IDENTIFICATION OF CLIMATE CHANGE TECHNOLOGY NEEDS FOR ANTIGUA AND BARBUDA

Prepared by Brian Challenger:
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Executive Summary

Article 4.5 and other provision of the United Nations Framework Convention on Climate Change (UNFCCC) identify technology and technology transfer as essential elements of the international attempts to respond to global climate change. Technology comprise both hard technologies (equipment) and soft technologies (training, software). In particular the UNFCCC recognizes the central role that technological development can play in both adaptation and mitigation of climate change. Nevertheless overall progress towards the realization of this provisions of the UNFCCC has been slow. Consequently countries have been requested to identify their technology transfer needs and priorities The present report is the result of consultations with various stakeholders as well as a review of available documentation.

Antigua and Barbuda constitutes one of the smallest members of the international community. The archipelagic island state is located in the eastern Caribbean with a tropical maritime climate. The country is a natural resources – particularly its coastal and marine environment and its climate-provide the basis for the country's dominant tourism industry. Notwithstanding impassive socio-economics indicators the country remains extremely vulnerable to natural disasters particularly hurricanes, earthquake and drought, as well as to the dislocations of the international economics systems.

Projections for the global climate change in the Third Assessment Report (TAR) of the Intergovernmental Panel on Climate Change (IPCC) point to the potential for average global increase temperature to also 6°c within one hundred years. Other projections included possible change in the frequency and magnitude of extreme weather events such as hurricane and droughts and accelerated sea-level rise. These can be expected have significant adverse impacts on Antigua and Barbuda natural environment and economics activity with effects such areas as human health, human settlements, water supply, agriculture, tourism and disaster preparedness.

In relations to forecast for the global mitigations of the climate change, these are expected to continue to rise, including from developing countries. This is also likely for Antigua and Barbuda with the amount of emissions likely to be determined more by economics fortunes than technological shifts. At presents the country's microscopic contributions to global GHG emissions comprise almost exclusively carbon dioxide deriving from the generation of electricity and road transportation.

For Antigua and Barbuda adaptation to climate change represents the priority areas for technology transfer. At the present stage of understanding of thee climate change, areas for priority attention are:

- **Strengthening Early Warning Systems**

IPCC Projections for more extreme weather points to the need to ensure that meteorological and disaster warning systems are in place. The purchase of critical meteorological instruments and equipment is envisage.

- **Integrating Climate Change into Development Planning**

The range of impacts across all sectors means that Policy makers need to have sufficient understanding of climate change to factor these conditions into decision- making for public and private sectors. A wide ranging programme of training, data collection, and targeted public awareness I s required.

- **Coastal Area Protection**

This is especially important given the importance in Antigua and Barbuda's capital and marine environment and its contribution to economics well being. These areas are extremely vulnerable to climate change and will require sustained management efforts incorporating climate change concerns.

In relation to programmes for the mitigation of climate change, priority areas included:

- Development of sustainable energy plan. This will be aimed at promoting energy efficiency and other measure that also contribute to GHG emissions

technologies, as well as assistance with introduction of demand side management programme aimed demand medium to long term reduction in growth of electricity demand and more efficient end use of electricity

- **Development of wind energy**

Technological development and the county's wind regime would seem to hold prospects for integrating wind energy into the country's energy supply. The need exists for technical and financial support in enabling the electricity utility and the government to make greater use of this climate change mitigation technology.

Various barriers can be identified to the successful transfer of these technologies. Paramount amount these are financial barriers that impede both public and private sector access to these technologies.

Other important barriers are lack of awareness/information and various and various institutional

The six Climate Change technology transfer

- strengthening early warming systems
- integrating climate change into development planning
- coastal area protection
- development of a sustainable energy plan
- enhancing electrical energy efficiency, and
- developing wind energy.

In addition to their role in addressing climate change concerns the priority needs also target existing sustainable development needs and objectives. This is especially important given the uncertainties surrounding future climate change.

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SECTION ONE
INTRODUCTION

1.1 Terms of Reference

Technology, and technological transfer, have long been recognized as an integral component of the development process. During the 1970s and 1980s the question of appropriate technology emerged, focusing on the issue of choice of technologies relevant to the needs of developing economies and societies. With climate change the significance of technology has gained added significance in recognition of the need to provide mitigation alternatives to present greenhouse gas emitting technological processes, and the need to develop and utilize technologies for enabling adaptation to the impacts of climate change.

The United Nations Framework Convention on Climate Change (UNFCCC) emphasizes the role of technology as an important element in responding to, and particularly mitigating[1], climate change. Nevertheless, progress in achieving the technology transfer goals of the Convention has generally been slow[2]. At the second meeting of the UNFCCC Conference of Parties (COP2), parties to the UNFCCC agreed to the initiation of a consultative process aimed at examining certain issues and questions relating to technology transfer and at providing recommendations for achieving agreement on measures for implementing Article 4.5 of the convention. A significant development has been the decision of COP6 to establish an expert group on Technology Transfer that would report to the subsidiary bodies of the UNFCCC.

In fulfilling its obligations under the UNFCCC Antigua and Barbuda, a non-Annex 1 Party to the Convention, has undertaken an assessment of climate change technology issues and needs. Specifically the assessment is expected to involve:

- a review of available climate change related documentation, including the Initial National Communications of Antigua and Barbuda, with a view to identifying 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 areas for climate change technology (transfer and development), so as to enable Antigua and Barbuda to identify priority technology needs areas for submission to the UNFCCC, and
- preparation of a report for consideration by the national Climate Change Steering Committee as to Antigua and Barbuda's principal technology needs for climate change.

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[1] The term "mitigation" is used here as defined by the IPCC as "an anthropogenic intervention to reduce the emissions or enhance the sinks of greenhouse gases" [IPCC, 2000].

[2] Progress has largely involved preparation of a series of reports on technology including the IPCC Special Report on Technological and Methodological Issues in Technology Transfer.

The assignment has been undertaken as a part of the Climate Change Enabling Activity being implemented by the Government of Antigua and Barbuda in conjunction with the United Nations Development Programme and the Global Environment Facility. The report is intended to contribute to the consultative process on Technology Transfer initiated at COP4 as well as wider on-going efforts to implement the provisions of Article 4.5 of the UNFCCC.

1.2 Climate Change Technology Transfer and the UNFCCC

The adoption into international law of the UNFCCC represents a response by the world community to combat the problem of global climate change. Article 2 of the UNFCCC establishes that the "ultimate objective" of the Convention is "the stabilization of greenhouse concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system". Arising out of this objective, the UNFCCC identifies a number of commitments and measures aimed at enabling the implementation and realization of the UNFCCC's objective.

In many ways the problem of climate change is a result of technological development. In particular it is the productive forces unleashed by industrial technologies that have largely resulted in the emission of ever increasing amounts of greenhouse gases into the Earth's atmosphere. However, the framers of the UNFCCC realized that in addition to causing the problems associated with climate change, technology also presents opportunities for responding to the problem.

Mention of technology in the UNFCCC first appears in the Preamble to the document and refers to the "application of new technologies" for greenhouse gas mitigation. Article 4.1(c) calls for all Parties "to promote and cooperate in the development, application and diffusion including transfer of technologies, practices and processes". Article 4.1(e) requires Parties to cooperate in preparing for adaptation to climate change.

Article 4.5 prescribes that developed Parties to the Convention "shall take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies ... to other Parties... to enable them to implement the provisions of the Convention". Article 4.7 goes further to provide that "the extent to which developing country Parties will effectively implement their commitments under the Convention will depend on the effective implementation by developed country Parties of their commitments under the Convention related to financial resources and transfer of technology".

Countries involved in the UNFCCC process have taken a number of decisions to advance the cause of Article 4.5. The fourth Conference of the Parties (COP4) held in Buenos Aires in 1998, agreed on the Buenos Aires Plan of Action one element of which establishes a consultative process on technology transfer. The process is expected to lead to recommendations on how issues and concerns should be addressed to achieve

agreement on a framework for "meaningful and effective actions" to enhance implementation of Article 4.5 of the Convention.

In addition to the UNFCCC, the Kyoto Protocol to the Convention also addresses the issue of technology transfer. The Protocol sets targets for greenhouse gas emissions reduction for developed (annex 1) countries. In terms of its relationship to non-annex 1 countries like Antigua and Barbuda, the Protocol establishes the Clean Development Mechanism (CDM) for promoting the transfer of environmentally friendly technologies to developing countries as a means to advance greenhouse gas mitigation.

At COP6 held in June 2001, agreement was reached on elements of an emissions trading regime. The agreement includes core elements for implementing the Buenos Aires Plan of Action and commitments to technical and financial assistance to developing countries vulnerable to the adverse impacts of climate change. COP6 also agreed to establish an Expert Group on Technology Transfer to enhance implementation of Article 4.5, to facilitate and advance technology transfer and to make recommendations to the SBSTA.

At the seventh session of the COP in November 2001, the Marrakesh Accords were adopted further advancing the operational details of the Protocol and seeking to pave the way for its introduction in time for the 10th anniversary of the UNCED meetings and agreements at the World Summit on Sustainable Development (WSSD) in South Africa in mid 2002.

COP7 also adopted the Marrakesh Declaration as an input to the WSSD. The Declaration emphasized the contribution that action on climate change can have on sustainable development and called for international action in various areas including technology transfer.

In addition to its role in responding to climate change, the UNFCCC, as one of the instruments to emerge from the 1992 United Nations Conference on Environment and Development (UNCED), seeks to incorporate and advance the wider goals of sustainable development. Specifically the UNFCCC recognizes that the principal responsibility for climate change rests with developed countries and that the main concern of developing countries is with overcoming existing constraints to development. Consequently actions taken by developing countries under the UNFCCC to address technology needs for climate change are expected to also target measures for satisfying their demands for sustainable development including economic growth and environmental protection.

1.3 Definitions and Theoretical Aspects of Technology Transfer

While the UNFCCC does not itself provide any definitions of technology, the IPCC has defined technology transfer as "the broad set of 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" (IPCC, 2000). As one commentator has noted "if the problem of climate change is to be mitigated, then methods have to be found by which appropriate technologies are harnessed as rapidly as

possible and in as efficient a manner as possible. This is particularly important in those countries that do not have the means either to develop or purchase environmentally efficient technologies in a range of economic activities"[3].

While the emphasis on technology in the UNFCCC is focused primarily on climate change mitigation, there is also recognition within the UNFCCC and IPCC processes of the importance of adaptation technologies as a priority area for action, particularly for highly vulnerable ecosystems such as found in small island States like Antigua and Barbuda[4]. Adaptation has been defined in the IPCC's Third Assessment Report (TAR) as "adjustments in natural and human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities"[5]. The TAR highlights the role of adaptation in improving possibilities for responding to the effects of climate change. Chapter 18 of the TAR on Adaptation to Climate Change notes that a "community's current level of technology and its ability to develop technologies are important determinants of adaptive capacity".

It is imperative that non-annex 1 Parties to the UNFCCC promote wider national and regional sustainable development goals while attempting to achieve the global targets and objectives of the UNFCCC. This is particularly important in the case of technology transfer since technologies adopted need to be relevant to existing concerns such as economic development and environmental protection.

Technological approaches involve both "soft" and "hard" technologies. Soft technologies – such as training and software – concerns the knowledge of techniques and processes for production of goods and services. Hard technologies – often called capital goods or hardware – refer to production inputs such as tools, equipment and machinery. Frequently technology transfer efforts concentrate on installing hard technologies and do not provide sufficient inputs of soft technological capabilities to enable these technologies to be successfully adopted by recipient countries in the developing world[6]. Klein and Tol indicate that "the development and deployment of either type of technology requires the right economic, legal and institutional context"[7].

As Trindade[8] points out there are many different forms of technology transfer. These include investment and trade decisions made by the private sector; the acquisition of

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[3] RK Pachauri, "Climate Change and Technology Transfer", in "Working Papers for Negotiators: Climate Change and Development", Luis Gomez-Echeverri (ed.), UNDP/Yale, 1988

[4] In fact the IPCC definition above mentions adaptation before mitigation, possibly in recognition of the increasing significance of adaptation as a response to the challenges of climate change.

[5] "Climate Change 2001: Impacts, Adaptation, and Vulnerability". Contribution of Working Group Two to The Third Assessment Report of the IPCC. IPCC 2001. Cambridge University Press.

[6] See "Development and Transfer of Technology: Status of the Consultative Process. Report of the Latin America and Caribbean Workshop". FCCC/SBSTA/2000/INF.6

[7] "Adaptation to Climate Change: Options and Technologies. An Overview Paper". JT Klein and Richard Tol. UNFCCC paper FCCC/TP/1997/3

[8] Trindade S.C., "A Flexible Framework for Meaningful and Effective Actions to Enhance the Implementation of Article 4.5 of the UNFCCC", UNFCCC Secretariat. Trindade identifies eight distinct stages in the technology transfer process:

skills and knowledge through formal and informal training by individuals; purchase of patent rights and licenses; and migration of skilled personnel with knowledge of particular technologies. In developing countries foreign investment generally plays a crucial role in allowing for the transfer of advanced technologies used in the productive and/or consumptive sectors. Technology transfer is also influenced by national, bilateral and multilateral assistance and financing programs as well as by the policies of regional and international development agencies.

Technology transfer includes transfers between developed countries, between developed and developing countries, and between developing countries. In terms of the exchange of technology from developed to developing countries much emphasis is placed in the available literature on the importance of the requisite human, institutional, and technical capacities to successfully adopt and manage the technological processes [9]. Generally, obstacles to the successful transfer of technologies include reasons relating to political, financial, technical, cultural and environmental factors.

Recent years have seen an increasing focus on technological transfer as essentially a private sector responsibility. This reflects the general movement away from Official Development Assistance and towards private investment as the engine for economic and social development including technology transfer. At the same time much of that investment has been in the larger emerging markets of the developing world with most of the so-called least developed countries, including a number of small island States, largely being excluded from the process of transfer of climate change related environmentally sustainable technologies[10]. This is probably less so for technologies associated with climate change adaptation (eg coastal management).

The opportunities would however appear to exist for an increased collaboration between public and private sectors on environmentally sustainable technologies through the Kyoto instruments especially (for developing countries) as far as the CDM is concerned. One of the main instruments for promoting the spread of environmentally friendly technologies is the Global Environment Facility (GEF) which also acts as the "financial mechanism" for the UNFCCC.

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1. Identification of technology needs
2. Search for adequate technologies and sources of supply
3. Choice of technology and supplier
4. Negotiation (agreement and conditions)
5. Transfer (organization and substance)
6. Adaptation, integration and operation
7. further development by the receiver, and
8. Implementation and diffusion by the receiver

[9] see FCCC/SBSTA/2000/INF.6 noted above.
[10] See "Implementing Agenda 21: Report of the Secretary General". E/CN.17/2002/PC. United Nations Economic and Social Council.

1.4 Conclusion

Article 4.5 and other articles of the UNFCCC highlight the role of technology and technology transfer as tools for responding to the challenges of global climate change particularly for developing countries. The next sections of the report examine the national circumstances of Antigua and Barbuda especially as these relate to the need for responding to climate change through the meaningful transfer of adaptation and mitigation technologies. Following this an examination will be done of some of the principal adaptation and mitigation technology options available to the country.

SECTION TWO

NATIONAL CIRCUMSTANCES OF ANTIGUA & BARBUDA

2.1 Physical and Climatic Features

Antigua and Barbuda are small tropical islands located at 17 degrees north and 62 -63 degrees west. In addition to the two main islands, the State also comprises a number of uninhabited islands, rocks and cays. The islands occupy a part of the north–eastern section of the Caribbean archipelago. Antigua comprises three fairly distinct topographic regions consisting of a volcanic region in the southwest, a central plain, and a limestone region in the northeast. Barbuda's topography is more homogeneous and consists primarily of limestone areas similar to those found in Antigua. The total land area is 440 square kms (Antigua 280 sq km, and Barbuda 160 sq kms) making Antigua and Barbuda one of the smallest members of the community of independent nations.

The climate is characterized as tropical maritime and is influenced primarily by the presence of the Atlantic Ocean and the Caribbean Sea. Average temperatures range from a high of 30.9 degrees Celsius (87.6 F) in August to a low of 28.2 degrees Celsius (82.8 F) in January. The island experiences two seasons: a dry season from December to July, and a wet season from August to November. The islands are among the driest in the Caribbean chain with annual rainfall averages of 30-39 inches in Barbuda and 40 inches in Antigua[11] (source: CEP, 1989).

In contrast to temperature that remains fairly constant, rainfall regimes display substantial annual and seasonal variability. For example in Barbuda in 1966 only 12.89 inches of rain were recorded, this increasing to 49.63 inches in 1979. Similarly for Antigua rainfall figures for the airport indicate variations ranging from a low of 25.09 inches in 1968 to a high of 67.29 inches in 1979. Rainfall amounts are particularly influenced by the annual Atlantic hurricane system with a substantial amount of the rainfall occurring as a result of tropical storms producing more than one inch of rainfall. Other influences on rainfall (and temperature) patterns include the ENSO phenomenon that tends to result in reduced rainfall and higher air surface temperatures during the El Nino phase, and increased rainfall and cooler air and sea surface temperatures during the La Nina cycle.

Arising from the low and variable rainfall regime, dry and arid conditions constitute a significant part of the country's climatic regime. The Antigua and Barbuda Meteorological department has categorized drought from slight to extreme, as shown in Table 2.1 below.

[11] The wide variation in Barbuda may reflect the absence of a centralized system for rainfall data collection.

Table 2.1
Categories of Meteorological Drought, as Defined by % of Average Yearly Rainfall of 40.98 inches (Antigua)

Category Drought	Rainfall (inches)	% of Ave. Annual Rainfall
Slight	38.93	95
Mild	36.88	90
Moderate	32.78	85
Moderate/ Severe	30.74	80
Severe	28.69	75
Extreme	24.50	70

(Source: Meteorological Office, 2001)

Based on annual rainfall assigned to each category by the Meteorological Office, some form of meteorological drought has occurred in Antigua in 20 of the 40 years between 1960 and 2000 (Jackson, 2001).

As small islands, the coastal and marine environment plays an important environmental and economic role. Mangroves, coral reefs, sea-grass beds, salt ponds and beaches are among the coastal and marine features that provide important habitats for marine biodiversity. As the country's National Report on Biodiversity indicates "Antigua's deeply indented bays and sandy beaches provide the setting for much of the island's important tourism industry. Equally, Barbuda's pink sand beaches and coral reefs provide an aesthetic and environmental feature unique in the eastern Caribbean"[12]. Additionally the country's coastal and marine resources form the basis for a small but important fisheries sector as well as providing natural defenses against storm surge and fulfilling other environmental functions. Cambers[13] (1993?) estimates that "about 21% of Antigua's 193km coast consists of sandy beaches, 11% mangrove and wetland, and 68% hard rock cliffs. In addition 6% of the coastline is protected with either revetments or bulkhead reclamations".

The country's terrestrial environment is also varied, ranging from isolated pockets of old growth forest in central areas of Antigua to scrub forests covering large areas of Barbuda and the eastern coastal areas of Antigua. Much of the terrestrial vegetation has been disturbed for plantation agriculture during the colonial period so that most of the land,

[12] See "Antigua and Barbuda's First National Report to The Convention on Biological Diversity". Government of Antigua and Barbuda, March 2001.
[13] Cambers G, "Assessment of the Vulnerability of Coastal Areas in Antigua and Nevis to Sea Level Rise". Published paper. Source and date unknown.

particularly on Antigua, has been deforested. The country's flat topography enables road access to virtually all areas, facilitating the distribution of settlements and industry.

As with most other small island territories, Antigua and Barbuda exhibit high levels of vulnerability to a number of natural disaster risks. In addition to hurricanes these include drought, earthquakes, volcanic activity[14]and tsunami. In addition to the natural forces determining these risks, hazard levels are also conditioned by human activity. As Maskrey points out "in Antigua and Barbuda, environmental degradation over recent decades may be leading to increased hazard levels". For example, "groundwater extraction, landfills and drainage may increase earthquake intensities in certain areas. Similarly the destruction of mangroves and natural coastal defenses may increase hurricane hazard ...erosion caused by infrastructure development and building on hillsides; beach sand mining on the perimeter of the island and uncontrolled sewerage disposal are examples of documented environmental degradation, which may increase hurricane, seismic and other hazards in the country (Maskrey 1997)[15]. Recent experiences with hurricanes have demonstrated the extent of vulnerability of coastal areas and of the vital tourism sector to hurricane activity.

Socio-Economic Features

The 2001 provisional population of Antigua and Barbuda[16] is estimated at approximately 75,741[17] people with 59% of the population residing in the parish of St Johns. The population is estimated to have grown by 16% since the last census in 1991. The country has a population density of approximately 688 persons per square mile. A finding from the 2001 census is the growth of suburban areas of St Johns so that population densities in these areas are substantially above the national average. In contrast, while the population of Barbuda has also grown by 16% since 1991 the population density on that island remains low with settlements confined to the Codrington village area.

Since the 1960s the economy of Antigua and Barbuda has been dominated by the tourism sector. At present the sector is estimated to contribute some 60% of GDP. Antigua and Barbuda's tourism product is based on its natural attractions particularly it's coastal and marine environment and weather conditions. Tourism arrivals come primarily from Europe and North America. The cruise industry is an important component of the tourism industry in Antigua and Barbuda. The tourism sector is one of the major sources of productive employment and is also the primary source of foreign exchange. As noted above much of the tourism industry is centered around the country's various coastal and marine attractions.

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[14] While the islands of Antigua and Barbuda do not have an active volcanic hazard the neighboring island of Montserrat, since 1995 has had to cope with an on-going volcanic eruption resulting in the displacement of persons to Antigua and Barbuda (and other islands) and with volcanic ash-falls occurring intermittently in Antigua.

[15] Maskrey A, " An Assessment of Disaster Early Warning Systems in Antigua and Barbuda". Unpublished. GTZ, 1997.

[16] Antigua and Barbuda Preliminary Census Report 2001, Department of Statistics, Ministry of Planning and Implementation. Antigua

[17] This figure is based on estimated resident population, as determined by the results of the 2001 census.

Notwithstanding its dominant position, the tourism industry in Antigua and Barbuda faces a number of challenges. Principal of these is the competitiveness of the product being offered at a time of extreme competition in the international tourism market. High labor, energy, and import costs have made Antigua and Barbuda a relatively high cost tourism service provider. Since 1995 the impacts of a number of hurricanes have also adversely affected tourism properties and the natural resource base that the country's tourism is based on.

Other strains relate to the environmental impacts of tourism particularly on the coastal environment. In a number of prime tourism areas, such as Dickenson Bay and Runaway Bay, poorly planned tourism development and infrastructure have resulted in severe coastal erosion. In some areas hard structures (groynes and breakwaters) have been utilized by private property owners often with adverse impacts on near-by shorelines. Despite these difficulties tourism is expected to remain the dominant export sector although government policy is also directed at promoting the expansion of financial services, information technology based activities, and a general diversification of the economy away from dependence on tourism to other service sectors.

Paralleling the rise of the tourism and service sectors has been the decline of the agricultural sector. Figures for 2000 indicate that the agricultural sector accounted for 4% of GDP with the fisheries sector contributing approximately half of this amount. Agricultural production remains characterized by low levels of capital investment and by the use of traditional technologies. Agricultural production includes fruits, vegetables and livestock. Government's policy aims to modernize farming techniques; encourage export promotion and import substitution; and through effective linkages with the tourism industry, reduce the leakage of foreign exchange earnings. A principal factor affecting the viability of the agricultural sector has been the country's variable rainfall the effect of which has often been severe droughts that have adversely impacted production in the sector.

Like the rest of the agricultural sector fisheries remains largely artisanal. Fishing effort is targeted primarily at near-shore pelagics and demersal reef species. In many instances these resources are already under pressure from anthropogenic sources such as over-fishing, loss of habitat, and coastal pollution. Nevertheless fisheries remains significant in terms of its nutritional contribution, impact on employment, and linkages to tourism. Future plans envisage greater exploitation of migratory pelagic species.

Despite various national and regional efforts over the years to promote development of a viable manufacturing sector, the sector continues to contribute only a very modest, and declining, share of the national economy. As Antigua and Barbuda's Initial National Communication to the UNFCCC notes "the small size of the sector reflects the lack of economies of scale for manufacturing enterprises in the context of such small economies,

especially in an era of market liberalization and competition from lower cost producers in developed and developing countries"[18].

Despite the obstacles imposed by small size and limited natural resources, Antigua and Barbuda has been able to achieve admirable levels of human development as witnessed in such indicators as health and education statistics.

However such indicators do not effectively capture the extent of vulnerability to external economic forces or the extent of vulnerability to natural disasters. Maskrey notes that 'hazard events such as earthquakes and hurricanes will tend to affect 100% of the country's area. Unlike larger countries, where hazard events normally affect only specific regions or sectors, Antigua and Barbuda suffers from total vulnerability. Relative losses, compared to population size and land area, are likely to be far greater than in a large country, meaning that capacity to absorb the impact of a hazard and recuperate is reduced. Due to this characteristic, most disasters in Antigua and Barbuda are large disasters, in that they affect the country as a whole". Antigua and Barbuda is also heavily dependent on tourism for GDP, foreign exchange and employment: a sector that is particularly sensitive to the impact of natural hazards and human events[19].

For example, Hurricane Hugo in September 1989 destroyed or damaged 2180 homes, resulting in the death of two persons and injuries to four hundred 400 and resulted in damages estimated at US$ 57.08 million or 17.6 % of GDP. Six years later, Hurricane Luis in September 1995 resulted in damage to virtually all homes in Antigua, resulted in death of two people and caused damages estimated at US$128.35 million or 30.5 % of GDP[20]. Over the decade 1989-1999, the twin island State was ravaged by six major hurricanes. Losses to the tourism sector were particularly significant reflected in a drop in visitor arrivals, the closure of several hotels (a few permanently), and lay-off of workers: given the contribution of tourism to the national economy this has of course had major ripple effects on the national economy.

Equally significant from the standpoint of technology transfer, these indicators provide little insight as to the extent of dependence on imported technologies or to the role of technological innovation in responding to threats to sustainable development. As with most other Caribbean countries, no systematic assessment of climate change technologies has previously been done of Antigua and Barbuda[21].

In terms of technology and technology transfer, the country's relatively simple economic structure based on the tourism industry and dependent on external markets for manufactured products means that there is little in the way of advanced industrial

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[18] " Antigua and Barbuda's Initial National Communications on Climate Change". Government of Antigua and Barbuda. May 2001

[19] The vulnerability of tourism was brought out most graphically following the terrorist attacks involving civil aviation of September 11th, 2001 and their consequent impacts on global air travel.

[20] E Benjamin and J Fernandez. "Vulnerability and Adaptation Assessment for Antigua and Barbuda". November 2000. Draft report.

[21] See for example "Jamaica Country Paper on Climate Change Technology Transfer". UNFCCC Regional Workshop on Technology Transfer. FCCC/SBSTTA/2000/INF 6

technologies. However at the same time the country's proximity to, and strong trading links with, North America and other developed markets has meant that a wide range of off-the-shelf technologies are available. Most of these technologies are privately owned and financed.

A regional assessment of renewable energy technologies notes that "few of the governments in the Caribbean region have developed policies to promote the use of RET [renewable energy technologies], or have even assessed their inventories of renewable resources"[22].

2.2 Conclusion

As a small developing island State, Antigua and Barbuda faces a number of challenges arising from its small size and attendant environmental, economic, and institutional constraints and limitations. The country's physical and climatic features provide the base for its principal economic sectors and these are already vulnerable to a range of climatic and natural hazards and external economic forces.

Notwithstanding these limitations Antigua and Barbuda has been able to achieve a relatively advanced level of social and economic indicators. Such progress is already under threat from the effects of economic globalization. An even more rigorous set of challenges to sustainable development is likely to be presented by threats arising from global climate change. The next chapter will provide an overview of climate change and its likely impacts in Antigua and Barbuda. An examination of GHG sources will also be undertaken. These measures are intended to provide guidance in defining environmentally sustainable climate change technology needs.

[22] see UNDP/GEF CREDP project document RLA/OO/G31

SECTION THREE

PROJECTIONS FOR CLIMATE CHANGE IMPACTS & MITIGATION FOR ANTIGUA & BARBUDA

3.1 Introduction

There is increasing scientific consensus that changes in the chemical composition of the Earths atmosphere due to the anthropogenic emission of GHGs are resulting in long-term changes to the global climate. While uncertainties remain as to the timing of these changes, scientific data and models allow for the identification of a number of trends and indicators. In 1995 the IPCC's Second Assessment Report confirmed a "discernible human influence on global climate". This was followed in the Third Assessment Report with the finding that global average temperatures have increased by 0.2-0.6 degrees centigrade since reliable records have been kept in the 1860s.

Data provided in the IPCC TAR points to some of the changes in the Earths climate that have already occurred. The 1990s have been the hottest decade on record possibly for the last 1000 years. Reflecting a trend throughout the 20th century, 1998 was the hottest year on record (influenced by an unusually strong El Nino) and with 2001 being the second warmest. The greatest extent of warming has occurred in northern latitudes particularly in continental areas. These conditions are part of a continuing trend to warmer global temperatures that have resulted in a rise of more than 0.6°C during the past 100 years, although the rise in temperature has not been continuous. Since 1976 the global average has risen at a rate approximately three times faster than the century-scale trend. The year 2001 will be the 23rd consecutive year with the global mean surface temperature above the 1961-1990 average (WMO, 2001)[23].

The IPCC TAR notes that global average night-time temperatures have increased more than day-time temperatures. There has also been increased variability in rainfall patterns in many regions throughout the world.

Based on available climate data there is no observed statistical change in the frequency of tropical storms/hurricanes. Changes in the frequency of these events appear to be influenced by complex inter-decadal and multi-decadal processes that may or may not have been influenced by human induced climate change.

The IPCC TAR points out that human impacts will continue to influence atmospheric composition throughout the 21st century and beyond. This will happen whether or not such initiatives as the Kyoto Protocol come into effect due to the time lag in the climate system in responding to any changes in GHG concentrations. This means that measures for adaptation to climate change assume an even greater significance as a response to climate change.

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[23] World Meteorological Organization (WMO) Press Release [December 2001], Geneva. (From http://www.wmo.ch/web/Press/Press670.html)

The IPCC TAR indicates that during the 20th century the Caribbean has seen an increase in temperature of about 0.6 degrees. Gray (1993)[24] notes that there is also evidence of a drying tendency at various stations in the insular Caribbean. This is reflected in a significant increase in rainfall variability with some stations in Jamaica, Trinidad, and the eastern Caribbean showing moderately declining trends from the 1960s. The effect of other anthropogenic influences such as urbanization and deforestation on these trends is unclear. The situation with regards to tropical storm activity is also unclear with some evidence of inter-decadal peaks and troughs; however, the period from 1995-1999 was particularly active for Antigua and Barbuda with direct impacts from five major storm systems.

3.2 Projections for Future Climate Change

Tables 3.1 to 3.4 present scenarios from the IPCC TAR for the Caribbean based on an ensemble of results from leading international General Circulation Models (GCM) [25] for temperature and precipitation.

Table 3.1: Annual Mean Temperature Change (degrees Celsius)

	GHG	GHG+A
2050s	2.03	1.71
2080s	3.06	2.64

Source: IPCC 2001[26]

Table 3.2 Annual Mean Precipitation Change

	GHG	GHG+A
2050s	-5.2	-1.3
2080s	-6.8	-0.7

Source: IPCC 2001

TABLE 3.3 Seasonal Mean Temperature Change (degrees Celsius)

	GHG 2050	GHG+A 2050	GHG 2080	GHG+A 2080
Dec-Feb	2.00	1.68	3.01	2.61
June-August	2.01	1.71	3.07	2.64

Source: IPCC 2001

Table 3.4 Seasonal Mean Precipitation Changes (%)

	GHG 2050	GHG 2050+A	GHG 2080	GHG+A 2080
Dec-Feb	3.4	5.9	-14.4	-6.9

[24] Calvin Gray, " Regional Meteorology and Hurricanes" in "Climatic Change in the Inter Americas Sea", ed. G Maul, UNEP, 1993

[25] Scenarios for GHG refers to models utilizing only GHG induced climate forcing. GHG+A refers to GHG forcing along with the moderating influence of aerosols.

[26] IPCC 2001, " Climate Change 2001; Impacts, Adaptation and Vulnerability. Contribution of Working Group 2 to the Third Assessment Report". .Cambridge University Press

June-August	4.8	8.5	-19.2	-8.2

Source: IPCC 2001

The IPCC TAR envisages a global mean sea-level rise of 0.09 to 0.88 meters between 1990 and 2100. Projections for extreme events indicate that there is likely to be an increase in tropical cyclone peak wind intensities over some areas. Similarly there is likely to be an increase in mean and peak precipitation intensities associated with extreme events such as hurricanes and tropical storms. El Nino conditions are projected to continue to influence weather patterns in the Caribbean.

The picture to emerge for Antigua and Barbuda and other Caribbean islands from these scenarios is one of a warmer climate, rising sea-levels, and increased variation in rainfall totals on an annual and seasonal basis. Storm and hurricane activity patterns are also likely to be affected, with higher sea surface temperatures expected to result in an increase in the intensity of these systems and possibly also an increase in the number of these events.

3.3 Projected Impacts of Climate Change in Antigua and Barbuda

The Antigua and Barbuda Initial National Communications to the UNFCCC as well as other reports[27] highlight the possible impacts of climate change on Antigua and Barbuda. Utilizing the IPCC scenarios for sea-level rise, air and sea surface temperature increases, and rainfall variability, as well as projections for increased hurricane activity, a number of possible severe adverse impacts on a number of key sectors and geographical areas can be identified.

In the coastal and marine environment these include the destruction of critical beach, mangrove, sea grass and coral reef ecosystems from sea-level rise, hurricane activity and temperature changes. This will have important implications for the country's vital tourism industry. Experiences from recent hurricanes, notably Hurricane Luis in 1995 and Hurricane Lenny in 1999, already point to the devastating physical and economic effects of hurricanes.

The major impacts of sea-level rise in Antigua and Barbuda (Cambers *op. cit*) are expected to be :

- Accelerated shoreline erosion
- Raised water levels in wetlands, ponds and lagoons
- Saltwater intrusion

Areas particularly at risk to sea-level rise include sections of the capital city of St. Johns, Barbuda, Parham, and the northwest coast where significant tourism development already exists. Additionally these and a number of other areas are likely to be at increased risk of storm surge. The tourism sector is primarily located in coastal areas so that any adverse

[27] Most notable among the reports on climate change pertaining to Antigua and Barbuda is the UNEP/Ministry of Planning "Climate Change Impact and Adaptation Assessment for Antigua and Barbuda". 1997.

impacts from sea-level rise and storm surge can be expected to have significant economic and social effects. As the coastal areas also include much of the nations infrastructure and human settlements, sea level rise impacts in these areas will have major national implications for water supply, electricity distribution and road communications.

Impacts in the coastal zone will also affect the country's fisheries industry and are likely to include further reductions in reef fisheries, additional damage to fishing gear from storm related activity, and shifts in the availability of pelagic fisheries.

Water supply is also another sector likely to be directly affected by climate change. Reductions in rainfall are likely to reduce surface and ground water availability. These measure are likely to increase reliance on more expensive sources such as deep well and/or desalinization technologies. Increased rainfall, particularly if in the form of torrential downpours is likely to produce landslides and soil erosion as well as damaging water intakes and flooding residential and commercial areas. Heavy rains from Hurricane Lenny in 1999 resulted in damage to housing and agriculture as well as producing substantial soil erosion and landslides.

Water availability will be a critical factor affecting the viability of the agricultural sector. Experiences from hurricane activity and droughts in the 1990s demonstrate the continuing vulnerability of agricultural production in Antigua and Barbuda to extreme weather events; conditions that would be expected to intensify with global climate change. Higher temperatures and the occurrence of more frequent severe rainfall events will also present problems in terms of the effect of heat stress on plant and animal health, and on soil conservation.

Human health and the health sector are also likely to be adversely affected by changes in temperature and in the hydrological cycle. Likely impacts of the scenarios include increased opportunities for breeding of dengue and malaria carrying insect vectors, both diseases already being endemic to the Caribbean. Other health risks associated with the scenarios include increased incidences of respiratory and cardiovascular diseases arising from rising temperatures and changes in the hydrological cycle. Stronger and/or more hurricanes will have implications for deaths and injuries from these events These pressures on the health sector will come at a period of existing stresses arising from such factors as an aging population, escalating health costs, and shortages of health care personnel.

Projections for more intense storm conditions are also likely to have a range of adverse impacts on Antigua and Barbuda and other small island countries. Both the coastal and terrestrial environment is vulnerable to the effects of strong winds and torrential rainfall associated with hurricane and storm activity. Economic impacts include those to housing and other property, to productive sectors particularly tourism, as well as increased expenditures for disaster relief, reduced foreign exchange earnings, and growing current accounts deficits. In terms of disaster response the effect of hurricane and storm activity include human misery and the need to devote additional scarce resources to disaster mitigation and relief activities.

3.4 Mitigation Scenarios

The structure of economic activity in Antigua and Barbuda, and consequently the types of technologies used, centre on the provision of tourism and related services. This structure is reflected in the results of the Inventory of Greenhouse Gases which reveals that the greatest proportion of greenhouse gases originate from the generation of electricity followed by road transportation. Also very significant is the level of emissions from bunker sources especially aviation. These are all reflective of the dominant role of tourism and affiliated services in the national economy. Tables 3.5 and 3.6 provide data from the GHG inventory.

Table 3.5 C02 Emissions and Removals by Sector 1990

GHG Sources and Sinks	**CO2/ EMISSIONS**	**CO2/ REMOVALS**
Energy	288	0
Industrial Processes	0	0
Agriculture	0	0
Land-use Change and Forestry	0	-96
Waste	288	-96
Total National Emissions and Removals		
Memo Items		
International Bunkers	167,3	0
Co2 Emissions from Biomass	3,42	0

Source: Initial National Communications

Table 3.6 Non- CO2 Emissions and Removals By Sector 1990

GHG Sources and Sinks	CH4	N2O	NMVOC	SO2
Energy	0	0	0	2.83
Industrial Processes	0	0	0.65	0
Agriculture	1	0	0	0
Land-use Change and Forestry	0	0	0	0
Waste	3.6	0.005	0	0
Total National Emissions and Removals	4.6	0.005	0.65	2.83
Memo Items				
International Bunkers	0	0	0	0
CO2 Emissions from Biomass	0	0	0	0

Source: Initial National Communications

As with a number of other countries, additional work needs to be done in relation to the non-energy sectors and specifically to more accurately determine the contribution of the Land-Use, Land-Use Change, and Forestry (LULUCF) sectors to GHG removals and emissions. However the level of Antigua and Barbuda's contribution to global emissions

is miniscule even within the framework of small island States which themselves are estimated to contribute less than 1% of total global emissions of GHGs.

Peak demand for electricity in Antigua is 33.3 MW supplied from fossil fuel fired power stations. Reciprocating diesel engines account for 70% of the installed capacity on the island of Antigua with the remaining 30% originating from a dual-purpose (water and electricity) steam plant. Peak demand on the island of Barbuda is nominally estimated at 350Kw all of which originates from diesel-powered engines. In recognition of the need to ensure the optimum balance between demand and supply the utility is presently reviewing the possibility for short term assistance in identifying likely supply and demand scenarios for electricity over the next few years.

The residential/domestic sector is the largest consumer category with some 50,000 MW.h out of a total of 120,000 MW.h. for 1998. This was followed by the commercial sector with 36,000 MW.h, tourism with 21,000 MW.h and government with 12,000MW.h (including street lighting). One characteristic of electricity production in Antigua and Barbuda is its high cost of approximately 26USc/KwH, one of the highest rates in the Caribbean and an important factor in investment decisions.

At the global level the International Energy Agency (IEA) World Energy Outlook 2000[28] identifies a number of projections for global energy markets through to 2020:

- World energy use and CO2 emissions will continue to increase steadily
- Fossil fuels will account for 90% of primary energy supply by 2020 – slightly up from 1997 the year of negotiation of the Kyoto agreement.
- Power generation in developing countries will account for nearly one-third of the increase in global emissions to 2020.
- Projected world primary energy demand increases by 57% between 1997 and 2020 an annual rate of 2%.
- Renewable energy technologies including solar, wind, waste, tide, and wave are expected at an annual rate of 2.8% over the period. Despite this rapid growth the share of renewable climbs to only 3% by 2020 from the present 2%. Concern over climate change will encourage deployment of renewable although they remain expensive compared to conventional fossil fuels.
- World electricity generation increases annually by 2.7% between 1997 and 2020. The electricity generation share of primary energy use increases from 36% to 38%. Developing countries are expected to require investment of around $1.7 trillion for power generation much of it in new generation plant

The projections and estimates for economic and social development in Antigua and Barbuda over the next ten years, as based on government and private sector plans, point towards few major changes in the structure of the economy. This would suggest little change also in the overall pattern of GHG emissions. These factors would seem to suggest that the rate of GHG emissions is likely to be determined more by the pace of

[28]International Energy Agency " World Energy Outlook 2000: Highlights". OECD/IEA, 2000. Paris.

economic development and demographic growth than by large-scale transformations in the structure of the economy.

Future GHG emissions to the year 2010 are therefore likely to mirror existing patterns with changes reflecting primarily economic growth or decline. This means a continuing dependence on fossil fuels as the primary sources of energy with electricity production and transport continuing to dominate GHG emissions. Following technological developments the opportunity should also exist for greater use of renewable energy and for increasing efficiencies in energy end uses including transportation and space cooling. Much of the development in renewable and energy efficiency will be driven by the availability and cost of fossil fuels. In turn this will be influenced by a range of factors including political stability in the major oil producing areas. These factors can be expected to heighten dependence of Antigua and Barbuda on imported technologies.

This means a continuing dependence on fossil fuels as the primary sources of energy with electricity production and transport continuing to dominate GHG emissions. Following technological developments the opportunity should also exist for greater use of renewable energy and for enhancing energy efficiency.

3.5 Conclusion

Scientific assessments from the IPCCs TAR and other reports project that small island States like Antigua and Barbuda will be among the communities most adversely affected by climate change. These impacts are likely to result in degradation to critical natural resources and the economic activities that are based on them. At the same time Antigua and Barbuda makes only nominal contributions to the emissions that cause climate change.

Technology transfer and development priorities for Antigua and Barbuda to respond to climate change will need to involve two distinct types of technology needs:

- Technologies that mitigate greenhouse gas concentrations in the atmosphere, and even more importantly
- Technologies that enable greater adaptation to the impacts of climate change.

The next chapters provide examinations of specific technology needs that can be used to advance the goals of Article 4.5 of the UNFCCC. These are drawn from a review of available studies and reports including the Initial National Communications as well as from discussions with stakeholders from key agencies involved in environmental protection and electricity generation and distribution.

SECTION FOUR

CLIMATE CHANGE ADAPTATION TECHNOLOGIES

4.1 Introduction

The IPCC has defined Adaptation to climate change to include "processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change". Technology is clearly vital in this regard and the transfer of technology has a major role to play if developing countries are to succeed in this regard. Chapter 18 of the TAR notes that "many of the adaptive strategies identified as possible in the management of climate change directly or indirectly involve technology (e.g. warning systems, protective structures, crop breeding and irrigation, settlement relocation or redesign, flood control measures). Hence a community's current level of technology and its ability to develop technologies are important determinants of adaptive capacity". The TAR also suggests that "openness to the development and utilization of new technologies ... is key to strengthening adaptive capacity".

The TAR notes that key features of climate change for adaptation are those that relate to variability and extremes, not simply changed average conditions. This points to the need to ensure that adaptation responses address extreme events since these are likely to present greater challenges for adaptation than the more subtle changes in average conditions. The TAR also highlights the need to ensure that adaptation responses are " consistent with or integrated with decisions or programs that address non-climatic stresses".

In looking at guidelines for technology transfer, a joint report of the International Energy Agency, and the United Nations Environment Programme (UNEP) suggests (based on the result of case studies) that successful climate change technology transfer projects should fulfill certain criteria. These include addressing an existing environmental problem, build markets for environmentally sound technologies, be cost effective, and not exacerbate other problems[29].

The South Pacific Regional Environmental Programme (SPREP) has identified elements of a comprehensive anticipatory adaptation response that involves adaptation response in terms of three strategies[30]:

1. Incorporating climate change and sea level rise considerations into all new development proposals.

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[29] "Technology Without Boundaries: Case Studies of Successful Technology Transfer". International Energy Agency/ UNEP/ Climate Technology Initiative. Paris. 2001

30 "The Development of Adaptation Guidelines in the Pacific: Executive Summary". South Pacific Regional Environmental Programme. Undated.

2. Developing proposals that are specifically aimed at addressing a possible effect of climate change and sea level rise.

3. Developing proposals that are aimed at building institutional and technical capacity to facilitate Strategies 1 and 2 and to manage the effects of climate change and sea level rise.

There has already been some identification of priority needs in the Antigua and Barbuda Initial National Communications to the UNFCCC and, along with consultations with stakeholders and other reports, these provide a the basis for the identification of climate change technology needs.

The technologies identified represent only a small portion what will be required. However these are seen as some of the core priority needs that will have multiplier effects as well as building the base for future actions. Given existing uncertainties in terms of timing and extent of changes from climate change the focus at this stage is on strengthening the information and scientific base, identifying technology needs, including technologies for strengthening of institutional capabilities for responding to climate change. In particular the assessment does not identify technology needs in the water sector, an area of technology needs that will be affected by changes in precipitation patterns and that is vital to sustainable development. This is expected to be examined in a separate report on technology transfer needs for the water sector.

4.2 Early Warning Systems

The Report of the United Nations Secretary General entitled "Implementing Agenda 21' notes that the world has experienced an exponential increase in human and material losses due to disasters over the last four decades. The report indicates that this has meant a ten-fold increase in economic losses during that period. The report adds that "the impact of these disasters, particularly in developing countries could have been mitigated through early warning and response systems'.

For Antigua and Barbuda historical data indicates that a total of 44 hurricanes have struck the islands between 1642 and 1996 (NODS, 1996): approximately one hurricane every eight years over the historical record[31]. Particularly violent hurricanes are reported to have occurred in 1681, 1772, 1792, 1804, 1835, 1871, 1950 and 1995. In 1995, storm surges of up to 14 feet were registered during Hurricane Luis (Maskrey, 1997). Hurricanes result in damage from water and wind with such effects as flooding and structural damage. Historically and continuing today, hurricanes present significant threats to life and property and can severely affect the social and economic life of the community.

31 Maskrey notes that this historical data is sketchy and may need to be checked and complemented with other sources.

As well as hurricanes, other tropical weather systems can result in flash flooding and other threats to life and property. In December 2001, flash flooding from a "freak storm" caused extensive damage to communications and utilities infrastructure.

A different meteorological hazard arises from drought conditions to which Antigua and Barbuda is already very vulnerable and which directly affects agricultural production but which also affects other elements such as the aesthetic appeal for tourism. During periods of drought, forest fires also impact negatively on watershed areas, placing further pressure on the water utility to meet demand. Various indicators have been identified to aid in identification of the onset of drought conditions.

The IPCC forecasts for changes in weather and climatic parameters, as well as the devastating impacts from extreme events, point to the need to strengthen meteorological early warning systems so as to provide stakeholders with advance information and allow for alternative decision making. This involves strengthening the capability of the national Meteorological service to provide the information that is required for tracking the weather as well as for building up a data base of information for analyzing and forecasting weather and climate. In addition to the benefits to Antigua and Barbuda this is of direct relevance to other eastern Caribbean countries (St. Kitts and Nevis, Montserrat, Anguilla, St. Maarten, British Virgin Islands) for which the Antigua and Barbuda meteorological service has responsibility as the focal point under the World Meteorological Organizations regional meteorological information service.

The main preoccupation of most Antigua and Barbuda residents and stakeholders from a meteorological standpoint is the provision of adequate information on hurricanes and other tropical storm systems. The Meteorological Office receives real time information on hurricane development and movement from the National Hurricane Center in Miami and issues advisories at six-hour intervals on radio and television to the public. Arising out of the experience of recent hurricanes and other events the service has developed close working relations with the electronic and print media. The service also provides a telephone hot-line, and operates a daily updated web site providing current and historical data as well as links to related sites.

Notwithstanding the important strides made in improving technical capability, significant gaps remain in terms of the quality of meteorological information available to the national meteorological service. Budgetary constraints impose technical, logistical and personnel restrictions on the work of the meteorological service. These limitations restrict the geographical scope for data collection, most notably in Barbuda where vulnerabilities to existing climate stresses are especially high due to the island's topography.

A number of important needs exist for strengthening meteorological data collection. There is the need for equipment to improve rainfall monitoring at various sites on Antigua and Barbuda. As noted above Barbuda presents special challenges. At present only voluntary monitoring of rainfall and temperature exists and is not part of a wider national data collection system. New technologies for Automatic Weather Stations would seem to hold out the prospect for providing cost effective weather data that could be fed

into the national meteorological data-base electronically. One such station now exists at the VC Bird International Airport on Antigua and technical capabilities already exist in-house within the meteorological service for operation and maintenance of the system. At the same time additional training will be required to ensure sustainability, including to build capacity in the Barbuda community to perform certain services related to the automatic weather stations.

Other needs include sunshine recorders and tidal gauges. Additionally there is the need for expansion of the meteorological service's computer capacity to keep pace with the increasing use of high-resolution data from the Internet as well as to cope with increasing data storage and communication demands. Additional computer hardware is also needed to enable expansion of the department's web site.

However the need still exists to improve meteorological hurricane coverage at local levels and with assistance from the European Union a project for installing a network of Doppler radar stations at strategic locations in the eastern Caribbean is underway. While Antigua and Barbuda will not have a Doppler system on its territory it is expected that the meteorological office will have a direct electronic link with the station on St Maarten that will enable it to access real time data for Antigua and Barbuda. The present plans for the regional Doppler project envisage a mosaic that would ensure coverage of all islands in the Caribbean with a coordinating role by the French authorities in Guadeloupe and Martinique.

Strengthening of the meteorological and climatological data management capabilities of the national meteorological service is an essential requirement if Antigua and Barbuda is to build institutional and technical capacity to facilitate adaptation strategies and manage the effects of climate change and sea level rise.

4.3 Integrating Climate Change Adaptation into Development Planning

Projections for Climate Change impacts on Caribbean countries suggest a wide range of possible adverse impacts in virtually all sectors. Because development policies, programmes, plans and projects are future oriented it is important that any investment in development take into account the likely effects of climate change and incorporate adaptation as necessary. Additionally, development decisions taken now will impact abilities to cope with climate change in the future. The need exists therefore to facilitate the inclusion of climate change a two strategic levels.

1. incorporating climate change concerns into existing development plans, and
2. strengthening institutional and technical capacity for integrating climate change concerns into future development activities

The thrust of technology transfer in this regard is therefore towards building capacity for anticipatory (rather than reactive) adaptation by building capacity for enabling incorporation of climate change concerns into development plans and programmes.

While all sectors and communities will need to be involved, government agencies and department will have a lead role to

- provide information to decision makers at all levels about climate change adaptive responses
- providing technical and financial assistance to adversely impacts and \or high risk group, and
- promoting development policies that incorporate climate change concerns.

Among the target agencies for this programme of capacity building are

- Ministry of Public Works
- Ministry of Environment
- Development Control Authority
- Fisheries Division
- Ministry of Agriculture
- Ministry of Finance
- Antigua Public Utilities Authority
- Architect Association
- Ministry of Health
- Natural Office of Disaster Services
- Ministry of Planning
- Ministry of Tourism

In other to achieve this level of adaptation planning tools such as local, regional and international climate change workshops, seminars, and academic programmes be implemented. This should be an integrated package of training and capacity building available to facilitate improved understanding of climate change. Most of this capacity building is aimed at establishing awareness and capacity at the national level at the sectoral level for incorporating climate change impact and adaptation concerns into development planning. Efforts in this area should be carefully coordinated and integrated with other related ongoing regional programmes such as those that might be underway through the CPACC project and its successor activities.

4.4 Coastal Area Protection

As the IPCC TAR indicates, coastal areas of small island States like Antigua and Barbuda are likely to be among the most vulnerable areas to the combined effects of climate change and sea-level rise. In Antigua and Barbuda the coastal and marine environment is particularly important with much of the country's human settlements, tourism facilities, utility infrastructure, and fisheries infrastructure located in these areas. Additionally the coastal zone has considerable environmental, recreational and cultural significance.

A report prepared for the UNFCCC notes that the coast-line is a complex, dynamic and inter-dependent set of subsystems. This requires "no regrets" adaptation options that maintain or enhance future choices and options for the coastal area and its resources[32].

The IPCC has identified three generic response options for coastal zones in relation to climate change. These are the so-called ***retreat, accommodate,*** and ***protect*** options (IPCC CZMS 1990)[33]. The first strategy involves retreat from or prevention of future development in coastal areas likely to be impacted. The accommodation option involves elevation of buildings, modification of drainage systems, and changes in land-use. These options allow for some loss to sea-level rise while trying to maintain ecological and economic functions of coastal areas. The protect option involves defensive measures and seeks to maintain shorelines at their present positions by either building or strengthening protective structures or through beach nourishment.

The retreat option generally is likely to present practical difficulties in terms of the possibility of relocating further inland particularly in urban and built up areas. In many cases lots are small and are bounded by existing structures or uses. Additionally as one commentator has noted "the idea of retreating and leaving land to be eroded by the sea and ... not being able to rebuild structures damaged in storms are not acceptable at the moment" (Cambers ibid).

The accommodation option (i.e. raising existing land and structures or placing them on piles) is likely to prove prohibitively expensive or impractical as a general rule in view of the type of structures already in the coastal zone. This may however be possible with future developments particularly if implemented in conjunction with building setback policy.

The extent of the natural resources and built structures in the coastal zone, and the difficulties in retreat and accommodation, suggests that, at least initially, attention will need to be directed towards protective measures. This however needs to be a part of a wider comprehensive and integrated approach to responding to climate change and sea level rise impacts in the coastal zone that also includes elements of retreat (eg enhanced beach setbacks) and accommodation (eg piles for new construction, and restriction on type of development), increased public awareness of the ecological and economic importance of the coastal zone, as well as institutional strengthening of agencies involved in coastal area protection and management.

At the same time, as Table 4.1 indicates, the costs associated with the various technologies for protection are considerable and will require either concessionary or grant financing. These estimates are based on 1992 costing and can therefore be expected to have increased considerably since the

[32] "Coastal Adaptation Technologies". UNFCCC Technical Paper FCCC/TP/1999/1.
[33] IPCC CZMS:1990. Strategies for Adaptation to Sea-level Rise. Report of the Coastal Zone Management Subgroup. IPCC Response Strategies Working Group. Ministry of Transport, The Hague

Table 4.1 Sea level Rise Protection Costs for Antigua[34] (1992 EC $m)

Protection Strategy	No Accelerated Sea-Level Rise	0.3m	1.0m
Sea-walls/ revetments • Length (km) • Cost	 2.5 5.25	 5.5 13.75	 7.5 30.0
Breakwaters • Length (km) • Cost		3.0 27.00	4.5 40.50
Beach nourishment • Length (km) • Cost	2.25 11.9	8.25 87.45	8.25 131.18

Source: Cambers

Assumptions :
Sea-wall /revetments
Base case: EC$2100 per meter. This would be for existing sea-walls that are rebuilt or strengthened.
0.3 meter rise: EC$2500 per meter
Breakwaters
Breakwater costs EC$9000 per meter
For rises of 0.3 and 1.0 meters, a combined method of breakwaters and beach nourishment is envisaged. For a 1.0 meter rise breakwaters would be longer and perhaps higher. These needed at some sites e.g. Dickenson Bay, Darkwood, Curtain Bluff.
Beach nourishment
Base: Dickenson Bay, Runaway and long Bay would need nourishment once.
0.3 meters: all bays with breakwaters and some additional would need nourishment twice.
1.0 meters: all beaches with breakwaters and some without would need nourishment three times.

Existing coastal zone management efforts are oriented towards the protection and sustainable use of critical habitats and ecosystems – coral reefs, mangroves and wetlands, beaches, and sea-grass beds. This reflects recognition of the dynamics of the islands coastal ecosystems and the need to enhance their natural functioning if the range of activities in the coastal area to be sustained. Efforts are presently underway to have the country's near-shore areas given various forms of protective status. By enhancing the health and productivity of these natural systems, that also play crucial roles in protecting against the impacts of climate change and sea-level rise, these strategies also conform to best practices for responding to climate change impacts.

[34] Note: figures do not include estimates for Barbuda

A critical need exists for the strengthening of the coastal resource data base. This is necessary to enable implementation of existing plans such as the system of protected areas, but also to provide coastal resource planners and managers with information to enable a fuller assessment of retreat, accommodation and protection options within the context of anticipated changes to the coastal regime from climate change. While some efforts have been underway through the regional CPACC project and other initiatives to improve the regional data base it is clear that at this stage additional efforts need to be focused on mapping, inventorying, and documenting of coastal resources.

Additionally large uncertainties remain as to the scale of climate change including sea-level rise. These uncertainties make it difficult for the whole range of players involved in coastal resource use – government agencies, hoteliers, fishermen, recreational users etc – to make the decisions and investments that will be needed to respond to climate change. As part of the technology transfer process, efforts should therefore be directed towards filling data gaps through the acquisition of such technologies as tide gauges, current meters, and salinometers. In addition to data gathering, efforts for addressing the impacts of climate change in the coastal and marine environment should include measures for a more comprehensive programme that includes public awareness and measures for strengthening of major coastal zone management agencies.

Provision of data acquisition technologies will also assist in identifying the costs involved in various coastal retreat, accommodation, and protection options. In many instances it is the private sector that will have to be most directly involved in investments such as coastal protection. At this initial stage of the effort to respond to climate change, data acquisition and other institutional strengthening activities should be aimed at facilitating: integration climate change into new development plans and proposals, providing a base for development of climate change projects, and building capacity.

4.5 Conclusion

This chapter has examined some of the principal priority areas for technology transfer of environmentally sustainable technologies for climate change adaptation. Climate change will be pervasive in its impacts and these are by no means the only areas that will require technology transfer – particularly missing is the area of freshwater resources that is to be dealt with in a separate report. At the same time the areas identified above are especially important in building the institutional and technical capacity for additional adaptive responses as present areas of uncertainty are clarified and additional scientific and technical data becomes available.

SECTION FIVE

CLIMATE CHANGE MITIGATION OPTIONS

5.1 Introduction

Article 4.1(b) of the UNFCCC establishes that all parties shall " formulate, implement, publish and regularly update national....programmes containing measures to mitigate climate change by addressing anthropogenic emissions by sources and removals by sinks" of greenhouse gases. This places an obligation on Antigua and Barbuda, and other parties to the convention, to implement activities that will contribute to the ultimate objective of the UNFCCC for the stabilization of greenhouse gas emissions at levels that would not result in adverse impacts to the Earth's life support systems.

Article 4.1(c) provides that all parties shall " cooperate in the development, application and diffusion, including transfer, of technologies, practices and processes that control, reduce or prevent anthropogenic emissions of greenhouse gases...in all relevant sectors, including the energy, transport, industry, agriculture, forestry and waste management sectors".

The IPCC TAR[35] notes that technologies and practices to reduce GHG emissions are constantly being developed. Many of these technologies focus on improving the energy efficiency of fossil fuel or electricity use and the development of low carbon energy sources since the majority of GHG emissions, as in Antigua and Barbuda, emanate from the energy sector. The Mitigation report of the TAR points out that there are several positive indicators in terms of trends towards the use of cleaner fuels and technologies including for wind turbines, hybrid engine vehicles, and energy efficiency.

At the same time running counter to these trends are economic and behavioral tendencies that are increasing total energy use. The TAR notes that "continued reduction or stabilization in retail energy prices... reduces incentives for the efficient use of energy or the purchase of energy efficient technologies in all sectors. With a few important exceptions, countries have made little effort to revitalize policies or programmes to increase energy efficiency or promote energy technologies".

This section of the report will indicate the mitigation options that exist for Antigua and Barbuda focusing on the energy sector. In addition to its role as the dominant source of GHGs, the energy sector also provides possibilities for achieving other important economic and environmental objectives. There are already a number of technologies available and there is considerable stakeholder interest in mitigation opportunities for the energy sector, including at regional and international levels. The priorities have been identified based on a review of existing documentation including the Antigua and Barbuda Initial National Communications and consultations with stakeholders.

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[35] 'Climate Change 2001: Mitigation. Summary for Policy Makers and Technical Summary of the Working Group Three Report". IPCC Secretariat, Geneva. 2001.

5.2 Development of a National Energy Policy

The structure of energy demand, and particularly electricity demand, in Antigua and Barbuda reflects the non-industrial nature of the economy and the dominance of the residential and commercial sectors in determining demand for energy. In general energy costs are comparatively high and along with high labor costs are a significant factor adversely influencing competitiveness particularly in the cost sensitive tourism sector.

To a great extent this reflects the fact that Antigua and Barbuda, like most small island States, has failed to develop a comprehensive and clearly defined national energy policy. At minimum a national energy policy can be expected to include measures for

- Promoting energy efficiency
- Maintaining stability in energy supply and prices
- Developing indigenous energy sources
- strengthening institutional bases for energy, and
- promoting energy security

The national energy policy of Jamaica, for example, seeks to identify the energy base, encourage the development of indigenous energy resources where economically viable and technically feasible, and ensure the security of energy supplies. Government's role has been identified as to foster, facilitate, and encourage the development of energy-efficiency measures as well as renewable energy sources.

A critical initial step for developing climate change mitigation activities for the energy sector is the preparation and political approval of a set of goals and objectives for the sector. This should be based on a process of multi sectoral consultation and seek to incorporate inputs from representatives of key stakeholder groups and agencies. As far as possible this initiative should be pursued as a part of a wider regional attempt, possibly as part of the CREDP project. This would allow for greater sharing of technical experiences and facilitate the processes of economic and technical integration embodied in the various regional protocols. At the same time the process will need to be country driven reflecting national priorities and based on national direction and management.

The establishment of a national Energy Policy will be essential for catalyzing further work in relation to implementation of work in such fields as renewable energy and energy efficiency.

5.2 Enhancing Energy Efficiency

The distribution and sale of electricity is the exclusive right of the country's State-owned public utility, the Antigua Public Utilities Authority (APUA). The utility was established by legislation as a statutory corporation in 1973 with the purpose of providing an integrated operational and management structure for water, electricity and telephone services.

As was noted in a 1981 report prepared under contract with USAID for the Ministry of Economic Development, the structure of energy consumption in Antigua and Barbuda provides little opportunity for major technological adaptations. This is particularly so with regard to electricity generation and in this respect government will likely need to identify options such as energy efficiency and conservation as short to medium term responses for achieving reductions in the rate of energy consumption (USAID, 1981[36]).

One area of immediate priority concern for the utility is the replacement of the existing fleet of diesel generators with more efficient machines. As a part of the effort towards replacement the utility has begun the process of bidding for 12MW of new capacity. When brought on-line this will reduce fuel costs as well as operational and maintenance costs: the move would also reduce the rate of growth, and possibly the level, of the country's GHG emissions. Present obstacles to the replacement of plant relate to the costs involved. In terms of financing, the utility has been involved in BOOT arrangements for the generation of power as a means for financing the acquisition of generating capacity. Such financing methods are likely to continue as the utility seeks to find innovative and effective mechanisms for meeting electricity demand.

A major component of electricity demand is utilized for water desalinization and the utility is also extremely keen to explore, and if possible exploit, underground reserves of water believed to be present below the surface as a possible means to phase out the fossil fuel hungry desalinization process.

The utility is also anxious to introduce a Demand Side Management (DSM) programme designed to influence consumer electricity usage in ways that would produce beneficial changes in the utility's load profile, reduce customer bills, and reduce APUA'S generation costs. The focus of the programme would be on residential and commercial customers through a combination of pricing incentives and support for technological shifts (e.g. from incandescent to fluorescent lighting). From a utility standpoint such measures optimizes the use of electricity thereby reducing costs for fuel and capital costs. At the same time from a national perspective the gains include less foreign exchange payments for fuel without any concomitant losses in national productivity or output. Significant experience in DSM has been acquired in Jamaica in a World Bank/GEF/Rockefeller Foundation supported programme with the Jamaica national utility and the opportunity would seem to exist for learning from the Jamaica experience in DSM. As with measures to advance the introduction of wind energy, a significant barrier to the introduction of a DSM in Antigua and Barbuda is the lack of in-house technical capabilities for developing and implementing a DSM programme at the APUA. The programme should therefore include measures for strengthening the APUA's ability to successfully implement as DSM projects in Antigua and Barbuda.

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[36] USAID/Government of Antigua. " Antigua Energy Assessment". 1981. prepared under USAID Contract # 538 0032

5.4 Wind Energy

Throughout the world there has been increasing interest in wind energy as a source of electrical power. This interest has emerged as a result of technological improvements in wind turbines, instability of oil prices, reduced costs of wind turbines, and concerns for climate change resulting from burning of fossil fuels. Reflecting the rapid developments in wind energy technologies the Government of Germany has announced its intention to substantially expand its utilization of wind energy including the possibility for use of off-shore facilities[37].

Historically, wind energy was used extensively in Antigua on the sugar estates, indicative of the generally favorable wind regime that is believed to exist at locations on both islands. More recently an attempt was made during the 1980s to establish a wind turbine in the north of the island as a pilot activity. Unfortunately drawbacks in the technology prevented progress beyond initial pilot stages as well as leaving some residue of suspicion as to the appropriateness of the technology for the Antigua and Barbuda setting.

Like other Caribbean countries Antigua and Barbuda is dependent on imported fossil fuels – diesel, gasoline, aviation fuels, kerosene, – for its energy supply. Over 50% of fuel imports are for electricity production. Electricity production derived from diesel engines accounts for approximately 70% of installed capacity with the remaining 30% originating from a dual-purpose electricity/desalinization plant.

Increasing interest has been displayed by various international private sector operators and NGO advocacy groups as to the possibility of BOOT and other types of investment financing for wind power turbines in Antigua. A critical gap is the lack of an adequate wind data set to enable the Antigua Public Utility Authority (APUA) to determine the extent and nature of the country's wind regime and therefore its ability to generate economically viable wind energy as a part of an energy supply mix complimenting diesel and other conventional electricity sources.

There is also the need to strengthen the technical capability of APUA to implement grid integrated wind energy projects. While there is considerable interest in the application and use of the technology, existing operational and technical realities restrict the utility's ability to undertake such a financial investment and technical shift without concessionary financing and technical support. The aim should therefore be to provide support to the utility

- to assess the potential for introduction of wind power,
- to identify appropriate sites and technologies,
- to assist the utility in identifying financing,
- and to provide training, technical advice and back-stopping during the project.

Such efforts are likely to obtain a boost from the initiation of the Caribbean Renewable Energy Development Project (CREDP) to be financed by the Global Environment

[37] "GERMANY BOOSTS WIND POWER".BBC. 16 January, 2002 (Internet)

Facility (GEF) and the government of Germany. The project aims at facilitating the removal of the barriers that presently restrict the introduction of renewable energy technologies in the Caribbean.

5.5 Conclusion

Small island countries like Antigua and Barbuda make only minuscule contributions to global greenhouse emissions. While the burden for achieving mitigation in emissions of GHGs does not rest substantially with these countries they are committed under the UNFCCC to developing measures for promoting reductions in emissions. If such initiatives are to be successful they need to be complimentary to other national efforts at achieving sustainable development.

The three climate change mitigation priority areas identified above are intended to satisfy demands for promoting sustainable energy futures for Antigua and Barbuda. In addition to the benefits for Antigua and Barbuda from their implementation they will also have wider global benefits in terms of their contribution towards reducing the level of atmospheric GHGs. In this context it becomes important that, as envisaged under the UNFCCC, financial resources are made available to enable the successful transfer of these technologies. This should include efforts to identify and remove those factors that might negatively affect the ability of countries to gain access to environmentally sustainable technologies.

SECTION SIX

BARRIERS TO TECHNOLOGY TRANSFER

6.1 Introduction

Much attention is focused in the literature relating to technology transfer on the issue of the various barriers that serve to impede the successful transfer of environmentally sound technologies to developing countries. For example the IPCC Technology Transfer (IPCC, report 2000) identifies a number of barriers to the transfer of environmentally sound technology. The report argues that governments can promote technology transfer by inter alia reducing these "barriers" through the initiation of a suitable enabling environment for technology transfer. Among the barriers identified by the IPCC in relation to mitigation technologies are

- Lack of full cost pricing that internalizes environmental and social costs
- Poor macroeconomic conditions
- Low private sector involvement because of lack of capital, in particularly for small firms
- Low, often subsidized energy prices, and
- Lack of markets for environmentally sustainable technologies due to uncertainty about technology, financing etc

In the case of the Caribbean region, the UNFCCC workshop on climate change technology transfer for the Caribbean and Central America has identified the following barriers in the region:

- Institutional barriers – including restrictive business practices
- Political barriers – particularly lack of sustained attention by policy-makers to sustainable development concerns
- Technological barriers – including lack of expertise
- Economic barriers – such as poor macro-economic conditions, and small size of commercial enterprises
- Lack of access to information – including in the private sector, and
- Financial barriers – including high initial capital costs and high interest rates

The purpose of this chapter is to briefly identify the principal barriers to introduction of environmentally sensitive technologies for climate change adaptation and mitigation in Antigua and Barbuda with a view to determining whether these obstacles present significant obstacles to technology transfer and, if necessary, to recommending incorporating measures that can assist in overcoming these barriers.

6.2 Financial Barriers

There is little doubt that financial constraints play a dominant role in restricting the transition towards the transfer of more environmentally sensitive technologies pertaining to climate change adaptation and mitigation in Antigua and Barbuda. For example in relation to the introduction of the principal technologies identified for adaptation – Automatic Weather Stations and coastal zone data collection equipment,– the main obstacles arise primarily from the lack of financial resources for purchasing and maintenance. In all cases technological constraints do not appear to act as serious constraints. Similarly there is a high awareness of the potential benefits of the technology.

The significance of the financial concern is highlighted even more so for mitigation technologies. An important characteristic of environmentally sustainable energy technologies is that there are high initial investment costs. Although these technologies generally have low maintenance and other operating costs, their initial capital costs tend to be a deterrent to adoption by developing countries already constrained by large external debts. This makes access to investment capital an essential requirement for the widespread adoption of clean energy technologies.

While multilateral lending agencies have traditionally provided capital for energy projects in developing countries, in the case of Antigua and Barbuda a combination of high per capita income and indebtedness have combined to restrict the country's ability to attract financing from multilateral development banks. As the CREDP project report to the GEF points out "overall, the important point regarding funding is not the availability of financing but the access to it by developers".

A recent report from UNDP and UNECLAC[38] has identified six "trends" affecting the financing of sustainable development in Latin America and the Caribbean:

1. External debt – that prevent the countries of the region, especially the poorest ones, from devising sustainable development strategies and allocating resources to environmental protection.
2. Declining flows of official development assistance (ODA), so that ODA flows now represent less than a third of commitments provided at the 1992 Earth Summit that gave birth to the UNFCCC.
3. Increased private international financial flows. However these tend to be highly volatile and to gravitate towards a few larger emerging economies particularly Brazil and Mexico
4. Increases in financial contributions from international agencies to support environmental measures.
5. The emergence of concessionary international multilateral funds most notably the GEF.
6. Domestic financing policies for sustainable development have been slow to emerge.

[38] ECLAC/UNDP. "Financing for Sustainable Development in Latin America and the Caribbean". LC/G2146(CONF.90/4).2001.

The trends identified in the UNDP/ECLAC report are particularly relevant to the Antigua and Barbuda situation. For example, while Antigua and Barbuda enjoys a relatively high per capita income, the country is also saddled with a large external debt. This clearly presents a formidable barrier to the transfer of technology for environmentally sustainable development at least in those areas where public sector finances are likely to be the primary source of funding. There are also concerns as to the apparent decline in GEF financing as a result of non-payment of voluntary contribution by some GEF donor governments.

As Table 6.1 below points out Antigua and Barbuda has benefited from a number of national and regional programmes financed by the GEF. However as the ECLAC/UNDP Financing report points out "the operational areas of the GEF need to be broadened in order to respond to the needs and realities of developing countries as well as the priorities of the international agenda". In the case of Antigua and Barbuda this would mean, for example, additional support for climate change adaptation and mitigation capital projects as well as increased support and more flexible procedures for non-governmental organisations. There is also concern as to the apparent decline in GEF financing as a result of non-payment of voluntary contributions by some GEF donor governments.

Table 6.1
List of GEF Funded Projects involving Antigua and Barbuda

National Projects	*Cost (US $)*
1. Enabling Activity for Climate Change:	$160,000
2. Enabling Activity for Biodiversity:	$140,000
3. Clearing house mechanism for biodiversity:	$14,000
4. Enabling Activity for Climate Change (Capacity Building):	$100,000
5. Country Case studies on CC impacts/adaptation assessments:	$250,000
6. Second Phase of Biodiversity Enabling Activities (GEF pipeline)	$190,000
7. National Biosafety Framework (GEF pipeline)	$ 135,000
8. Developing Sustainable island Resource Management Strategies which address the Conservation of Globally Significant Biodiversity (**GEF pipeline**):	$3.8 million
9. Support for National GEF Focal Point:	$24,000
10. National Capacity Development Initiative (**GEF pipeline**):	$200,000
11. Enabling activities for POPs (**GEF pipeline**)	$500,000
GEF Small Grants Program (National NGO projects)	
1. Management of Land Resources Youth Skills Development in Antigua and Barbuda and the OECS:	$45,000
2. Grays Green Pollution Reduction Project:	$25,000

Regional Projects

1. Caribbean Regional Energy Development Programme:	$12.45 million
2. CPACC:	$6.3 million
3. Building capacity for conducting vulnerability and adaptation:	$120,000
4. OECS Solid Waste Management Project:	$50.5 million
5. Mainstreaming Adaptation into climate change (MACC)	$9.6 million
6. Implementation of an Integrated Archipelagic Ecosystem Management and Sustainable Development Programme For the Eastern Caribbean **(GEF pipeline)**:	$20 million
7. Integrating management of watersheds and coastal areas in Caribbean SIDS **(GEF pipeline)**:	$10 million
8. Conserving Biodiversity and Preventing Land Degradation in small island ecosystems in the Caribbean **(GEF pipeline)**:	$18 million

6.3 Awareness and Information Barriers

Inadequate knowledge is also presently a major barrier to the transfer of technologies. While substantial awareness of technology needs exists among technical agencies directly involved with the issues at hand – coastal protection, disaster response etc – it is fair to say that awareness of climate change and climate change issues among the general public is still extremely limited. This is particularly important in those instances where the private sector and other elements of civil society will have to be involved at some stage in the technology transfer process possibly through financing or actual implementation.

As a report on Capacity Development in SIDS prepared by Professor Albert Binger points out " there is an evident tension between desired economic growth and mitigation and adaptation responses to climate change, leading to lukewarm public, policymaker and stakeholder support for such response strategies. This lack of support is amplified by the technical complexities and uncertainties that surround the scientific research....and is further compounded by the lingering memory of colonial exploitation"[39].

In some instances this situation requires that projects and activities for affecting technology transfer may need to incorporate components directed towards raising awareness either at a public or more focused level. A particular need is to facilitate the flow of information to high-level policy makers in private and public sectors.

A survey of technology transfer needs conducted on behalf of the UNFCCC secretariat concluded that in developing countries "decision makers on environmentally sound technologies .... operate with limited information"[40]. Interestingly among the main information needs identified in the survey were for information on the availability of financing for technology transfer. As a part of the initiative to assist developing countries in gaining access to environmentally sustainable technologies, attention is being paid by

[39] Albert Binger ," Capacity Development Initiative. Country Capacity Development Needs and Priorities: Report for Small Island Developing States". September 2000. GEF-UNDP Strategic Partnership.
[40] "Technology and Technology Information Needs Arising From the Survey of Developing Country Parties". Paper # FCCC/SBSTA/1998/INF.5

the UNFCCC secretariat to establishing an internet based climate change technology information exchange network. This should go some way in aiding countries in identifying technologies appropriate to their situation.

6.4 Technological/Capacity Barrier

Barriers exist in the form of limited technical capabilities. As the Binger report points out "technical capacity for dealing with atmospheric matters is particularly demanding of specialized up-to-the minute training" with the consequent need for advanced training and for professional networking. This observation is equally relevant to the range of other technical disciplines involved with climate change adaptation and mitigation.

The problem of lack of capacity to deal with highly complex matters such as climate change is a feature of small island territories like Antigua and Barbuda arising from small populations and limited development opportunities. A key part of the effort to remove technical capability constraints is therefore the need for strengthening national institutions that will take leading roles in facilitating the transition towards environmentally sustainable technologies. This should include non-governmental agencies and organizations. Weaknesses in capacity exist at all levels – individual, institutional, and systemic – and therefore require fairly extensive attention as well as a supportive enabling environment if they are to be meaningfully addressed. In many instances lack of data and bureaucratic strictures prevent realization of sustainable development activities.

To some extent technological barriers are intimately tied to financial constraints and in particular point to the significance of the provision of financial resource flows from annex 1 to non-annex 1 countries if the ultimate objective and other goals of the UNFCCC are to be realized.

6.5 Institutional Barriers

Institutional barriers refer to the range of factors that arise out of inherent structural and institutional factors and which impinge on the country's ability to receive and successfully utilize transferred environmentally sustainable technology. These vary from barriers relating to inappropriate or out-dated legislative frameworks to barriers emanating from cultural traits and characteristics.

Small island States generally face a number of institutional barriers resulting from innate structural limitations often tied to small size. In Antigua and Barbuda for instance the traditional vertical structures of public administration mean that mechanisms for cross-sectoral coordination and cooperation among stakeholders required for sustainable development have not been a strong enough feature of environmental governance. Similarly there will be the need to ensure that legislative and regulatory provisions and actions are adequate for enabling the successful transfer of environmentally sustainable technology and do not impede this process.

The importance of incorporating measures for identifying and addressing institutional barriers means that project design should aim to take these factors into consideration so as to prevent them from serving as obstacles to the implementation of technology transfer projects. This points to the importance of participatory involvement by stakeholder representatives in project planning.

It would not seem however that institutional factors are likely to represent insurmountable obstacles to the transfer of the environmentally sustainable technologies identified in Chapter 6 above. The report of the Latin America and Caribbean regional workshop on technology transfer identifies three institutional barriers – restrictive business practices, lack of commercial structures at the rural level, and poor national coordination – as present in the region. While the problem of coordination certainly exists it is felt that the other two may be more reflective of larger countries of the region

As noted above a number of GEF projects for example have already been successfully implemented in Antigua and Barbuda. The need exists however to ensure that measures for identifying and removing, or responding to, institutional barriers are adequately incorporated into the climate change technology transfer process.

6.6 Conclusion

Like most small island countries Antigua and Barbuda is confronted by a range of barriers to the successful transfer of environmentally sustainable technologies for climate change adaptation and mitigation. These include financial, information, technical, and institutional barriers. Tables 6.1 and 6.2 below provide a guide as to the relevance of barriers affecting the transfer of environmentally sustainable climate change adaptation technologies to Antigua and Barbuda.

Table 6.2 Barriers to Transfer of Climate Change Adaptation Technologies

	Early Warning systems	Capacity building for integrating climate change into development planing	Coastal protection
Financial Barriers	3	2	3
Awareness/Information Barriers	3	2	3
Technological Barriers	1	2	2
Institutional Barriers	1	1	2

*Key:
3= high level barrier; 2 = middle level barrier; 1 = low level barrier

Table 6.3 Barriers to Transfer of Climate Change Mitigation Technologies*

	National Energy Policy	Wind energy application	Enhanced energy efficiency
Financial Barriers	1	3	3
Awareness/ Information Barriers	2	2	2
Technological Barriers	3	3	1
Institutional Barriers	2	1	1

*Key:
3= high level barrier; 2 = middle level barrier; 1 = low level barrier

The assessment above suggests that financial constraints constitute a principal barrier accompanied by others deriving from lack of awareness, capacity constraints, and various institutional factors. In any case it is necessary to examine each technology project separately in terms of the barriers that it is likely to encounter. The next chapter will provide some indicative project profiles intended to serve as possible templates for climate change technology transfer and to facilitate more detailed project development.

SECTION SEVEN

PRIORITIES FOR TRANSFER OF ENVIRONMENTALLY SUSTAINABLE CLIMATE CHANGE TECHNOLOGY: PROJECT PROFILES

The following project profiles are presented as possible initial guidelines for the transfer of environmentally sustainable climate change adaptation and mitigation technologies. In addition to strengthening capacity for meeting the projected challenges of global climate change, the projects are also targeted at meeting existing sustainable development concerns and priorities.

The project outline format adopted broadly follows certain elements of the Logical Framework Analysis (LFA)[41] utilized by the Global Environment Fund (GEF) and a number of other national and multilateral development financing agencies.

1. PROJECT TITLE: STRENGTHENING OF METEOROLOGICAL EARLY WARNING SYSTEMS

Development Objectives:

1. To strengthen national capabilities to collect and store meteorological data so as to monitor changes in climatic parameters
2. To strengthen national meteorological early warning capacities for responding to extreme weather events

Assumptions

- Continuing government commitment to strengthening of the meteorological service including through availability of personnel and logistical support
- Financing available for acquisition of equipment

Immediate Objectives

- Improved technologies available for meteorological data collection and forecasting.
- Capacity exists to successfully utilize new technologies.

Outputs/Activities

1. Purchase and installation of meteorological equipment
2. Training of personnel
3. Data collection

[41] See for example "Introduction to the LFA: A Reader". GEF secretariat. 2000.

2. PROJECT TITLE: Integrating Climate Change into Development Planning

Development Objective

1. To integrate climate change concerns into the development planning and implementation process
2. To raise the awareness of climate change concerns among decisions makers in public and private sector

Assumptions

- Availability of technical knowledge on climate change impacts and adaptations for Antigua and Barbuda
- Political commitment exists for promoting incorporation of climate change concerns into development planning

Immediate Objectives

- To sensitize decision makers in public and private sectors about climate change impacts and adaptations
- To facilitate preparation of guidelines for incorporating climate change concerns into development planning
- To train technicians in methods for incorporating climate change into development activities and planning
- Institutional linkages between climate change and economic and planning agencies further strengthened

Outputs / Activities

4. Climate change sensitization and training workshop and seminars developed and implemented
5. Data base on climate change strengthened
6. Institutional linkages and networks established
7. Development control guidelines and standards amended to incorporate climate change consideration and concerns
8. Public awareness and sensitization programmes developed and implemented

3. PROJECT TITLE: STRENGTHENING PLANNING FOR CLIMATE CHANGE IMPACTS AND ADAPTATIONS IN THE COASTAL AND MARINE ENVIRONMENT

Development Objective

To strengthen the capacity of coastal stakeholders to identify, and plan for, the anticipated impacts of climate change in coastal and marine areas.

Assumptions

- Interagency cooperation exists for data acquisition and coordination.
- Political support exists for advancing integrated response to problems of climate change in coastal and marine environments.

Immediate Objectives

- Coastal resource stakeholders better able to incorporate climate change concerns into development activities.
- Coastal resource stakeholders have access to improved data base for enabling decision making on coastal development in scenarios of climate change

Outputs/Activities

1. Data collection equipment needs identified and purchased
2. Data collection of critical coastal and marine resources and processes
3. Training provided to relevant staff
4. Public awareness programme developed and implemented
5. Development guidelines in coastal areas modified to reflect climate change parameters
6. Coastal resource data and development guidelines available on the internet and in printed format

4. PREPARATION OF A NATIONAL SUSTAINABLE ENERGY PLAN

Development Objective

- Sustainable utilization and management of energy resources in Antigua and Barbuda as part of efforts to achieve sustainable development.

Assumptions

- Political and administrative support exists for establishment of the plan
- Stakeholders participate in process of plan preparation

Immediate Objectives

- Preparation of a comprehensive sustainable energy plan that incorporates inputs from a wide range of stakeholders and that has political endorsement

Outputs/Activities

1. Consultants hired and work-plan developed

2. Background, information and research papers prepared
3. Sectoral technical consultations
4. Public outreach and feedback
5. National consultations
6. Preparation of daft report and recommendations
7. Official endorsement
8. Publication and distribution

5. IMPROVING ENERGY EFFICIENCY IN THE ELECTRICITY SECTOR FOR ANTIGUA AND BARBUDA

Development Objective

National economic and environmental, as well as global GHG emission reduction, benefits achieved from improved energy efficiency in the electricity sector.

Assumptions

- Prices of fossil fuels remain high and/or volatile
- Financial resources are available
- Natural disasters do not impair implementation

Immediate Objectives

- Replacement of existing generating equipment with more efficient engines
- Demand Side Management (DSM) programme developed and implemented by APUA
- Technical capacity of Antigua Public Utilities Authority [APUA] strengthened.

Activities/Outputs

1. Identify technology needs for generator replacement
2. Develop financing prospectus
3. Implement generator replacement programme
4. Identify technical and financial sources for DSM programme
5. Develop DSM programme and work-plan
6. Implementation of DSM pilot project

6. DEVELOPING WIND ENERGY IN ANTIGUA AND BARBUDA.

Development Objectives

To develop wind power as a source of energy for Antigua and Barbuda

Assumptions

- Wind regime allows for development of wind energy
- Financing available
- Institutional capacity exists for development and utilization of wind energy

Immediate Objectives

- To undertake a feasibility study for wind energy in Antigua and Barbuda including an assessment of the wind regime
- To integrate wind power into the national electricity grid
- To develop in-house capability within APUA for wind power development
- To enable independent power production of wind energy
- To reduce load factors on APUA diesel generators
- To reduce Antigua and Barbuda's emissions of GHG

Activities/Outputs

- Technical assistance secured to develop detailed wind power initiative
- Feasibility study conducted of wind power
- Pilot sites identified
- Wind technologies identified and purchased
- Training and technology transfer
- Integration into APUA grid
- Technical monitoring and support
- Development of incentives for independent power producers

Conclusion

The above project profiles represent the indicative elements for technology transfer projects for Antigua and Barbuda. They have emerged from a review of the literature as well as from discussions with stakeholders in various sectors. They are by no means exhaustive of the needs of the country but do represent some of the priority areas.

In all instances financial resources will be required to implement these programmes and, in line with the spirit and text of the UNFCCC, partnerships should be sought with Annex 1 parties to the UNFCCC, as well as with the financing mechanism of the convention, to secure financing. In all instances however national resources from public and private sectors will be also be required to move forward the adaptation and mitigation programmes outlined above. In these cases it is essential that partnerships also be fostered at the national level including through the exchange of information.

APPENDIX 1: LIST OF PERSONS CONSULTED

- Mrs. Cheryl Appleton, Chief Fisheries Officer
- Mr. Philmore James, Deputy Chief Fisheries Officer
- Mrs. Patricia Julian, Director, NODS
- Mr. Philmore Mullins, Deputy Director, NODS
- Mr. Patrick Jeremiah, Director, Meteorological Service, VCBIA
- Mr. Keithley Meade, Meteorological Service, VCBIA
- Mr. Matthew, Meteorological Service, VCBIA
- Mr. Leonard Josiah, Meteorological Service, VCBIA
- Mr. Peter Benjamin, General Manager, APUA
- Mr. Lyndon Francis, Electricity Manager (Generation), APUA
- Mr Sean Cenac, Ministry Of Planning
- Mrs Diann Black-Layne
- Mr Sherrod James, Environmental Awareness Group
- Mr Franck Jacobs, Director of Statistics

APPENDIX 3

SELECT CLIMATE DATA: ANTIGUA

CLIMATOLOGICAL DATA V.C. BIRD INTERNATIONAL AIRPORT

COOLIDGE ANTIGUA

Particulars		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
Normal Daily Temp.	°F	77.9	77.4	78.4	80.2	80.2	82.0	82.2	81.9	81.3	81.3	79.3	78.3
	°C	25.5	25.2	25.8	26.8	26.8	27.8	27.9	27.7	27.4	27.4	26.3	25.7
Normal Daily Max. Temp.	°F	82.8	82.9	83.5	84.6	85.6	86.9	87.3	87.6	87.3	86.7	85.1	83.5
1969 - 1995	°C	28.2	28.3	28.6	29.2	29.8	30.5	30.7	30.9	30.7	30.4	29.5	28.6
Normal Daily Min. Temp.	°F	72.1	71.8	72.5	73.9	75.7	77.5	77.7	77.7	76.6	75.7	74.7	73.0
1969 - 1995	°C	22.3	22.1	22.5	23.3	24.3	25.3	25.4	25.4	24.8	24.3	23.7	22.8
Extreme Max. Temp.	°F	87.8	87.8	91.4	89.6	91.4	91.4	93.2	91.4	91.4	91.4	89.6	87.8
1969 - 1995	°C	31.0	31.0	33.0	32.0	33.0	33.0	34.0	33.0	33.0	33.0	32.0	31.0
Extreme Min. Temp.	°F	62.6	62.6	64.4	64.4	68.0	71.6	69.8	71.6	69.8	68.0	66.2	60.8
1969 - 1995	°C	17.0	17.0	18.0	18.0	20.0	22.0	21.0	22.0	21.0	20.0	19.0	16.0
Avg. Monthly Rainfall	ins	2.24	1.48	1.84	2.66	4.43	1.95	3.41	3.96	5.53	5.15	5.31	3.44
1960 - 1995	mm	56.9	37.6	46.7	67.6	112.5	49.5	86.6	100.6	140.5	130.8	134.9	87.4
Max. Monthly Rainfall	ins	6.29	4.35	7.05	7.82	18.10	7.60	9.63	11.00	16.15	14.10	15.50	7.82
1960 - 1995	mm	159.8	110.5	179.1	198.6	459.7	193.0	244.6	279.4	410.2	358.1	393.7	198.6
Min. Monthly Rainfall	ins	0.79	0.39	0.57	0.48	0.23	0.23	0.56	0.95	1.09	0.49	0.89	0.48
1960 - 1995	mm	20.1	9.9	14.5	12.2	5.8	5.8	14.2	24.1	27.7	12.4	22.6	12.2
Max. Rainfall in 24 hrs	ins	1.65	0.87	3.12	3.61	7.06	2.58	2.91	5.35	7.42	8.33	6.37	5.80
1960 - 1995	mm	41.9	22.1	79.2	91.7	179.3	65.5	73.9	135.9	188.5	211.6	161.8	147.3
Avg. Relative Humidity	07 LST	81.0	81.0	81.0	81.0	82.0	82.0	83.0	83.0	84.0	85.0	85.0	83.0

1960 - 1995	15 LST	72.0	72.0	72.0	72.0	74.0	75.0	77.0	76.0	77.0	78.0	77.0	75.0
Mean Wind Speed1969 - 1995	KNOTS	12.8	12.4	12.1	11.9	12.0	13.4	14.2	13.0	10.8	9.6	10.5	11.7
Prevailing Wind Direction1981 - 1995		090°	090°	090°	100°	110°	100°	090°	090°	090°	100°	090°	090°
Mean Sky Cover in Octas1970 - 19897am - 6pmLST		3.7	4.1	4.0	4.5	5.1	4.9	4.5	4.6	4.8	4.9	4.4	4.2
Mean No. of Days Temp.32°C or above1976 - 1995					0.04	0.70	1.30	2.80	4.30	4.20	1.50		
Mean No. of Rainy days(more than 1 mm)1976 - 1995		10.0	8.0	8.0	9.0	10.0	8.0	11.0	13.0	11.0	13.0	13.0	13.0
Mean Sea Level Pressure	07 LST	1016.3	1016.4	1015.9	1015.3	1015.4	1016.5	1016.7	1015.5	1014.2	1011.7	1013.7	1015.2
(in mbs) 1970 - 1995	15 LST	1015.3	1015.4	1015.1	1014.2	1014.5	1014.1	1016.1	1013.1	1011.4	1012.2	1012.5	1014.1
Average Temperature	°F	77.4	77.4	78.1	79.2	80.8	82.2	82.6	82.8	82.0	81.1	79.9	78.3
	°C	25.2	25.2	25.6	26.2	27.1	27.9	28.1	28.2	27.8	27.3	26.6	25.7

Source: National Meteorological Service of Antigua and Barbuda