change with other development goals and objectives[13]. This is important given the long timeframes and uncertainties associated with climate change, as well as the need to reduce existing vulnerabilities so as to strengthen capacities (ecological, technical and infrastructural) for responding to a changing climate.

Finally, ***Mitigation*** of climate change refers to efforts to reduce emissions of the greenhouse gases that cause global climate change, and to efforts that enhance the sinks[14] of greenhouse gases. Mitigation includes greenhouse gas emission reductions through policies and measures involving use of renewable energy, increased efficiency of energy use, and enhancement of greenhouse gas sinks through sustainable forest management.

[10] See above op cit.
[11] While short term benefits may arise it is difficult to see any sustainable benefits to be derived from climate change.
[12] Third Assessment Report (Working Group II, p. 867).
[13] See for example "Climate Impact and Adaptation Assessment: A Guide to the IPCC Approach". Martin Parry and Timothy Carter. Pages 114 – 136. Earthscan. 1988. Also "The Adaptation Policy Framework: Users Guidebook". Final Draft. UNDP/GEF New York. November 2003.
[14] Sinks refers to processes that remove carbon dioxide and other greenhouse gases from the atmosphere.

4. OVERVIEW OF SAINT LUCIA

4.1 Introduction

The island nation of Saint Lucia is located at 13 degrees north and 61 degrees west in the Lesser Antilles of the eastern Caribbean archipelago, situated between the archipelagic country of Saint Vincent and The Grenadines to the south and the French territory of Martinique to the north.

Saint Lucia has a population of approximately 162,000 persons[15]. Table 1 provides information on the growth of St Lucia's population over roughly the last 150 years. The figures demonstrate rapid population growth since the 1960s. However population trends indicate a shift towards more stable population growth. For 2001 population density was 280 persons per square kilometer nationally, with the figure rising to 760 in Castries.

Table 4.1: Census Population 1843-2001

Year	Population
1843	20,694
1901	49,883
1960	86,108
1970	100,893
1980	113,409
1990	133,308
2001	151,143

Source: Compendium of Environmental Statistics 2001

The island has a total land area of 616 sq. km. consisting primarily of a rugged topography that reflects its volcanic origin, and is characterized by a narrow coastal zone and a mountainous interior which rises to a height of 950m at Mt. Gimie. In addition to the mountainous areas, the island also possesses a number of valleys important to agricultural production and human settlements.

Saint Lucia possesses only limited natural resources presently capable of sustained exploitation. These consist primarily of fertile lands, coastal resources such as beaches and fisheries, and pumice. Considerable potential exists for harnessing of the country's alternative energy sources such as wind, solar and geothermal.

[15]July 2003 Estimate. Source: CIA World Factbook. 2003.

The island's landscapes provide habitats for a number of terrestrial and marine species of flora and fauna with life zones on the island varying from tropical dry forest in coastal areas to tropical rain forest in mountainous interior locations. Terrestrial fauna include over one hundred and fifty species of birds, seventeen reptiles, nine mammals and four amphibians including a number of endemic species. Pressure from habitat loss and over-exploitation means that a number of species of flora and fauna are threatened.

Biodiversity in coastal and marine environments is also rich and includes coral reefs, sea-grass beds, rocky shores, wetland areas and sandy beaches, along with the various fisheries and other living marine resources associated with these habitats. These coastal resources provide the basis for the country's tourism and fisheries sectors.

4.2 Existing Climate

The climate of Saint Lucia can be characterized as tropical maritime, reflecting the influence of the sea and the country's geographical position in the western Atlantic. The island has a mean maximum temperature of 30.1 Celsius and a mean minimum of about 24.5 Celsius so that there is only limited seasonal variation in temperature. Diurnal (daytime vs. night-time) variation is of the order of 6 degrees Celsius whereas seasonal variation is near 2 degrees Celsius. The coolest months are December to March and the warmest from August to October. Altitude and topographic factors result in a number of micro-climates.

In contrast to temperature, rainfall figures can vary significantly on spatial, seasonal and annual bases. The island experiences a rainy season generally from June to December and a dry season from February to May. Average total annual rainfall is about 1700 mm with September being statistically the rainiest month. Orographic influences result in significantly higher rainfall over the mountainous interior than in coastal areas, with the northernmost and southernmost areas of the island being the driest. Heavy rainfall events are generally the result of various tropical weather systems such as tropical cyclones and tropical waves, as well as the influence of the Inter-Tropical Convergence Zone. Winds are generally out of the east between 070 degrees and 100 degrees at an average speed of about 16 m.p.h. The windiest months are from January to July.

Saint Lucia lies within the path of the annual Atlantic hurricane season that lasts from May to November. During this period, and particularly from July to October, oceanographic and atmospheric conditions result in the formation and passage of a number of tropical waves, storms, and hurricanes across the Atlantic. Weather conditions associated with the passage of these tropical weather systems include strong winds and torrential rainfall. Saint Lucia's history contains many instances of the loss of life and destruction to property resulting from these conditions.

4.3 Overview of the Economy

Historically, the economy of Saint Lucia has been based on the production and export of agricultural produce. During the 1970s and 1980s, banana production for sale to protected markets in the United Kingdom dominated the economy, providing the principal sources of employment and foreign exchange. The advent of free market arrangements for bananas in the UK and European markets since the latter half of the 1990s has proved problematic for small high cost banana producers like St Lucia where cultivation of the fruit by small farmers, low technological inputs, and difficult terrain have meant that the industry is unable to compete with large multinational agricultural corporations. Present thrusts in agricultural development include improving competitiveness through soil and water management and improving business skills and capabilities in the agricultural sector. In addition to bananas, other agricultural produce include root crops, livestock and poultry, citrus and mangoes. Markets include export, tourism and domestic markets.

Following on the decline of the agricultural sector has been the rapid expansion and development of St Lucia's tourism sector based on a number of attractions including the country's climate, dramatic natural scenery, coastal and marine features, and cultural festivals. Tourism now constitutes the main engine of economic growth, including providing the main source of employment and having substantial linkages with other sectors such as retail, construction, agriculture and services. In addition to stay over visitors, Saint Lucia also attracts large numbers of cruise ship passengers, with the cruise sector witnessing some of the most significant growth in terms of visitor arrivals over the last decade. Government plans envisage continued reliance on tourism as a major catalyst for economic growth and development.

In addition to the tourism and agricultural sectors, other major sources of economic activity include construction, transport and communications, and

government services. Manufacturing industry is aimed primarily at local markets and consists mainly of agro-industrial products, textiles, and construction materials. Within the agricultural sector, fisheries constitute a major sub-sector.

Notwithstanding considerable achievements in a range of social and economic indicators, as well as in diversifying the economy, Saint Lucia faces a number of critical obstacles to sustainable development. Principal among these are problems of persistent poverty and their associated environmental and social effects. Estimates for 1995 indicated poverty levels at 25% of the population. Downturns in economic activity reflected in the decline in the banana industry, the slowdown in tourism earnings after 9/11, and declines in the manufacturing sector are believed to have exacerbated trends such as an increase in urban poverty and increased numbers of elderly persons affected by poverty. A number of government programmes are aimed directly and indirectly at eliminating and/or alleviating some of the problems associated with poverty in Saint Lucia.

4.4 Institutional Arrangements for Climate Change

Institutional responsibility for management of climate change concerns in Saint Lucia resides with the Sustainable Development and Environment Section of the Ministry of Planning, Development, Environment and Housing. This Section coordinates activities for the implementation of many of the environmental conventions to which Saint Lucia is party. Among its ongoing activities in relation to climate change are efforts aimed at sensitisation of principal stakeholders, public awareness, and capacity building on matters relating to sustainable development. In terms of the UNFCCC, the main activities at this stage revolve around implementation of the responsibilities relating to the reporting and other requirements of the convention, measures to promote capacity building, and public awareness activities.

Another agency with primary responsibility in the area of climate change is the Meteorological Department, which is responsible for the collection and analysis of meteorological data. In addition, the National Climate Change Committee (NCCC) a multi-sectoral steering committee comprising various public and private sector agencies, provides technical input on climate change to the Sustainable Development Unit.

4.5 Vulnerability to Existing Climate and Weather

A critical set of obstacles to sustainable development arises from the island's vulnerability to a number of natural disasters. In particular, Saint Lucia's geographic location and topographic profile make it prone to various weather related disasters. These include hurricanes, floods, droughts, fires, storm surge, and coastal erosion. Other non-climatic hazards and risks include earthquakes, volcanic eruptions, fires, marine accidents, and tsunamis.

Historically, hurricanes and floods have had the most disastrous impacts. In the last half century a number of storms and hurricanes have resulted in the loss of life and property. These hurricanes include Hurricane Janet in 1955, and hurricanes Abby and Edith in the 1960s, all of which resulted in economic losses to agriculture, infrastructure and other property. In 1980 Hurricane Allen caused nine deaths, rendered 6,000 persons homeless, and caused damage estimated at EC$250 million. In 1994, Tropical Storm Debbie resulted in losses in excess of EC$230 million. In 1996 a strong tropical wave incurred an estimated EC$12 million in damages to properties and infrastructure. In 1999, the eastward moving Hurricane Lenny generated storm surge that caused extensive damage in coastal areas. These represent significant events in the Saint Lucian context and require the diversion of limited resources from other development priorities towards relief, rehabilitation and reconstruction activities.

In addition to vulnerabilities arising from topography and other natural factors, there is also the influence of human activities that enhance risks resulting from natural causes. Deforestation, inappropriate land use, poorly planned physical development, and certain agricultural practices increase the risk of landslides and flooding that cause substantial damage to property, crops and coastal resources. Increasing volumes and improper disposal of solid wastes also contributes to flooding, particularly in built up areas, and increases risks of disease and contamination.

Another significant vulnerability relates to drought. Saint Lucia depends on surface sources to meet its water requirements with rainfall being unevenly distributed both spatially and temporally. At present, annual dry season conditions invariably affect the availability of water supplies to residential and other consumers. This is particularly significant in view of Saint Lucia's

economic dependence on agriculture and tourism. In the case of agriculture the variability associated with drought conditions continues to seriously affect agricultural development and exports, including fruit quality and supplies in the economically important banana industry. In the case of tourism, rapid growth and high per capita demand characterize water usage in this sector. Recent severe drought events, such as in 2001, resulted in rationing of water supplies at tourism properties, as well as temporarily reducing the attractiveness of the islands natural scenery that is a critical component of the tourism experience for which Saint Lucia is marketed.

In addition to impacts on the economic sectors, drought conditions in Saint Lucia also adversely affect human health. These impacts include increased cases of gastrointestinal illnesses, one of the principal sources of morbidity in Saint Lucia, and enhanced risks for dengue fever as a result of increased storage of water. Dry dusty conditions also affect respiratory health.

Other weather related vulnerabilities relate to erosion of coastal areas from storm surge and rising seas that adversely affect residential, tourism and fisheries property and infrastructure.

At a more general level, as a result of their size, small island developing States like Saint Lucia are recognized as being particularly vulnerable to economic, environmental and security risks. For Saint Lucia, recognition of such vulnerabilities has spurred various regional cooperation initiatives aimed at reducing vulnerability and increasing resiliency through the sharing of limited resources and undertaking of joint activities.

5. CLIMATE CHANGE MITIGATION ISSUES

5.1 Energy Generation Sector

Saint Lucia's Initial National Communication reports that the country produced a total of 432 Gigagrams in emissions of GHGs in 1994. Most of these emissions originated from the energy generation sector followed by the transport sector.

In terms of electricity generation, Saint Lucia's peak demand has climbed from 30.7MW in 1994 to 43.4 in 2002. The island presently has an installed capacity of 68.8MW supplied by diesel generators. Between 1995 – 1999, electricity demand expanded by 32%. Official forecasts suggest that base

demand for electricity will increase at an average of 5.2% annually over the next few years with an estimated cost of approximately US$1million annually required to fund this expansion[16].

The country has achieved virtually 100% electrification. An interesting development from a climate change perspective has been the growth of summer time demand for electricity during day time, so that peak demand is now experienced in the day driven by extensive air-conditioning use in office buildings rather than traditional night time peak demands related to lighting[17]. At present, there is no renewable energy in the energy supply mix for electricity generation for Saint Lucia.

Reliance on petroleum-based electricity has meant that electricity costs have been affected by the steady increase in global oil prices that have occurred since 2002. The high cost of petroleum products has renewed interest in renewable energy and in energy conservation programmes. Experience with earlier efforts suggests that a number of regulatory, institutional, financial, and technical requirements are needed if efforts for energy efficiency and use of renewable energy are to become institutionalised and sustainable. These requirements include the availability of low cost or concessional financing for purchase of technology, availability of information regarding opportunities in these areas, and certain levels of technical capability among energy producers and end-users.

5.2 Road Transportation

The INC identifies the road transport sector as the second main source of GHGs in Saint Lucia[18] in 1984. Growth in this sector has been particularly rapid with the number of registered vehicles increasing by approximately 25% in the five-year period from 1997 to 2001. At the end of 2003, Saint Lucia had a vehicular registration of 40,026,[19] a high per capita index of vehicle ownership for a developing country. The rapid growth of road transport may have resulted in the sector now accounting for a larger share of fuel imports and greenhouse gas emissions than the energy generation sector.

[16] Information relating to energy generation is taken from "Energy Sector Policy and Strategy: a Green Paper for Discussion. Volume 1". Ministry of Physical Development, Environment, and Housing, Government of Saint Lucia. October 2003.
[17] This may reflect both warmer or more humid conditions as well as a shift to more "modern" building designs.
[18] Emissions arising from international air and sea transport are regarded as fugitive emissions and are not recorded as national emissions in the GHG inventory agreed under the UNFCCC.
[19] Source. Saint Lucia Road Transport Board. January 2004.

Table 2 below provides a comparison of transport sector shares of petroleum imports. This indicates that transportation does consume a greater amount of petroleum imports than energy generation. Unfortunately this figure does not disaggregate road transport and other domestic uses from international transportation. This is significant since IPCC and UNFCCC reporting requirements separate international, so-called fugitive emissions, from emissions involving domestic sources. This is especially important in the case of St Lucia where long haul aircraft utilizing St. Lucia consume large quantities of fuel.

Table 5.1: Transport Share of Petroleum Imports Bill (EC$ million)

	1998	1996	1994
Transport sector cost (CIF)	43.7	34.9	27.3
LUCELEC fuel costs (CIF)	23.9	28.0	20.2
Total Petroleum Costs	67.6	62.9	47.5
Transport sector share (%)	65	56	57
LUCELEC share (%)	35	44	43

Government of Saint Lucia. Energy Sector Policy and Strategy (A Green Paper For Discussion). Volume 1. Ministry of Physical Development, Environment and Housing, Castries, St Lucia. October 2003.

For the road transport sector in addition to the problems associated with greenhouse gases from vehicular emissions, there are also more immediate development concerns related to lost productivity, road safety, air and ground pollution, infrastructural development and costs, and foreign exchange leakage. Nonetheless, despite the problems relating to the transport sector, effective regulation of growth in the sector remains difficult given the strong demand for personal transportation and the reliance on petroleum dependent imported transportation technologies.

5.3 Energy Efficiency and Conservation

In general, the structure of energy consumption in Saint Lucia is characterized by a large number of small consumers in residential, tourism, and commercial sectors. This has implications for the type of mitigation measures that can be successfully used. Energy efficiency/conservation

measures would appear to provide opportunities for reducing rates of growth and overall consumption of imported GHG producing energy sources.

As the IPCC has pointed out, hundreds of technologies currently exist that can improve the efficiency of energy appliances and equipment and building structures, the main end users of energy in Saint Lucia. In the case of buildings available technologies can result in emission reductions of as much as 30%[20]. The Government of Saint Lucia will have a major role to play in creating an environment that allows private sector driven technology transfer for energy efficiency through such measures and policies as full cost pricing of fossil fuels, regulatory actions, and customs and duties.

In Saint Lucia responsibility for energy conservation measures resides with the Sustainable Development Unit and with the national electricity utility. Actions in this regard have tended to be prompted by movements in petroleum product prices and there is yet to be a long-term national plan on energy conservation embracing a range of public and private sector stakeholders. Improvements in energy efficiency have the potential to reduce foreign exchange outflow for petroleum imports, reduce pollution associated with petroleum fuels, and to provide avenues for employment in energy conservation related occupations

5.4 Natural Gas

In Saint Lucia and elsewhere in the eastern Caribbean, interest exists as to the possibility of a natural gas pipeline from Trinidad in the south to Guadeloupe in the north. As envisaged, the pipeline would be used to generate electric power in the French territories of Guadeloupe and Martinique, and in Barbados, from where overall demand for electric power is expected to rise by at about three per cent a year. Energy cost reductions are estimated to be as high as 40-50 per cent for power companies using No. 2 fuel oil to generate electricity[21].

Advantages of natural gas are that it is a cleaner fuel; is versatile in its application; the technologies for using this resource are in use and widely available; and natural gas can be adapted as a transport and household fuel with fairly marginal conversion costs. These factors make natural gas a potentially attractive option for greenhouse gas emission reduction and

[20] IPCC 'Climate Change 2001: Mitigation. Summary for Policy Makers and Technical Summary of the Working group 111 Report. IPCC Secretariat. Geneva. 2001.
[21] "C'bean gas pipeline behind schedule". Trinidad Guardian February 19,2004

energy substitution in Saint Lucia, once issues such as base demand for (and therefore feasibility of) the fuel and costs for installation of the necessary infrastructure can be addressed.

5.5 Renewable Energy

Expected economic growth and development mean that efficiency increases alone will be insufficient to reduce GHG emissions from the energy sector. Options to reduce emissions per unit of energy produced include various forms of new and renewable energy. Saint Lucia would appear to possess considerable indigenous energy potential particularly in solar, wind, biomass, and geothermal energy sources.

The Initial National Communication of Saint Lucia indicates that the country's Sustainable Energy Development Plan (SEDP) projects that 20% of the installed electricity generation would come from renewable energy by 2010. In order to achieve this a number of activities are envisaged in the SEDP including resource assessments, reform of the power sector, and the establishment of a project investment fund. At present solar energy for heating is in widespread use in residential and other applications.

The government's Green Paper on Energy Sector Policy and Strategy notes that at "the present time renewable energy makes no contribution to the supply mix in St. Lucia. Even though it appears that wind and geothermal energy could make a significant contribution to the energy supply mix, existing energy sector policies do not encourage the rapid development of these renewable energy resources. New policies will need to be put in place to facilitate the speedy introduction of renewable energy production in the national energy mix".

5.6 Geothermal Energy

Efforts towards exploitation of the islands geothermal energy have been enhanced by the recent signing of a US$10 million agreement between government and private investors for initial exploration and development of geothermal energy on the island's west coast. The resultant geothermal power is intended for electricity base load application with official forecasts for geothermal providing up to 15 to 20 percent of the total annual production of electricity. Press reports indicate that an economic impact study produced by the National Economic Council (NEC) estimates that the potential savings to the St. Lucia economy will be in the vicinity of EC$2.5

million annually for each one cent reduction in the per unit cost of electricity. The NEC report estimates that government would also earn royalty payments and that the potential sale of carbon credits could be applied to further reduce electricity prices to consumers. Development of geothermal energy would also contribute towards national energy security.

5.6 Mitigation in the Land Use, Land Use Change, and Forestry (LULUCF); Wastes; and Agriculture Sectors

The Initial National Communication of Saint Lucia indicates that the country produces small amounts of various GHGs through processes of land use, land use change, and in the forest ecosystems[22]. Nevertheless Saint Lucia's Initial National Communication indicates that the LULUCF category is a net sink of GHGs so that the country is under no legal or other obligation to undertake mitigation activities in these sectors.

The Initial National Communication points out that some emissions of GHGs, chiefly methane and nitrous oxide, also occur from Wastes and from the agricultural sector. In the case of Wastes, these emanate primarily from landfill activities. For agriculture, emissions derive from the digestive processes of animals and from management of agricultural fields. In all instances these represent negligible contributions to overall national emissions.

Consequently, any mitigation activities in these sectors should be directed primarily at non-climate change related concerns, such as improving agricultural efficiency or environmental and economic benefits in landfill management, with climate change mitigation benefits as a by-product or additional benefit. At the same time there is the need to be aware of opportunities for technology financing and other opportunities that may exist for these sectors through linkages with climate change for example under the Clean Development Mechanism of the Kyoto Protocol.

5.7 Conclusion

The prospects for mitigation of climate change in Saint Lucia are fairly wide ranging and include opportunities for mitigation in the energy, transportation, forestry, agriculture and wastes sectors. Given the fact that most of the country's GHG emissions originate from the energy and transportation sectors, the concentration on mitigation efforts would appear

[22] Termed LULUCF in the UNFCCC acronyms.

to be most required in those sectors. Additionally mitigation in the energy and road transport sectors appears to provide significant opportunities for economic and environmental benefits for Saint Lucia and therefore to be consistent with the need to link climate change technologies with wider national development goals and objectives.

6. PROJECTIONS FOR CLIMATE CHANGE

6.1 Global Changes

Technology needs for responding to global climate change will be dependent on the types of impacts that climate change produces. The International Energy Agency in its forecasts for world energy to 2020, indicates that world energy use and related $C0_2$ emissions will continue to increase steadily with fossil fuels accounting for 90% of the world primary energy mix by 2020[23]. As a result emissions of GHGs will be significantly higher than those required for meeting the requirements of the UNFCCC for stabilizing global emissions at levels that would allow sustainable development to proceed.

The report of Working Group 1 of the IPCC Third Assessment Report entitled "Climate Change 2001: The Scientific Basis", concludes that globally averaged surface temperatures have increased by 0.6° – 0.2°C during the 20th century. The report projects globally averaged surface temperatures in 2100 to increase by 1.4° - 5.8°C relative to 1990, while globally averaged sea level is projected to rise 0.09 to 0.88m by 2100.

The IPCC projections indicate that globally, warming would be accompanied by increases and decreases in precipitation in various regions. In addition, there would be changes in weather variability, and changes in the frequency and intensity of some extreme climate phenomena. These in turn will profoundly impact the Earth's ecosystems, affecting terrestrial and marine biodiversity and the economic production systems related to them. Other projected changes include shifts in oceanic currents, shifts in terrestrial life zones, and reductions in global ice cover.

Influencing these changes in climate will be the actual amount of greenhouse gas emissions that occur into the atmosphere. The overall scenario for future energy demand and supply will be determined by a number of factors

[23] International Energy Agency. 'World Energy Outlook ". 2000. Paris

including technological innovation and development, geopolitical concerns, and environmental/climate change policies.

6.2 Impacts of Climate Change in the Caribbean

IPCC projections for climate change the Caribbean reflect global forecasts. By 2050 temperatures in the region are projected to increase by approximately 2°C while rainfall totals are generally expected to decline particularly during the traditional rainy season period. Both daytime and night-time temperatures are expected to increase. Rainfall variability, already a problem for Saint Lucia, can be expected to intensify so that in addition to increased periods of drought, incidents of flooding and other heavy rainfall events are also likely to increase. Tables 3 and 4 provide information on IPCC projections for climate change for temperature and precipitation.

Table 6.1: IPCC Temperature Change (°C) **Projections for the Caribbean – 2050s**

	Annual mean temperature change	Temperature December/ February	Temperature June/August
GHG	2.03	2.00	2.01
GHG + A[24]	1.71	1.68	1.71

Source: IPCC. Climate Change 2001: Impacts, Adaptation and Vulnerability. TAR 2001

Table 6.2: IPCC Precipitation Projections for the Caribbean - 2050

	Annual mean precipitation change (%)	Precipitation change (%) December – February	Precipitation change (%) June - August
GHG	-5.2	3.4	-14.4
GHG + A	-1.3	5.9	-6.9

Source: IPCC. Climate Change 2001: Impacts, Adaptation and Vulnerability. TAR 2001

IPCC analysis of projections for behaviour of tropical storms and hurricanes indicates that additional research is needed to gain a fuller understanding of the impacts of climate change. Nevertheless, some scientific assessments suggest that there is likely to be an increase in the intensity, and possibly frequency, of tropical storm systems.

[24] This refers to the impacts of greenhouse gas emissions along with emissions of Aerosols, which generally produce localized short term cooling of air temperatures.

These changes in climatic parameters can be expected to have a considerable effect on the natural resource base of Saint Lucia and be reflected in impacts on economic activity, human health, and socio-political institutions. Many of the likely sectoral impacts of climate change are identified in Saint Lucia's Initial National Communication.

For example in relation to water resources, Saint Lucia already faces considerable difficulty in meeting demand at certain times. Anticipated impacts of projected climate change include intrusion of salt-water into fresh water particularly in coastal and estuarine areas with likely adverse implications for ecological systems and for human uses. While projections for enhanced tropical storm activity can be expected to result in temporary increases in water supply, this is likely to be offset by destruction and/or modification of watersheds by increased frequency and/or intensity of rainfall. Extreme rainfall events are also likely to increase existing problems of soil erosion, siltation, and damage to water intakes, dams and reservoirs. All these projections indicate increased stress on already stressed water resources.

Projections for precipitation in the Caribbean also suggest that agricultural production will continue to be intimately affected by the availability of water. Overall, projections for greater variability in rainfall, higher temperatures, annual reductions in rainfall, and greater evaporation can be expected to impact negatively on agricultural production.

In the coastal areas enhanced storm activity will result in destruction and possible loss of ecologically important coastal ecosystems (such as coral reefs, mangroves and sea-grass beds), the loss of recreational beaches for local and tourist uses, increase significantly the costs of damage to coastal property (residences, hotels and other commercial properties) and infrastructure (ports, roads and communications), and serve as a disincentive to investment in coastal areas. These impacts are likely to be enhanced by the effects of sea-level rise.

In the health and human settlements sector, higher temperatures associated with climate change will increase morbidity and mortality from heat-related illnesses. Droughts will reduce water availability for many communities particularly in low-income areas. Impacts from changes in hurricane strength and frequency will include loss of life and damage to property and this will necessitate the use of appropriate building standards and guidelines. In the

health sector, a range of adaptive technologies will be required including for strengthened monitoring and vaccination programmes, research, and information systems.

Empirical evidence suggests that there may already be some indicators of changes in weather and climate parameters affecting Saint Lucia. These changes include greater variability in rainfall, warmer night-time temperatures, and increasing episodes of warming of sea surface temperatures.

Adapting to these changes will require the use of technologies that reduce vulnerability to climate change and of technologies that can enhance resilience to adverse effects. In addition to awareness, an adequate enabling environment will need to exist to facilitate adoption of these new technologies. This would include the availability of financing and the presence of a regulatory structure that promotes adherence and restricts non-compliance with any necessary codes, practices and standards. Climate change technologies will be required in all sectors but will also be required at crosscutting levels particularly in terms of capacity building and public awareness.

6.3 Climate Change and Technology Needs

Actions to promote adaptation to climate change, and the technologies for these purposes should be consistent with wider socio-development goals and objectives. A major aim of adaptation, and of the technologies for adaptation, will therefore be to integrate climate change concerns into human activity in a manner that satisfies climate and non-climate related objectives.

Saint Lucia's contribution to global climate change is microscopic so that adoption of climate change mitigation technologies should be determined by technological choices that are primarily targeted at non-climate change related needs but also satisfy, or are not conflicting with, climate change related objectives. In Saint Lucia's case these would include development of new and renewable sources of energy and improved energy efficiency to improve economic performance and reduce greenhouse gas emissions.

Saint Lucia's climate change technological needs should therefore be aimed at two levels:

1. Enabling **adaptation** to possible adverse consequences of alterations in critical weather parameters. At the same time, the urgency of existing development concerns and uncertainties in the nature and timing of climate change mean that it is important that adaptation measures are integrated into other wider development objectives.
2. On the **mitigation** side, forecasts suggest that global emissions will exceed the targets needed for stabilizing climate change at levels that will allow sustainable development to proceed. This along with technological developments is likely to spur adoption of cleaner energy options. For Saint Lucia, mitigation technology measures in many instances can provide possibilities for economic as well as environmental benefits.

7: NATIONAL DEVELOPMENT PRIORITIES

7.1 Official Development Plans

Priorities for climate change technology should be linked to national objectives for sustainable development. This reflects the need to ensure that climate change concerns are incorporated into national development plans and programmes. At the same time uncertainties as to the specific details of future global climate change[25] mean that it is also necessary to adopt approaches that are consistent with wider sustainable development plans and objectives. Additionally climate change – along with such factors as population growth and environmental degradation – will be one of many factors that in the future will affect Saint Lucia's ecological systems and economic development.

The 2003 - 2004 Saint Lucia Budget Speech entitled "Advancing Infrastructural Development and Economic Recovery in an Uncertain World" highlights a number of the major development concerns facing Saint Lucia and the official ongoing and planned responses to these challenges. The Budget address points out a number of the external forces that have adversely impacted Saint Lucia's economic performance and outlines measures in target sectors – bananas, tourism, manufacturing, construction, services and financial services – for enabling economic recovery. Underlying these measures are the concerns to provide employment; improve infrastructure such as roads and schools; strengthen the

[25] Uncertainty is particularly prevalent in regards to likely regional changes in climate and for small land spaces like Saint Lucia.

government's fiscal performance; and generally to provide improvements in the standard of living of the population.

The Budget seeks to restrict the growth of recurrent expenditure; to promote capital expenditures as a stimulus to wider economic growth and for the provision of services; and to identify new revenue measures. Reflecting concerns for social issues, the principal recipients of budgetary resources include the education and health sectors, as well as the national capital development programme focusing on various aspects of infrastructural development.

In terms of linkages to climate change a number of major efforts are underway by the Government of Saint Lucia to promote the sustainability of critical natural resource assets on which development is dependent – and where impacts of climate change are in many instances likely to be most significant. These include initiatives in the management of coastal areas, assessment and improved management of water resources, establishment of a national disaster mitigation policy and strengthening of capability in this field, and development of an integrated national lands policy. Additionally the Government of Saint Lucia has elaborated a National Climate Change Policy and Adaptation Plan that outlines sectoral and macro level measures for enabling adaptation to climate change[26].

7.2 Development Technology Needs

On the issue of technology needs, a 2004 report commissioned by the Government of Saint Lucia on strengthening science and technology capabilities in Saint Lucia noted that while there was an increasing appreciation at policy and enterprise levels of the need to enhance economic competitiveness through technological innovation, science and technology standards were generally below those required for international competitiveness. Allied to this were the existence of inadequate levels of institutional capability for technology and a weak policy framework for promoting science and technology in Saint Lucia.

This is relevant to the issue of technology needs for climate change as in many cases appreciation of the significance of climate change issues, and therefore of the technological responses associated with them, is still at an early stage. This suggests that a crucial element of the initial response to promoting the use of environmentally sustainable climate change

[26] National Climate Change Policy and Adaptation Plan. Government of Saint Lucia. 2003.

technologies in Saint Lucia should relate to increasing technical awareness of the issue, and of the type of technological responses that will enable adaptation to, and mitigation of, a changing climate.

7.3 Linkages to Climate Change

Development plans for Saint Lucia are intimately connected to changes in global climate. Tourism, the main emphasis for future development, is dependent upon maintenance of environmental quality as are plans for agriculture, the other main export sector. Projections for the effects of global climate change suggest that changes in rainfall and temperature regimes, sea level rise, and enhanced tropical storm activity will impact heavily on Saint Lucia's natural resources with potentially serious adverse implications for economic activity and human health.

In terms of measures related to climate change mitigation, plans exist for expansion of the islands road transport network and for the reform of the energy sector including development of geothermal energy and various forms of renewable energy. These initiatives represent responses to the increased number of vehicles on the roads in the case of the transport network, and an attempt to modernize the energy generation sector to promote economic efficiencies and provide a stable energy platform for economic development.

The national development priorities for Saint Lucia are focused on efforts that will promote meaningful employment and provide an economic environment that will allow for economic growth and development, poverty reduction and the provision of internationally acceptable standards in such areas as education, health and environmental management. While recognition exists of the importance of technology to economic development, the institutional framework and supporting infrastructure (e.g. legislation, technical institutions, and stakeholder awareness) for promoting technology development remains weak.

In addition to satisfying its own development priority needs, Saint Lucia's technology needs are also related to the country's obligations under Article 5 of the UNFCCC to promote research and systematic observation of climate change related parameters. In addition to data on rainfall, winds, temperature and other climatic information this requires the collection and analysis of data in such fields as biodiversity and land use change so as to gain a more complete picture of the relationship between changing climate and wider

socio-economic and environmental processes. This information is expected to be of sufficient quality and transparency to meet requirements for official international data transfer.

Information of this nature is central to climate change adaptation activities by providing data on existing and changing weather and climate, as well as being vital for climate change mitigation initiatives by providing information for mitigation options such as wind and solar energy. A number of studies have pointed to the growing inadequacy of the global climate observation system for providing the required level of data and information to meet the needs of assessment of climate change[27].

Technology needs for climate change for Saint Lucia will encompass a wide range of areas where impacts may occur, and where opportunities for mitigation arise that are consistent with other economic activities. Given official development emphasis in certain target areas such as tourism and agriculture, it will be necessary for climate change adaptive measures that target realization of these goals. Similarly mitigation activities that can be expected to contribute to sustainable economic development such as energy efficiency can be considered as among the priority climate change technology needs for Saint Lucia. The present state of awareness of climate change means that information awareness is an essential element of any move to promote technology for climate change.

8. IDENTIFICATION OF CLIMATE CHANGE TECHNOLOGY NEEDS

8.1 Introduction

Various efforts have already pointed to a number of adaptation and mitigation requirements and priorities for St Lucia. The climate change technology options outlined below have therefore been drawn from various sources. In some instances, it is necessary to infer the types of technologies that may be needed from the measures proposed. Many of the adaptation and mitigation options are included in the Initial National Communication, which identifies a number of priority needs for responding to the challenges of climate change. Additional priorities have been identified during

[27] See for example The United States Detailed National Report on Systematic Observations For Climate: United States Global Climate Observation System Program. National Oceanic and Atmospheric Administration. August 2001.

discussions held with stakeholders. Other possible technological approaches relevant to St Lucia are provided in various national technical reports as well as in UNFCCC and IPCC documents.

The Tables below identify adaptation and mitigation options, indicate the wider development benefits associated with these options, indicate the climate change technologies required, as well as indicating the principal barriers that presently exist to use of the technologies. For adaptation, climate change technologies in eight sectors have been identified. These are based on sectors identified in the Initial National Communication as well as priority areas (e.g. disaster management) to emerge during stakeholder consultations and from the documentary review. For mitigation, the sectors examined are energy generation, transport, geothermal, renewable energy, and LULUCF and Wastes.

The technologies highlighted generally relate to mechanical or physical processes along with the associated skills and supporting human resource capabilities required for their use.

8.2 Technology Needs for Adaptation to Climate Change

Adaptation to Climate Change will involve action across a range of sectors and activities. In many instances the first element of adaptation will be receiving and understanding information on the impacts of climate change, and devising adaptation responses to these. The critical issue here will be the ability to modify behaviors, processes and practices that increase risk and to adopt responses that reduce vulnerability to climate change.

In many instances, technology needs will involve modifications in use of existing technologies, rather than the need for new technologies. In a number of cases technologies are already in use for responding to problems associated with climate existing climate and variability (e.g. air conditioning, meteorological monitoring equipment, and GIS). These technologies will in many instances also be needed to adapt to climate change, though they may need to be modified to meet changed circumstances arising from climate change and other future developments.

To be successful, adaptation measures will also require various supportive legislative, institutional, human resource, and technological policies and measures.

8.2.1 Coastal Zone

The coastal zone will be on the front-line of impacts from sea level rise, intensified storm action, temperature change and shifts in ocean currents. This is in addition to existing pollution and other development stresses. The significance of coastal areas for human settlements, tourism, and infrastructure means that adaptation measures will be crucial to ensuring economic and social progress and development.

Saint Lucia's Initial National Communication identifies various policy and administrative measures for managing adaptation in the coastal area. These emphasize soft technological approaches such as relocation, as well as harder technological needs such as breakwaters and sea walls.

A number of barriers constrain adaptation in coastal areas including financial constraints, limited public awareness, and institutional limitations. In some cases technology needs are required to address these weaknesses such as information technologies for facilitating increased technical and public awareness. Financial constraints emerge as a persistent barrier.

As noted earlier, the Government of Saint Lucia has initiated a programme for strengthening natural resource management in coastal areas. This is likely to be supportive of the type of technical and participatory responses needed for enabling adaptation.

Table 8.1: Coastal Zone

Adaptation Option	**Development Benefit**	**Technology Needs**	**Barriers**
Restrictions on future development	Restricts future losses and enhances existing ecological functions and their economic benefits (fisheries, tourism etc).	Information technologies (computer hardware and software, GIS). Human resource development.	Costs. Limited land space available. Lack of technical information. Limited public awareness.
Reinforcing existing structures (e.g. docks)	Protection of existing costly coastal infrastructure. Very often the least cost medium term response.	Groynes, bulkheads and seawalls. Information technologies. Construction engineering tools	Costs. Environmental concerns. Limited technical capabilities.

		and techniques. Environmental engineering tools and techniques.	
Flood plain management	Protection of residential, commercial, tourism and agricultural development. Health benefits.	Information technologies (GIS, computer hardware and software). Saltwater intrusion barriers. Meteorological measurement equipment. Floodgates and tidal barriers.	Development pressures. Costs. Limited institutional framework.
Improved data collection and analysis	Provides information for policy making and for increasing awareness. Builds technical capacity. Low cost response. Contribution to global climate research.	Information technologies. Technical training.	Limited appreciation of significance. Financial constraints. Limited technical capabilities.
Building Codes	Promotes sustainable development. Effective least cost option.	Information technologies (GIS, computer hardware and software).	Popular attitudes. Limited enforcement capability.
Habitat Protection and reforestation	Advances continued use of important marine resources, provides resistance to storm surge and sea-level rise.	Information technologies (GIS, computer software and hardware). Environmental engineering tools and techniques. Meteorological measurement equipment.	Limited available land-space. Development pressures. Limited public appreciation. Costs.

		Public awareness. Seed material. Human resource development.	
Guidelines and restrictions on sand mining.	Protection of critical habitats and beaches. Ensuring sustainable sand supply. Shoreline protection.	Information technologies (GIS, computer software and hardware). Environmental engineering tools and techniques. Replacement building aggregate materials.	Development pressures. Enforcement difficulties. Cost of alternatives.
Artificial Reefs	Assure future fisheries by reduced pressure on existing reefs. Promote continued employment and earnings in fisheries and dive tourism sectors. Reduced coastal erosion	Meteorological monitoring equipment. Human resource development.	Costs. Popular acceptance. Competing development interests.

8.2.2 Freshwater Resources

Models for climate change impacts in the Caribbean suggest that altered precipitation patterns are likely to be among the most significant effects. This will affect Saint Lucia where the two dominant sectors are both already sensitive to water shortages and variability in water supply and quality. Consequently adaptation measures for freshwater are critical to the viability of these key sectors as well as for maintaining human health and well-being.

The Initial National Communication emphasizes adaptations to physical plant and technologies as well as various policy and information initiatives for promoting climate change adaptation for freshwater resources.

Barriers to transfer and use of these technologies include the financial costs involved as well as wide ranging social and economic issues (e.g. land ownership, competing interests, stakeholder awareness etc). Various

initiatives are underway to address many of the problems affecting management of freshwater resources in Saint Lucia. These range from the privatization of the water utility to the elaboration of national land and water policies for Saint Lucia.

Table 8.2 Adaptation Options for Freshwater Resources

Adaptation Option	**Development Benefits**	**Technology Needs**	**Barriers**
Reductions in line losses.	Economic savings to utility and consumers. Increased availability of water for consumption. Improved health and sanitation. Meteorological measurement equipment.	New Pipelines. Water treatment facilities. Geographic Information Systems.	Costs.
Restoration of Riverbanks and Wetlands	Increased availability of freshwater supplies. Relatively low cost and environmentally sound approach. Enhances eco-tourism potential	Geographic Information Systems. Meteorological monitoring equipment. Environmental engineering tools and methods. Earthmoving equipment. Computer hardware and software.	Costs. Land Ownership and legal issues. Public Awareness.
Improved data collection and analysis	Provides information for policy making and for increasing awareness. Builds technical	Information technologies. Technical training. Public awareness.	Limited appreciation of significance. Financial constraints. Limited technical capabilities.

	capacity. Low cost response. Contribution to global data banks.		
Water Conservation	Increased supply of freshwater to consumers. Reduction in costs from water wastage. Sustaining riverine levels and ecological processes.	Public Awareness. Low flow water technologies for domestic uses (e.g. toilets and faucets) Institutional Strengthening for Water Conservation. Drip and trickle irrigation technologies.	Limited Institutional Capacity. Limited Public Awareness. Cost of Conservation Technologies.
Forest Resource Management	Enhanced Security of Water Supply. Soil Conservation. Eco-Tourism linkages. Cultural benefits. Improved water quality.	Geographic Information Systems. Computer hardware and software. Meteorological measurement equipment. Public awareness.	Development Pressures. Institutional constraints. Limited Public Interest.
Development of National Water Management Plan	Enables long-term response to water issues. Meteorological measurement equipment. Allows stakeholder participation in response.	Geographic Information Systems. Computer hardware and software. Meteorological measurement technologies.	Institutional Constraints.

Increasing Available Water Resources	Allows for meeting present and expected future demands in residential, tourism and industrial activity.	Water storage (dams and reservoirs). New pipelines to reduce leakage and seepage). Desalinization plant. Meteorological measurement equipment.	Costs. Competing development interests. Complex technical choices. Institutional Constraints.
Maintaining Water Quality	Essential for health, agriculture, industry etc. Ensuring environmental quality.	Pollution prevention and control technologies. Water monitoring equipment. Public awareness. Pipelines. "Smart Bacteria". Patrol vehicles.	Costs. Lack of equipment. Inadequate surveillance capability.
Water Recycling and Re-use	Cost-effective response. Allows for optimum use of limited resources.	Pipeline and treatment facilities. Human resource development. Public awareness	Social acceptability. Costs. Public awareness. Technical considerations.

8.2.3 Tourism

Impacts of climate change on tourism will emanate from a number of sources including those on the coastal zone, higher operating costs from increased temperatures and impacted water supplies, as well as from hurricane and storm action. The critical role of tourism in the national economy in terms of employment, linkages with other sectors, and foreign exchange means that the success of measures for adaptation will be important to wider national development.

The Initial National Communication indicates a number of adaptation options for the tourism sector in Saint Lucia. As with other sectors, adapting the tourism sector to the impacts of climate change will require the use of hard technologies (e.g. sea walls) and soft technologies (e.g. human resource development, public awareness). Because of the nature of the industry, adaptations in other sectors (e.g. health, water supply, coastal zone) will have direct relationships with the tourism sector.

Barriers to the utilization of climate change adaptation technologies in the tourism sector in Saint Lucia include costs of adaptation such as refurbishment of capital stock, as well as limited awareness of vulnerabilities to existing and future climate, and competing sectoral interests.

Table 8.3 Adaptation Options for Tourism

Adaptation Options	**Development Benefits**	**Technology Needs**	**Barriers**
Maintaining Coastal Tourism Attractions.	Contribution to sustaining main economic sector. Environmental protection for biodiversity, storm surge, and marine resources.	Integrated coastal zone management. Human resource development. Information technologies. Environmental engineering tools and techniques (beach nourishment, wetland reforestation, seawalls, revetments, bulkheads). Coastal monitoring equipment. Meteorological monitoring equipment. Public awareness.	Limited awareness of issues. Costs. Limited institutional capabilities. Competing development interests.

Protection of Tourism Facilities and Infrastructure.	Contribution to sustaining main economic sector. Employment benefits. Minimizing economic losses to tourism.	Hurricane/storm resistant physical structures. Public awareness. Information technologies. Human resource development.	Costs. Limited awareness of issues. Weak regulatory framework.
Data collection and analysis	Provides information for decision making in important tourism sector. Contribution to global data banks.	Information technologies. Human resource development.	Limited awareness of issues. Costs.
Maintaining Terrestrial Tourism Attractions	Contribution to sustaining main economic sector. Watershed protection. Biodiversity protection. Employment benefits.	GIS hardware and software. Remote sensing. Satellite imagery. Human resource development. Meteorological monitoring equipment. Land-use planning. Liquid and solid waste management equipment.	Competing development interests. Limited public awareness. Costs. Weak regulatory framework.
Diversification of Tourism Product	Reducing dependence on existing tourism attractions. Employment generation. Economic linkages to other	GIS tools. Human resource development. Information technologies. Tourism development planning.	Limited public awareness.

	sectors.	Public awareness. Landscaping tools and technologies.	

8.2.4 Agriculture

Distinctive features of agriculture include its vulnerability to existing weather and climate, its traditional resiliency to changing weather conditions, and its ongoing processes of adaptation to constantly changing conditions. Despite its resilience, projected impacts of climate change on Saint Lucia could devastate present systems and approaches of agricultural production. This would have adverse effects on employment, economic growth, human health, and the natural environment.

Adaptation options identified within the Initial National Communication and in UNFCCC documentation emphasize a number of scientific and technical responses. Technology needs related to these options vary from irrigation to contour terracing and crop research. These will in many instances need to be supported by measures for capacity building and stakeholder awareness. Barriers confronting climate change technology needs for agriculture include financial, institutional, and socio-cultural factors.

Table 8.4 Adaptation Options for Agriculture

Adaptation Option	**Development Benefit**	**Technology Needs**	**Barriers**
Changing land topography to improve water uptake, reduce run-off, and reduce soil erosion.	Improved agricultural productivity. Reduced soil erosion and resultant river and coastal pollution. Reduced agricultural losses from floods and droughts.	GIS technologies. Earth-moving equipment (graders, bulldozers, cranes etc). Meteorological monitoring equipment. Agricultural engineering technologies	Limited awareness. Limited institutional capabilities. Costs.

		(contour terracing, deep plowing, windbreaks). Human resource development.	
Data collection and analysis.	Provides information for policy making and for increasing awareness. Builds technical capacity. Low cost response. Contribution to global research and data.	Information technologies. Technical training. Public awareness.	Limited appreciation of significance. Financial constraints. Limited technical capabilities.
Introduction of salt tolerant crops	Will allow for continued use of lands affected by sea level rise.	Seed material. Propagation facilities. Human resource development.	Public awareness of need. Markets for produce. Familiarity with existing crops.
Hydroponics	Allows for improved crop production. Allows for greater consistency in production. Possibility for employment and exports.	Hydroponic production facilities. Chemicals. Human resource development. Information technologies.	Costs. Limited technical capability. Limited stakeholder awareness. Market constraints. Lack of familiarity with the technology.
Introduction of heat and drought tolerant crops and animals.	Will assist present efforts for agricultural production during periodic droughts.	Research facilities. Seed and propagation material. Human resource	Costs. Limited stakeholder awareness/interest. Existing market arrangements.

	Facilitate agricultural employment and exports.	development. Public awareness. Meteorological monitoring equipment. Artificial cooling technologies (air conditioning, fans etc).	
Crop research	Promotes agricultural development including agro industry.	Laboratory research facilities and equipment. Human resource development. Information technologies.	Costs. Limited institutional and technical capabilities.
Greenhouses	Allows for improved crop production.	Improved greenhouse Technologies. Information technologies.	Costs. Land constraints. Market limitations.
Farm relocation	Prevents long-term losses to farmer and community. Provides new opportunities for agricultural production.	GIS hardware and software. Information technologies.	Low policy priority. Electoral concerns. Costs. Limited availability of appropriate lands.
Improved pest and disease management	Reduces losses to farm and agricultural sector from insect and other pests.	Information technologies. Human resource development. Public awareness. Environmentally friendly extermination and control material and	Costs. Limited institutional capabilities. Limited stakeholder awareness.

		equipment.	
Agricultural diversification.	Promotes wider economic growth and sectoral linkages. Potential for employment and exports.	Information technologies. Human resource development. Meteorological monitoring equipment.	Market factors. Familiarity with existing production.
Forest management	Maintenance of freshwater supply quality and quantity. Maintaining employment opportunities linked to forestry (timber, agriculture, ecotourism etc) Reducing soil erosion and its and its adverse environmental impacts	GIS technologies. Information technologies. Remote satellite data. Public awareness. Meteorological monitoring equipment. Human resource development.	Competing development interests. Limited institutional capabilities. Inadequate public awareness/interest.
Irrigation systems	Allows for improvements in water supply to agriculture. Improved quality of agricultural production.	Dams and reservoirs. Water distribution systems (pipes, pumps, treatment facilities). Drip irrigation. Environmental agricultural engineering. Information technologies.	Costs. Availability of water supply. Available land resources.

8.2.5 Health

Human health represents a cross-cutting set of issues and concerns that will be affected by the impacts of climate change on water supplies, housing and other buildings, and agriculture. In many instances existing health concerns of solid and liquid waste management, cardiovascular disease, and maintenance of public health facilities will be adversely affected by projected future changes in climate.

Adaptation measures in the Initial National Communication report include physical, policy and institutional capacity needs. Central to many of these will be capacity building and public awareness efforts that provide information to stakeholders (ranging from specialist medical personnel to the general public) on the effects of a changing climate on human health and welfare.

Existing barriers to the adoption of technologies for climate change adaptation in the health sector include the costs involved, limited personnel, and lack of public awareness of linkages between weather/climate and health.

Table 8.5: Adaptation Options for Health

Adaptation Option	Development Benefit	Technology Needs	Barriers
Strengthened environmental health.	Tackles many existing principal public health and sustainable development concerns. Cost effective *vis-à-vis* secondary and tertiary health care.	Human resource development. Solid waste collection receptacles and vehicles. Heavy-duty equipment. Public awareness. Vector eradication supplies and equipment. Human resource development.	Limited public awareness. Costs. Institutional constraints. Changing role of public health services.
Improved data collection and	Enhances decision making	Information technologies.	Low policy priority.

analysis.	for health and sustainable development. Contribution to global research and data.	Human resource development. Laboratory testing equipment	Competing fiscal demands. Limited institutional capability.
Strengthened development control	Integrates economic, spatial and socio-cultural concerns. Critical to sound environmental management and physical development. Cost effective means for enhancing integrity of physical structures. Reduces losses to natural disasters.	Information technologies. GIS technologies. Public awareness. Human resource development.	Limited institutional capacities. Competing development interests. Inadequate public awareness/interest. Costs.
Medical interventions	Contribute to enhancing population health and welfare.	Vaccination equipment and supplies. Medical facilities. Human resource development. Public awareness.	Costs. Limited institutional capabilities.

8.2.6 Human Settlements

Climate change impacts on human settlements include those deriving from intensified storm and hurricane activity, increasing temperatures, and impacts in coastal areas. In many instances, human settlements in Saint Lucia are already vulnerable to adverse impacts of existing features of climate and weather. For human settlements, many other factors will

determine the impacts of climate change, including the extent of urbanization and official and public attitudes to such matters as building standards and public health.

Adaptation options identified in the Initial National Communication and in UNFCCC adaptation literature[28] focus on strengthening policy and institutional measures as well as on harder technology options. Because of the cross-sectoral impacts of climate change on human settlements it is important that adaptive policies and measures for responding to the impacts of climate change on human settlements be consistent with wider development objectives.

Barriers to adoption of climate change technologies for human settlements relate primarily to financial constraints at the governmental, enterprise and household levels and to the lack of awareness of the links between climate and development.

Table 8.6: Adaptation Options for Human Settlements

Adaptation Option	**Development Benefit**	**Technology Needs**	**Barriers**
Inland relocation	Reduces risks and costs to vulnerable coastal properties.	GIS technologies. Information technologies. Heavy-duty equipment. Human resource development. Public awareness.	Costs. Public response. Limited lands for relocation.
Strengthened development control.	Integrates economic, spatial and socio-cultural concerns. Critical to sound environmental management and physical development.	Public awareness. Human resource development. GIS technologies. Information technologies.	Limited institutional capabilities. Competing development interests.

[28] See "Adaptation to Climate Change: Options and Technologies. An Overview Paper". R. Klein and R. Tol. UNFCCC FCCC/TP/1997/3. October 1997.

	Cost effective means for enhancing integrity of physical structures. Reduces losses to natural disasters.		
Hazard mapping.	Provides information for assessing physical risks. Reduces losses from natural and other disasters.	GIS technologies. Information technologies. Human resource development. Meteorological monitoring equipment.	Costs. Limited institutional capability.

8.2.7 Disaster Response

Projections for changes in frequency of tropical storms and hurricanes, increased temperatures, and sea-level rise arising from climate change are among factors expected to contribute to a global increase in incidents of natural disasters arising from storms, floods and droughts. These natural phenomena already impose heavy financial costs on Saint Lucia across all aspects of social and economic life so that future development prospects will be dependent on successful adaptation to projected extreme weather events associated with global climate change.

The Initial National Communication does not directly identify technology needs for climate change for disaster response. However it would appear that technology needs would embrace various hard requirements in terms of equipment and supplies, as well as soft requirements for technologies relevant to policy development, stakeholder awareness and human resource development.

Table 8.7 Adaptation Technology Needs for Disaster Response

Adaptation Options	Development Benefits	Technology Needs	Barriers
Community Response	Enables short, medium and long	Information technologies	Traditional attitudes.

	term action. Social and community empowerment. Participatory approach encourages ownership.	(computers, internet, GIS); environmental engineering (e.g. contour terracing, artificial reefs). Human resource development.	Costs. Limited institutional capability. Bureaucratic procedures. Weak community structures.
Emergency Preparedness	Reduced disaster losses (life and property).	Communications equipment. Meteorological monitoring equipment. Information technologies. Audio-visual hardware and software. All-terrain vehicles.	Costs. Limited institutional capabilities. Public awareness.
Hazard and Risk Management	Reduced disaster losses (life and property). Cost effective response to minimizing vulnerability to climate and non-climate risks.	GIS technologies. Information technologies. Human resource development.	
Improved data collection and analysis	Provides information for decision-making (e.g. trend analysis) and for increasing awareness. Provides institutional memory of disaster events.	Information technologies. Technical training. Public awareness.	Limited appreciation of significance. Limited technical capabilities.

	Builds technical capacity. Represents a relatively low cost response. Contribution to global research and data collection efforts.		

8.3 Technologies For Mitigation Of Climate Change

The report of the IPCC's Third Assessment Report Working Group Three, entitled "Climate Change 2001: Mitigation", points out that there are an increasing number of technologies presently available for mitigating climate change through reducing emissions of greenhouses gases into the atmosphere. These include technologies for reducing emissions from energy, transportation, LULUCF, agriculture, and wastes. Unfortunately, in many instances, limitations of small size means that these options do not represent immediate or medium term prospects for micro-States such as Saint Lucia where the small size of the market as well as limited technical personnel restricts the opportunity for adoption of even well established technologies such as those for mass transit in the transport sector, or for many instances of fuel switching or waste heat recovery in industry and energy generation.

Against this background, and in view of the need to link climate change technology needs to development priorities, it is important that mitigation technology choices for Saint Lucia represent win/win options that are consistent with wider goals for national social and economic development. This is also important given Saint Lucia's microscopic contribution to global GHG emissions. Consequently the climate change mitigation technology options presented below represent those that can be regarded as representing possible viable options for Saint Lucia in the context of its wider development efforts and not solely for purposes of climate change. The options are drawn from the Initial National Communication as well as from the IPCC TAR.

8.3.1 Energy Generation

Energy generation provides one of the principal sources of Saint Lucia's GHG emissions. Provision of a secure and stable electrical supply will be essential for maintaining economic and social development. Demand for

electrical energy can be expected to rise as population increases and development in sectors such as tourism proceeds.

Mitigation technology needs in the energy generation sector involve a combination of hard technologies in the form of equipment and other capital inputs, as well as soft technologies that provide capability for utilizing the hardware. In most cases the technologies involved are not new but have benefited from recent technological and/or pricing developments that enhance their potential for application. The principal barrier to use of these climate change mitigation activities remains the financial costs involved.

Table 8.8 Mitigation Technology Needs for Energy Generation

Mitigation Options	**Development Benefits**	**Technology Needs**	**Barriers**
Fuel switch to cleaner and cheaper fuels (possibly natural gas).	Reduced pollution with attendant health and environmental benefits. Lower energy costs.	Natural gas Pipeline and Storage facilities. High performance engines. Conversion of existing plant to natural gas. Human resource development. Information technologies.	Costs. Environmental concerns. Lack of experience with natural gas as a fuel for energy generation. Need for conversion to use alternative fuels.
Improved transmission efficiency.	Reduced real costs of electricity. Lower costs to electricity suppliers.	Electricity lines and feeders. Information technologies. Human resource development.	Costs.
Demand side Management.	Relatively low cost. Benefits accrue at individual and national levels. Incentive, rather than command, based approach.	Human resource development. Public awareness. Information technologies. Energy saving domestic and	Low policy priority. Costs. Limited institutional capability.

	Promotes stakeholder awareness and action.	tourism sector equipment.	
Data collection and analysis	Provides information for policy making, for investment, and for increasing awareness. Builds technical capacity. Contribution to global research and data collection efforts.	Information technologies. Technical training. Public awareness.	Limited appreciation of significance. Financial constraints. Limited technical capabilities.

8.3.2 Road Transport

In Saint Lucia road transportation represents the fastest growing source of GHG emissions. Experience globally demonstrates difficulties in controlling growth in this sector due to its close association with lifestyle changes and the virtually complete dependence on fossil fuels in the sector. Saint Lucia faces special challenges in aiming to meet the challenges of reducing emissions in road transport arising from the country's mountainous topography which limits possibilities for certain types of mass transit and also requires increased fuel use because of the topography.

Mitigation options should be complimentary towards wider national goals such as tourism development, reducing imports of fuel, enhancing safety in road transportation, and maintaining environmental quality. In addition to hard technologies, other needs such as human resource development, public awareness, and transport policy measures will be essential elements for successful adoption of mitigation measures in the road transport sector in Saint Lucia.

Table 8.9 Mitigation Technology Needs for Road Transport

Mitigation Options	Development Benefits	Technology Needs	Barriers
Mass transit	More efficient use of energy.	Energy efficient rail system.	Costs. Safety regulation

	Employment possibilities. Safety standards above vehicular travel. Provides important public service.	Public buses. Information technologies. Human resource development. Public awareness.	concerns. Topography. Cost effectiveness (population size?)
Improved vehicle efficiency	Reduced average energy use for road transport. Reduced air and ground pollution. Financial savings from gasoline.	Vehicle energy performance enhancing tools and techniques. Public awareness. Human resource development.	Public awareness. Limited institutional capacity. Lack of regulatory framework. Costs.
Road transport Planning	Cost effective approach. Allows for incorporation of different stakeholder and sectoral interests.	Information technologies. GIS technologies. Human resource development. Public awareness.	Limited institutional capacity. Topographical and spatial constraints. Costs. Sectoral interests.
Alternative transport fuels (natural gas, biofuels, electric).	Reduced dependence on fossil fuels. Cleaner energy sources.	Natural gas, biofuel and electric stations. Human resource development. Vehicle fuel conversion kits.	Costs. Technical feasibility in Saint Lucia not yet assessed.

8.3.3 New and Renewable Energy

Closely linked to energy generation is the issue of development of Saint Lucia's considerable potential in renewable and geothermal energy. With economic growth, rising living standards and population increase, efforts for mitigation in the energy sector will require more than energy efficiency to achieve significant reductions in GHG emissions from energy generation. Consequently there will be the need to intensify efforts at developing the various indigenous forms of renewable energy so as to enable a shift to new

and renewable energy as a complement to petroleum derived energy sources. In addition to benefits relating to GHG mitigation, development of these sources has the potential for satisfying wider national development goals in terms of employment, foreign exchange savings, and reducing environmental pollution.

Barriers towards use of these mitigation technologies relate to awareness, costs, and institutional and policy gaps and weaknesses. Various efforts for advancing integration of renewable energy into the supply mix are already underway, including a National Sustainable Energy Plan and a regional project being financed by the Global Environment Facility with support from the Government of Germany[29].

Table 8.10 Mitigation Technology Needs for New and Renewable Energy

Mitigation Options	Development Benefits	Technology Needs	Barriers
Solar energy development.	Foreign exchange savings. Employment possibilities. Reduced dependence on imported fossil fuels.	Photovoltaic applications (lighting, cooling, heating, general power). Human resource development. Information technologies.	Costs. Unlikely to provide major amount of power in short to medium term.
Geothermal energy.	Foreign exchange savings. Employment possibilities. Reduced dependence on imported fossil fuels.	Geothermal electricity generation technology. Human resource development. GIS technologies. Information technologies.	Costs. Technical assessments. Inherent risks associated with exploratory drilling?
Wind energy.	Foreign exchange savings. Employment	Wind turbines. Grid interconnection capabilities.	Technical assessments. Costs. Restrictive

[29] Caribbean Renewable Energy Development Project (CREDP).

	possibilities. Reduced dependence on imported fossil fuels.	Information technologies. Human resource development.	institutional framework. Limited public awareness.
Improved data collection and analysis	Provides information for policy making and for increasing awareness. Provides private sector with information. Builds technical capacity. Low cost response. Contribution to global research and data collection efforts.	Information technologies. Technical training. Wind, solar, and related measurement technologies.	Limited appreciation of significance. Financial constraints. Limited technical capabilities.
Ocean Thermal Electric Current (OTEC)	Foreign exchange savings. Employment possibilities. Reduced dependence on imported fossil fuels. Freshwater by-product can contribute to domestic and agricultural water supply.	OTEC plant. Human resource development.	Costs. Technical feasibility not yet established. Technical capabilities.

8.3.4 LULUCF & Wastes

The Initial National Communication identifies the LULUCF, Wastes, and Agricultural sectors as sources of GHGs. However the scale of these emissions remain so miniscule as to negate any effort to link them with

mitigation efforts for global climate change. Nevertheless, it is possible to identify certain areas where climate change mitigation technologies can contribute to wider national development goals. These include measures for sustainable management and protection of forest resources, and for possible harnessing of methane from the country's landfill.

Table 8.11 Mitigation Technology Needs for LULUCF and Wastes

Mitigation Options	**Development Benefits**	**Technology Needs**	**Barriers**
Forest management for GHG mitigation.	Watershed protection. Ecotourism related revenues. Employment.	Meteorological measurement technologies. GIS technologies. Information technologies. Public awareness. Environmental management Tools and techniques.	Competing development interests. Cots. Public awareness.
Utilization of methane from landfills.	Provision of energy for national use. Foreign exchange savings. Employment possibilities. Reduced dependence on imported fossil fuels.	Methane powered engines. Human resource development.	Operational feasibility. Environmental concerns.
Data Collection and analysis	Provide information for decision-making and public awareness. Contribute to	Information technologies. Laboratory testing equipment. Human resource	Costs. Limited technical capabilities.

	global data collection and research efforts. Build local capacity.	development.	

8.4 Conclusion

From the climate change technological options outlined above, seven main interrelated categories of climate change technology needs can be identified for Saint Lucia:

1. Information technologies – e.g. computer hardware and software, Geographic Information Systems (GIS), training, and Internet access.
2. Environmental engineering technologies – e.g. reforestation, waste management, watershed management, coastal area management (e.g. terracing, sluices, and restoration/rehabilitation of degraded systems that provide natural barriers such as coral reefs and mangroves).
3. Habitat protection technologies e.g. for protecting forest and coastal habitats.
4. Civil works – e.g. breakwaters, water treatment facilities, drainage systems.
5. Management technologies – e.g. training, public awareness, resource management methodologies, Strategic Planning (e.g. adapting building codes to mitigate climate change impacts); EIA.
6. Meteorological and environmental measurement technologies – e.g. Automatic Weather Stations, rain gauges, tidal gauges, automated salinity and temperature gauges.
7. Energy technologies – e.g. energy efficient electricity plants, wind turbines, Photovoltaics, and energy conservation technologies.

In most cases, the technology requirements identified include hard and soft technologies. Critical barriers to adoption of climate change relevant technologies are the availability of financial resources, limited awareness of climate change adaptation and mitigation issues and technologies, a variety of institutional constraints, inadequacies in data, and limited technical capabilities.

9. BARRIERS TO AND POSSIBILITIES FOR CLIMATE CHANGE TECHNOLOGY

9.1 Introduction

As noted above a number of barriers presently exist to the introduction of climate change technologies in Saint Lucia. These include the costs associated with purchase and maintenance of these technologies, the financial feasibility of these options, limited institutional capacities for implementation, and inadequate awareness of the possible impacts of climate change and of the technological and other options available for responding to these changes.

In order to overcome these barriers it will in many instances be necessary to pursue other actions that can create an enabling environment to allow individuals, households, enterprises, communities, and government agencies to adopt adaptation and mitigation strategies and technologies necessary for meeting the challenges of global climate change.

9.2 Adaptation Barriers and Possibilities

Several approaches exist to adaptation of climate change. These include institutional, technological, legal, and regulatory measures and policies. In most cases some combination of all of these types of responses will be required given the pervasiveness of the likely impacts of global climate change. However, one essential element will be to build awareness, as increasing understanding of climate change processes and impacts will be a necessary first step to responding. The tables above identify that limited awareness of climate change at sectoral levels remains a principal barrier to technology transfer and use.

In order to overcome barriers relating to awareness the following crosscutting measures will be needed:

- Improving awareness of potential implications of climate change among decision-makers at all levels (from grass-roots to national level policy makers).
- Increasing knowledge of climate change and climate variability, including through improved understanding of long-term weather and of short-term weather forecasting.

- Enhancing research, development, and demonstration efforts of climate change adaptation technologies.

These types of efforts are likely to be particularly important in raising the awareness of important stakeholder groups (such as owners of coastal tourism properties) that may be required to undertake costly remedial and preventative measures.

At the same time these measures themselves face obstacles in relation to the cost of even these actions, and financial constraints and limitations are identified as among the principal barriers to satisfying climate change adaptation technology needs for Saint Lucia. These financing barriers exist at three levels:

1. The cost of the technology itself is expensive (e.g. beach nourishment and construction of groynes or other coastal defences; or the reforestation of watersheds).
2. Financial feasibility of the technology is constrained by the small size of operations (e.g. measures for relocation of structures from threatened coastal areas).
3. In addition to the actual technologies the costs of the supporting institutional structures (regulations, personnel, equipment) represent challenges for government finances in the face of competing development financing challenges for payrolls, health facilities, maintaining law and order etc.

Financing adaptation measures will be particularly difficult for persons in lower income communities who will need to adjust housing design, possibly relocate from vulnerable coastal and/or hillside areas, and take other precautionary and proactive measures that can be expected to present financial challenges.

While various possibilities for financing the development and use of adaptation can be identified, it is likely that the financing of climate change adaptation technologies will remain a major impediment to their introduction in Saint Lucia. Among the type of policy measures that can be put into place for securing financing for technologies include:

- Introduction and enforcement of technology standards (e.g. for low water use flush toilets, and rainwater harvesting) that will ensure introduction of these technologies.
- Direct government spending, through integrating climate change concerns into existing recurrent expenditure programmes and projects.

- Tax and fiscal incentives for persons and enterprises engaging in an identified set of adaptive actions (e.g. coastal or watershed protection).
- International and regional financing sources (Caribbean Development Bank, World Bank, Inter-American Development Bank), by integrating climate change adaptation concerns into bilateral and multilateral loans and assistance (e.g.
- Support for indigenous research and development activities utilizing available educational and technical facilities.
- International assistance from the Global Environmental Fund.
- International assistance through the Climate Change Adaptation Fund to be established under the Clean Development Mechanism of the Kyoto Protocol[30].

Notwithstanding these possibilities, financing of adaptation technology needs for Saint Lucia is likely to remain a considerable constraint to their introduction in Saint Lucia.

9.3 Mitigation Barriers and Opportunities

As with adaptation a number of barriers exist to introduction of climate change mitigation technologies in Saint Lucia.

In the energy generation sector virtually all of the barriers identified restrict the introduction of environmentally sustainable technologies and practices. Privatization of the electricity supply and deregulation of fuel prices represent initial steps by the Government of Saint Lucia to improve the efficiency of energy supply and demand. Nevertheless additional measures will be required in terms of its wider energy policy if measures for promoting energy conservation and adoption of new and renewable energy are to succeed. As with efforts for adaptation, a number of awareness building actions are likely to be required for accelerating movement to sustainable energy futures.

For a variety of reasons, climate change mitigation efforts in Saint Lucia are likely to be addressed through a portfolio of instruments involving

[30] The coming into effect of the Kyoto Protocol will trigger the implementation of the Clean Development Mechanism (CDM) designed to encourage *inter alia* the transfer of environmentally sustainable technologies to developing countries. A proportion of funds generated from the CDM are to be applied to implementation of adaptation projects in developing countries.

regulation, technology, capacity building, and technology. The IPCC[31] identifies so-called "market failures", that distort market-based forces, as a major source of difficulty confronting introduction of climate change technologies in developed and developing countries. These include subsides for fuels and other measures that inhibit the diffusion of technologies that provide economically efficient alternatives to existing energy uses.

9.3.1 Energy Generation

For spatial and environmental reasons many of the options available internationally for reducing GHG emissions from the energy sector involve technologies, such as nuclear energy or cogeneration, that are not feasible in the Saint Lucian context.

The Energy Sector Policy and Strategy [32] identifies a number of policy priorities for reform of the petroleum sub-sector. These include pricing, taxation, safety and standards regulation, and alternative fuels, particularly natural gas. Technology needs identified include equipment for the terminalling of the fuel, as well as for regasification of the fuel. Other measures advocated in the Energy Sector Policy and Strategy for reform of the energy sector emphasize institutional and regulatory actions including appointment of an Independent Regulator.

Alongside these policy measures for creating a favorable enabling environment for mitigation activities, the need for financing of the accompanying technology needs remains a principal obstacle to adoption of mitigation technologies in Saint Lucia. Mechanisms that can be identified for advancing energy conservation and management programmes in relation to financing include:

- Use of energy efficiency standards to promote use of mitigation oriented energy technologies. This involves regulating public use of particular technologies and thereby enforcing their use.
- Voluntary standards (e.g. among hoteliers) to advance introduction of agreed environmental standards.
- Regional and international development agencies (e.g. CDB, World Bank, GEF) can provide financing and technical assistance for mitigation related projects.
- The Clean Development Mechanism of the Kyoto Protocol which allows developed countries to invest in and gain international

[31] Climate Change 2001. Mitigation. Summary for Policymakers and Technical Summary of the Working Group III Report. WMO/UNEP. 2001.
[32] Government of Saint Lucia Energy Sector Policy and Strategy Volume I. Ministry of Physical Development, Environment and Housing, Castries, Saint Lucia, October 2003.

emission credits, from GHG mitigation projects in developing countries. Problems with this mechanism include difficulties in estimating mitigation estimates. For small countries like Saint Lucia it is unclear how attractive the CDM would be as an initial source of investment.

9.3.2 Road Transport

A number of barriers confront efforts towards GHG mitigation in the road transport sector in Saint Lucia including financial constraints, inadequate awareness, and weaknesses in technical capacity at various levels. The IPCC Mitigation report notes the difficulties that have arisen in terms of efforts to control GHG mitigation in the road transport sector. Central to successful measures are sustained programes of awareness raising as well as integrated approaches to urban and transport planning.

Traditional sources of financing for public sector investments in transport come from road taxes, and loans from various sources. Introduction of mandatory and voluntary standards also represent methods for facilitating technology transfer in the road transport sector.

9.3.3 LULUCF and Wastes

Barriers confronting utilization of climate change technologies for LULUCF and Wastes also range across regulatory, institutional and other areas. The issue of costs again arises as a major constraint both for government, which will be required to take a lead role in activities such as reforestation, and for individual landowners and enterprises.

For agriculture and forestry lack of capacity for scientific research will affect the development of agricultural production (crops and livestock) and forest cultivars suited to the needs of a changing climate. In forestry, macro-economic trends that favor certain types of land uses such as housing and tourism also present barriers to mitigation in the this sector.

For solid wastes, the principal barriers to technology transfer include limited financing and institutional capacity, and the need for community involvement. Efforts for harnessing methane are also likely to face lack of experience with these technologies and possible environmental and safety concerns relating to possible escape of gases.

Measures identified by the IPCC to address financial and other barriers in these sectors include:

- Expansion of credit and savings schemes.
- Improvement of disaster warning systems, and
- Strengthening research and development into impacts of climate on tropical agriculture and forestry.

Additional possibilities for funding and technical assistance include regional and international development banks and the Global Environmental Facility. In areas such as research and development opportunities would also seem to exist for enhancing regional cooperation in these areas.

10. CONCLUSION

Climate change technology needs assessments are intended to provide an indication of priority environmentally sustainable technologies that can assist developing countries like Saint Lucia to adapt to and mitigate against climate change.

Scientific projections for changes in global climate can be expected to have profound impacts on the natural environment of Saint Lucia, with consequent impacts on virtually all aspects of economic and social development. As a small island developing country, Saint Lucia is already vulnerable to existing weather and climate patterns particularly extreme weather events such as hurricanes and droughts.

National development priorities for Saint Lucia revolve around efforts at securing economic development and growth, job creation, maintaining government's fiscal integrity, the provision and enhancement of public services and infrastructure, and protection of the country's natural environment. Given the extent of the present problems confronted by developing countries like Saint Lucia and the uncertainties in the science of climate change, any measures taken to advance technology acquisition and use for climate change, whether for adaptation or mitigation, should be consistent with wider national development goals.

A range of adaptive measures, across such sectors as coastal zone, fresh water management, disaster response, tourism, health, agriculture and human settlements will be needed to allow activities aimed at promoting sustainable development to continue. At the same time while Saint Lucia's emissions of GHGs make only microscopic contributions to global climate change, possibilities would appear to exist for adopting mitigation measures

in such areas as energy generation and conservation, road transport, and new and renewable energy that can meet climate change mitigation objectives while also contributing to national development objectives. Additionally certain cross-cutting technology needs exist, particularly for information technologies for data collection and analysis, meteorological measurement equipment needed for mitigation and adaptation technologies, and for capacity building. As well as meeting national priorities for climate change adaptation and mitigation, many of the technology needs identified can be expected to assist Saint Lucia in meeting its obligation for providing data and information to the global climate observation system.

Technology needs identified for climate change include a wide range of hard and soft technologies. All will require supportive institutional, regulatory and policy frameworks that serve to provide the type of enabling environment necessary for introducing these technologies.

The technology needs presented here should be viewed, as “first generation” technology needs in that they represent an initial set of responses to the problems of global climate change. Depending on the processes of adaptation and mitigation, other technology needs and requirements will arise.

While technology needs will be critical for responding to the challenges presented by climate change, other factors such as stakeholder awareness, availability of financial resources, and regulatory and institutional frameworks are also vital to overcoming many of the barriers that exist to incorporating climate change adaptation and mitigation into development plans and programmes. A particular set of needs relates to awareness of climate change as an essential first step in tackling adaptation and mitigation priorities for technology transfer and use and Appendix 3 provides an indicative project profile for this activity.

APPENDICES

APPENDIX 1

UNFCCC DECISION 4/CP.7

Development and transfer of technologies (decisions 4/CP.4 and 9CP.5)

The Conference of the Parties,

Recalling chapter 34 of Agenda 21 and the relevant provisions of the programme for the further implementation of Agenda 21 on the transfer of environmentally sustainable technologies adopted by the United Nations General Assembly at its nineteenth special,

Pursuant to the relevant provisions of the Convention, in particular, its Articles 4.1, 4.3, 4.5, 4.7, 4.6, Article 9.2(c), Articles 11.1, 11.5, and Articles 12.3 and 12.4,

Recalling its decisions 11/CP.1, 13/CP.1, 7/CP.2, 9/CP.3, 4/CP.4, 9/CP.5 and the relevant provisions of its decision 1/CP.4 on the Buenos Aires Plan of Action,

Recalling further its decision 5/CP.6 containing the Bonn Agreements on the implementation of the Buenos Aires Plan of Action,

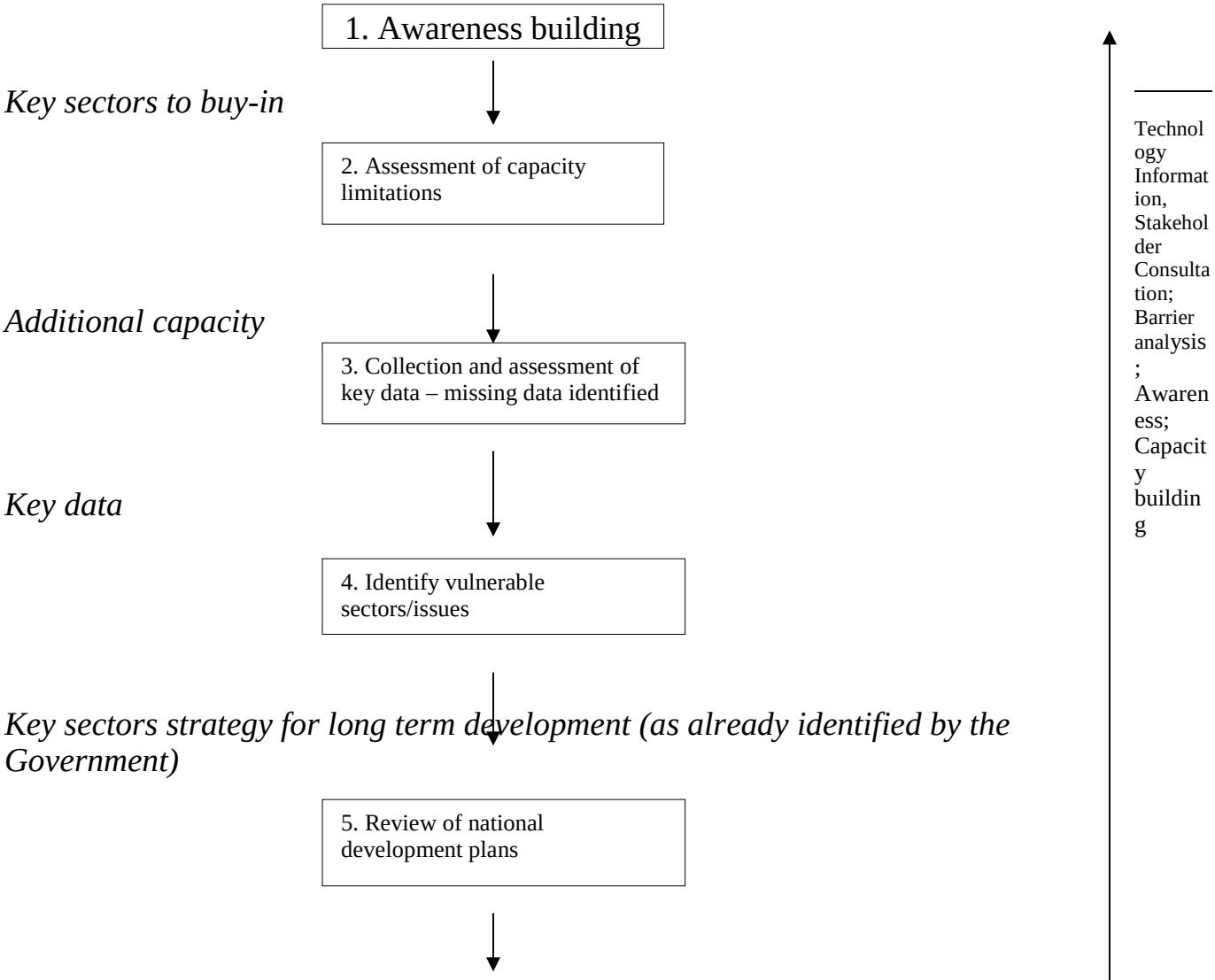
1. Decides to adopt the framework for meaningful and effective actions to enhance the implementation of Article 4, paragraph 5, of the Convention contained in the annex to this decision as part of the technology transfer consultative process (decision 4/CP.4);
2. Decides to establish an expert group on technology transfer to be nominated by Parties, with the objective of enhancing the implementation of Article 4, paragraph 5, of the Convention, including inter alia, by analyzing and identifying ways to facilitate and advance technology transfer activities and making recommendations to the SBSTA. The Conference of the Parties will review at its twelfth session the progress of the work and terms of reference, including, if appropriate, the status and continuation of the expert group;
3. Requests the Global Environmental Facility, as an operating entity of the financial mechanism of the Convention, to provide financial support for the implementation of the annexed framework through its climate change focal area and the special climate change fund established under decision 7'CP.7;
4. Urges developed country Parties to provide technical and financial assistance, as appropriate, through existing bilateral and multilateral cooperative programmes to support the efforts of the Parties in implementing the programmes and measures identified in the annexed framework and to enhance the implementation of Article 4, paragraph 5, of the Convention;
5. Requests the Convention secretariat:

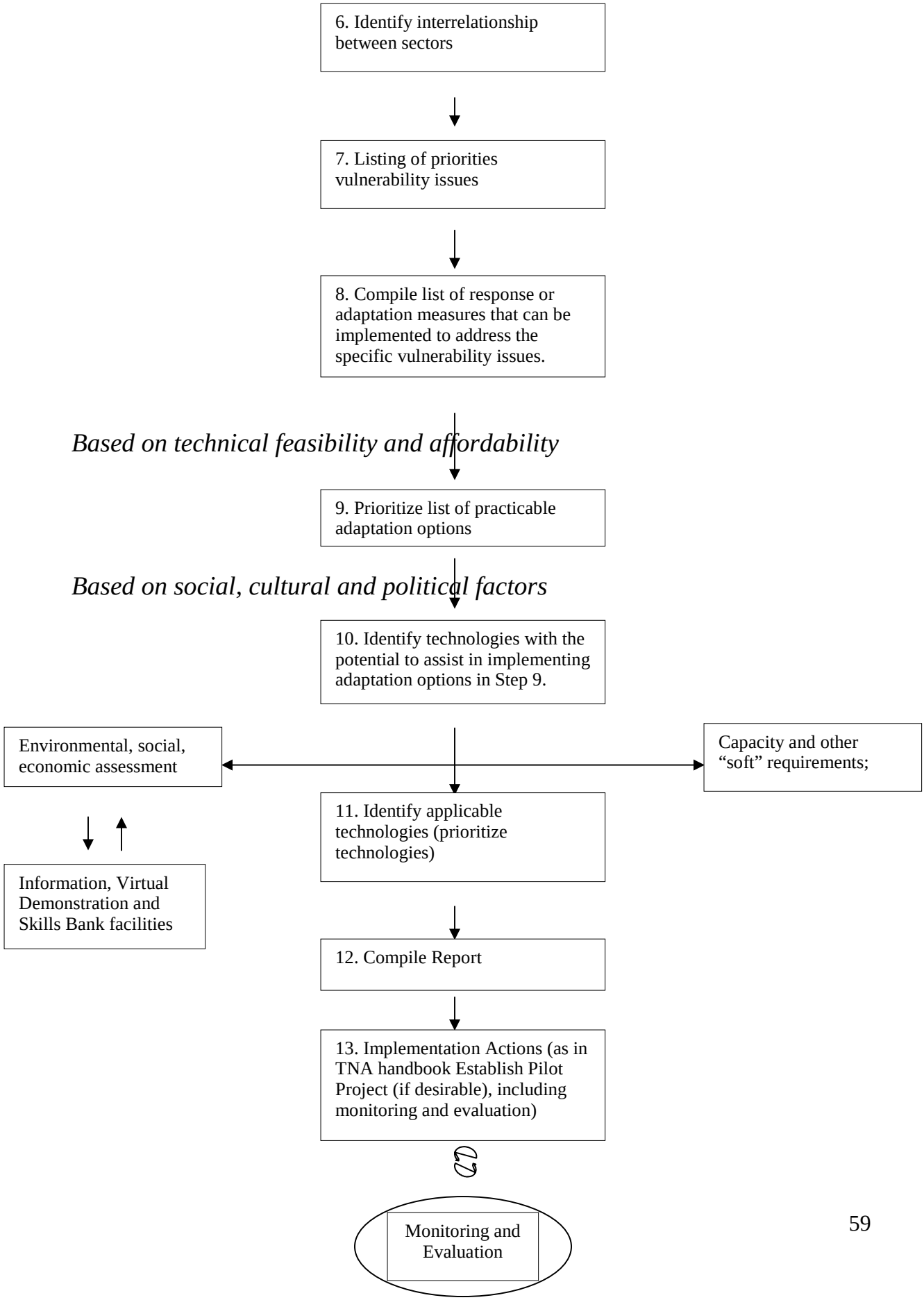
(a) To consult with relevant international organizations, and solicit information on their capabilities and abilities to support certain activities identified in the framework for meaningful and effective actions contained in the annex to this decision, and to report on its findings to SBSTA at its seventeenth session.

(b) To facilitate the implementation of the annexed framework in cooperation with the Parties, the Global Environmental Facility and other relevant international organizations.

8th plenary meeting
10 November 2001

APPENDIX 2: Draft Framework of Modified TNA Activities as applied to Adaptation




6. Identify interrelationship between sectors
7. Listing of priorities vulnerability issues
8. Compile list of response or adaptation measures that can be implemented to address the specific vulnerability issues.
Based on technical feasibility and affordability
9. Prioritize list of practicable adaptation options
Based on social, cultural and political factors
10. Identify technologies with the potential to assist in implementing adaptation options in Step 9.
Environmental, social, economic assessment
Capacity and other "soft" requirements;
11. Identify applicable technologies (prioritize technologies)
Information, Virtual Demonstration and Skills Bank facilities
12. Compile Report
13. Implementation Actions (as in TNA handbook Establish Pilot Project (if desirable), including monitoring and evaluation)
Monitoring and Evaluation

APPENDIX 3: Climate Change Information System Project Profile

Project Title: Climate Change Information Systems

Problem: The level of awareness and understanding of climate change adaptation and mitigation among decision makers remains low. Consequently vulnerabilities to the impacts are increasing and available mitigation technological options are not being utilized.

Objective: To promote increased knowledge and awareness of climate change issues and concerns among critical stakeholders through the provision of electronic based sources of information including a pilot programme for assessing implementation.

Links to Sustainable Development: Activities dealing with disaster response, health, agriculture, tourism, and coastal zone will benefit from information that reduces vulnerability in these sectors to existing climate extremes (drought, hurricanes, floods etc.) as well as enhancing ability to adapt to future changes in climate.

Assumptions: Adequate institutional arrangements exist for facilitating information flows. Targeted stakeholders are desirous of accepting and utilizing information relating to sectors.

Barriers: Financial resources. Limited technical capabilities (equipment, personnel).

Ongoing Initiatives: The Ministry of Planning has established a web site for information on climate change issues relating to Saint Lucia. Public awareness activities are ongoing using different media including workshops, newsmagazines and posters. Some existing knowledge of climate change issues among technical personnel.

Technology Needs: Information; management.

Activities:

1. Enhancement of database
2. Training of technical staff
3. Orientation of target audiences
4. Establishment of climate information network
5. Implementation of pilot phase
6. Technical backstopping and support

Indicative Budget:

1. Hardware/computers – US$15,000.00
2. Training and Orientation – US$ 15,000.00
3. Pilot phase – US$10,000.00
4. Total – US$40,000.00

The table above identifies the climate change and sustainable development *problems* and concerns to be addressed by the project outlined. The *Objective* refers to the overall goal that the project seeks to address. The table also identifies the beneficial effects that the project can have in other areas of *sustainable development* such as environment and employment.

Assumptions look at some of the external factors that are assumed to be in place if the project is to be successful, but which the project has no control over.

Barriers are factors that can be expected to present obstacles to project implementation.

Ongoing initiatives refer to some of the activities that may be already taking place, or be planned, that are likely to have significant linkages with the project.

The *Technology needs* row identifies the main types of technologies that may be required. The *Activities* row provides an indication of the type of policies and measures necessary to implement the project. The *Indicative Budget* row gives rough guidelines as to some of the financial costs that may be involved in implementation of the project.

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APPENDIX 4: ABBREVIATIONS

GHG	Greenhouse Gases
GIS	Geographic Information Systems
IEA	International Energy Agency

INC Initial National Communication
LULUCF Land Use, Land Use Change and Forestry
SEDP Sustainable Energy Development Plan
UNDP United Nations Development Programme
UNFCCC United Nations Framework Convention on Climate Change

APPENDIX 5: PERSONS CONSULTED

1. Mr. Bishnunarine Tulsie – Head, Sustainable Development Unit, Ministry of Physical Development, Environment and Housing.
2. Mr. Crispin d'Auvergne, Sustainable Development Unit, Ministry of Physical Development, Environment and Housing.
3. Mr. Cornelius Fevrier, Sustainable Development Unit, Ministry of Physical Development, Environment and Housing.
4. Ms Judith Ephraim, Sustainable Development Unit, Ministry of Physical Development, Environment and Housing.
5. Ms. Joanna Octave, Sustainable Development Unit, Ministry of Physical Development, Environment and Housing.
6. Mr. Joseph Maxwell, representative, Insurance Council of Saint Lucia
7. Mr. Cornelius Edmunds, LUCELEC
8. Ms Anita James, Ministry of Agriculture
9. Mr. Christopher Cox, , Ministry of Agriculture
10. Ms. Keren Monrose, Ministry of Agriculture
11. Ms. Shanta King, WASCO
12. Mr. A. Frederick, WASCO
13. Ms Dawn French, NEMO
14. Mr. Herbert Regis, Met Office
15. Mr. Descartes, Met Office
16. Mr. Daune Heholt, Physical Planning
17. Mr. David Joseph, Environmental Health Division
18. Ms Annette Augustine, Transport Division, MCW
19. Ms Susanna Scott, Department of Fisheries
20. Mr. Herold Gopaul, CEHI

Ms. Camille Roopnarine, CEHIAPPENDIX 6: DOCUMENTARY SOURCES

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