# CHAPTER SEVEN

# MITIGATION ANALYSIS

***Guyana, as a Party to the UNFCCC, has a responsibility also to take actions to mitigate Climate Change by striving to reduce emissions of Greenhouse Gas and promote removals by "conservation and enhancement, as appropriate, of sinks and reservoirs of greenhouse gases" UNFCCC.***

***The strategies highlighted here have been prioritized in terms of short term, medium term and long term and concentrate on policy and technology options that will require external funding, technological and capacity building assistance.***

***An aerial view of a section of Guyana's rainforest***

# 7.0 MITIGATION ANALYSIS

## 7.1 INTRODUCTION

It has been recognized during the past decade that increasing concentrations of greenhouse gases (GHG) in the atmosphere may lead to climate change and attendant environmental impacts, most of them adverse for countries like Guyana. Hence, various efficiency improvements and technological efforts have been directed towards identifying suitable Greenhouse gas mitigation (GHGM) options aimed at reducing emissions, notably of carbon dioxide ($CO_2$).

Mitigation analysis involves the development of programs related to sustainable development in the context of Climate Change and to the development of methodologies for assessing mitigation measures and of policy options for implementing adaptation/mitigation alternatives that shall allow Guyana to abate the increase in GHG emissions and to enhance their removal by sinks.

As was seen in the GHG Inventory chapter, the major economic sectors that contribute to GHG emissions in Guyana are the Energy sector, mainly in $CO_2$ emissions through energy use and transportation, and the Agriculture and Waste sectors, which contribute mainly to $CH_4$ emissions. As for GHG removals; the Forestry sector is the major sink for $CO_2$.

### 7.1.1 Macro-economic Impacts of Response Measures

With respect to macro-scale impacts of adaptation response measures (specifically to cope with the direct and indirect effects of climatic change on the living conditions, economy and society of Guyana), it should be noted that many of the measures have been proposed as being important components of a national development strategy regardless of climatic change. This is particularly the case of the proposed actions to reinforce the sea defences against changes in sea level. As was pointed out in previous chapters, the coastal area is already a crucial component of Guyana's economy and society. Permanent sea defences were not built throughout the coast and those in place need routine maintenance.

With respect to mitigation response strategies (reduction of greenhouse gas emissions), many actions suggested can also be justified in relation to other desired effects. Supporting such project/investment is not only necessary for coping with climatic change effects but can result in acquiring funding internationally.

Assessing the macro-economic impacts of the response strategies for Guyana's economy is beyond the scope of the National Communication because the detailed evaluation economic costs and benefits involved depend upon strategic decisions to be taken in the various sectors. However, the potential effects of mitigation and the costs and benefits of adaptation measures are provided as follows:

1. The impacts of mitigation measures must be seen against the backdrop of change (generally growth) in GDP. Will mitigation measures stifle economic growth? The answer clearly is that the mitigation measures must be achieved within the context of the National Development Strategy (NDS) especially as it relates to transfer of technology, industrial development and efficiency in the energy and industry sectors.

2. In an eventual detailed assessment of macro-economic costs and benefits, it would be important to distinguish between short and long term impacts.

   Short term impacts of mitigation measures, and also some adaptation measures (e.g. reinforcing sea defences), involve significant investment. Two points can be made:

- Investment in such mitigation and adaptation measures in the short term will generally generate positive impacts on employment (direct and through multiplier effects), income, taxes and consumption.

- The extent of these results can be expected to vary according to the degree to which such investment is funded from external (international) sources and the conditions under which the funding is provided. Direct external contributions would have little or no negative impact because the investment would not be taking away from current consumption in Guyana, except for any re-allocation of resources (e.g. public sector staff) necessary to manage such investment and projects.

Some points can also be noted about long term impacts:

- Long term strategies for mitigation may dampen economic growth slightly, but this is likely to have little negative impact. Notwithstanding, some long term strategies may however be positive; this would be the case if the measures were also an investment in the country's development, e.g. the refurbishing of sea defences.

- Furthermore, this investment can be seen as protecting the country's productive potential. It can therefore contribute to maintaining and enhancing economic growth and development.

- Generally, the measures involving investment in human resources and institutional capability should also be seen as having substantial positive effects for the country. Such efforts, while entailing training and set-up costs, will also have positive effects of building resilience and flexibility into the country's management. While some of this is specific to climatic change (e.g. monitoring equipment), a good deal of effort in the long term would have a positive effect on human resource capability generally.

In any detailed assessment of the macro-economic impacts of mitigation measures, it would be important therefore to:

- Define short and long term costs and benefits in relation to employment level, taxes, income and investment.

- Take into account the effects of investment according to source (internal or external) on the economy.

- Take into account the growth and development scenarios developed under the National Development Strategy (NDS) to use as a yardstick in measuring these macro-economic impacts

- Take into account the overall effects of the mitigation and adaptation measures on the resilience and adaptability of the country's economy and society, and

- Build up the analysis of overall impacts from sector by sector analysis.

In conclusion, it appears essential to view the chosen mitigation and adaptation strategies as a multi-purpose investment in the future of the country's economy and society. These strategies would therefore become even more compelling and such a perspective would facilitate the leveraging of the necessary investment funds to undertake the work.

## 7.2 MITIGATION OPTIONS/STRATEGIES

GHG emissions reductions for Guyana can be assessed by examining an extensive array of technologies and policy measures that accelerate technology development and use, diffusion and transfer in all sectors.

Enhanced GHG removals by sinks in the Guyanese context may include efficient land management and use, and measures aimed at conserving and sequestering carbon in the forestry and agriculture sectors.

In the following sections, several mitigation strategies applicable for each sector are described. This should give the Guyana Government a working list from which to base their eventual program of reduction and control of GHG. The mitigation strategies described are based on best practicable technology currently in use in other jurisdictions so it should not be difficult for Guyana to receive assistance to implement some of these options.

Table 7.1 presents a priority listing of short, medium and long term technology-based mitigation strategies for Guyana on a sector-by-sector basis. Table 7.2 presents a listing of viable policy options that the government of Guyana may use to mitigate its emissions of GHG.

*Table 7.1: Priority listing of Mitigation Strategies based on Technology Alternatives for Guyana*

| Sectors | Short Term (2000-2005) | Medium Term ( 2006-2020) | Long Term ( 2021 and Beyond ) |
|---|---|---|---|
| *Energy* | • Modernization of power plants<br>- energy efficient<br>- retro-fitting<br>- decarbonisation<br>- distribution efficiency<br>• hydropower | • Less carbon-intensive fuels<br>• Switching to renewable energy<br>• wind farms, solar systems | • Continue to promote renewables |
| *Transportation* | • Efficiency improvement<br>- less carbon-emitting fuels<br>- tyre and lubricants<br>• Pollution devices<br>- catalytic converters<br>• Import restrictions | • Alternative energy<br>- diesel, natural gas<br>• More efficient engines<br>- 4-stroke<br>- electronic systems | • Modern hybrid vehicles<br>• Traffic and fleet management systems<br>• modal shifts<br>- rail in the interior |
| *Buildings* | • Reducing energy use<br>- energy-efficient cooling systems<br>- more efficient lighting, cooking appliances<br>- updating building codes | • Thermal integrity<br>- Cooling losses<br>• Regulations<br>- energy conservation labels | • Choice of materials<br>- wood instead of concrete |
| *Agriculture* | • $CH_4$<br>- rice cultivation<br>- forage quality<br>- cooking fuels<br>• $N_2O$<br>- controlled fertilizers<br>- nitrification inhibitors<br>- solution of fertilizers | • $CH_4$<br>- hybrids<br>- upland rice<br>• $N_2O$<br>- less use of undesirable fertilizers | • $CH_4$<br>- hybrids<br>- new crops<br>• $N_2O$<br>- reclamation of abandoned lands<br>- carbon sequestration |
| *Land Use and Forestry* | • Carbon conservation<br>- control deforestation<br>- harvest regimes<br>- control fires and pests | • Carbon sequestration<br>- forest area and density<br>- carbon storage in soils and wood products | • Carbon sequestration<br>- forest area and density<br>- carbon substitution/use of wood products |
| *Waste* | • Source reduction<br>- recycling<br>- composting<br>- incineration | • Source reduction/conservation<br>- recycling<br>- composting<br>- incineration | • Recovery of $CH_4$<br>- downstream use |

***Table 7.2: Priority listing of Mitigation Strategies based on Policy Instruments for Guyana***

| Sectors | Short Term ( 2000-2005 ) | Medium Term ( 2006-2020 ) | Long Term ( 2021 and Beyond) |
|---|---|---|---|
| *Energy* | • Energy conservation<br>- sensitization<br>- transmission losses<br>• Demand side management<br>- pricing<br>- competition<br>- subsidies | • Facilitate less carbon-intensive technologies<br>- accelerated depreciation<br>- agreements on more efficient equipment<br>• Development of comprehensive energy plan for the whole of Guyana | • Regulatory programs<br>• Market pull and demonstration<br>- development/ application of efficient technologies<br>• Implementation of energy plan |
| *Transportation* | • Legislation<br>- speed limiters<br>- reduction of vehicle use<br>- car pooling | • Government incentives<br>- licensing : energy efficient vehicles<br>- pricing: alternative fuel use | • RD & D: vehicle transport system technology |
| *Buildings* | • Regulation<br>- mandatory energy efficiency standards<br>• Voluntary Measures<br>- builders/ manufacturers | • Market-based programs<br>- incentives: energy-efficient products<br>• Procurement programs<br>- large purchases of energy<br>- efficient products | • RD & D:<br>- new energy<br>- efficient building materials and products |
| *Agriculture* | • $CH_4$<br>- agricultural reform<br>• $N_2O$<br>- market-based programs<br>- regulatory measures | • $CH_4$<br>- agricultural reform<br>• $N_2O$<br>- voluntary agreements<br>- import restrictions | • $CH_4$<br>- modernization<br>• $N_2O$<br>- voluntary agreements<br>- international support |
| *Land Use and Forestry* | • Regulatory measures<br>- slow deforestation<br>- reforestation | • Regulatory measures<br>- monitoring<br>- forest management | • Policy incentives<br>- substitution |
| *Waste* | • Regulatory<br>- legislation/institutional capacity<br>- imports control | • Voluntary agreements<br>• Incentives | • Technical assistance<br>• Institutional strengthening |

### 7.2.1 Energy Sector

**Energy Production and Consumption**

***Energy Industries/Industry***

Guyana derives the bulk (> 90 %) of its power supply from the generation of electricity by thermal power plants fed by carbon-rich liquid fossil fuels (See Chapter 4).

Several Greenhouse Gas Mitigation (GHGM) technology-based options have been proposed for reducing GHG emissions in the energy sector (See Table 7.1). For instance, some of the short-term options for mitigating $CO_2$, the most important GHG, in the energy sector includes: the modernization of existing power plants through the use of energy efficient technologies for new power plants or retro-fitting existing plants with modern efficient technologies such as decarbonisation of flue gases and fuel.

In the medium term, mitigation options for Guyana may include the use of less carbon-intensive fuels, such as switching from liquid fossil fuels to natural gas or simply the use of cleaner liquid fuels where costs can be justified. The greater use of renewable energy technologies for power generation such as solar and wind energy, which may not be cost-effective in the short-term because of the technology limitations and hydro power, for which Guyana has a huge potential, are viable short and medium-term mitigation options for Guyana. In the longer term mitigation options may include wind farms and wind/solar thermal generating systems for regional development.

The oil-fired power plants in Guyana are probably the largest sources of GHG emissions. A viable mitigation option would be the phasing out of existing power plants and replacing them by new, natural gas fired power stations (medium term strategy). The existing power plants can certainly be optimized for more efficient fuel use by simply implementing a regime of preventative maintenance. However, trying to switch these power plants to cleaner burning fuels (diesel as opposed to fuel oils) is expensive and not cost-effective in the context of the age of the plants. The benefits of these two strategies would be realized in reduced fuel costs, reduced equipment repair costs and a stabilization of electricity costs to the consumer. One other action, which will have to be addressed, probably in the short term, is making the transmission/distribution system more efficient.

As for the policy options that the government of Guyana may choose to use in the short term to mitigate $CO_2$ emissions in the energy sector, these are: the use of demand side management options that focus on pricing, competition and government subsidies to ensure a preference for cleaner fuels (See Table 7.2).

Another viable short-term policy alternative would involve modified energy consumption patterns through the use of pricing strategies and the sensitization of the public to energy conservation, and the reduction of transmission and distribution losses through system optimization techniques including the integrated operation of grid networks.

In the medium term, the govemment of Guyana may choose measures that facilitate the penetration of less carbon-intensive technologies, such as provisions for accelerated depreciation of new equipment and negotiated agreements with industry that favour the use of modern and more efficient equipment.

Alternatively, in the long term, the government of Guyana may choose to use utility demand-side management programs and regulatory programs and market pull and demonstration programs that stimulate the development and application of advanced and efficient power-generating technologies.

Other long-term policy options that the government of Guyana may adopt include government regulatory measures, voluntary agreements with the power generating utilities and infra-structural measures aimed at removing institutional barriers and the development of a comprehensive and efficient energy system planning. One long-term option is the purchase of power from a neighbouring country.

***Transportation***

The transportation sub-sector is another sector where significant gains in GHGM can be achieved in Guyana. In 1994, this sector consumed 19 % of all the liquid fossil fuels imported into Guyana.

Some of the more viable technology-based measures that may be used to reduce GHG emissions in the transportation sector of Guyana in the short term may include: energy use efficiency improvements through the use of less carbon emitting fuels such as natural gas, improvements in tyre performance and lubricants and other accessories such as transmission improvements and the use of lighter vehicles, especially for urban use. Other short-term options may include the mandatory installation of pollution removal devices such as catalytic converters in vehicular exhaust emission systems and the implementation of tougher legislation relating to exhaust emissions (See Table 7.1).

Another feasible policy directive applicable to the transportation sector in the short term is the restriction of the importation of foreign used vehicles to cars that are a maximum of five (5) years old and to heavy vehicles that are a maximum of three (3) years old. This will provide much needed control to the increasing population of older vehicles on the roadways of Guyana. Ideally, the first approach to controlling or reducing $CO_2$ emissions from tail pipes is to restrict the age of the vehicles on the roads to those that may meet better emission standards. Consequent with this approach, will be the reduction in consumption of fuel, since older cars use more fuel per mile than new cars.

In the medium term, the use of alternative energy sources, for instance switching to diesel from gasoline, although this may increase emissions of $NO_x$ and particulates, and even to LPG and CNG. Alternatively, the greater use of more efficient and less-polluting engines, such as conversion from 2-stroke to 4-stroke engines and greater use of electronic engine systems may be other medium-term mitigation options.

In the long term, when hybrid vehicles technologies are sufficiently improved, costs permitting, this may be a very attractive $CO_2$ mitigation alternative. Also, infrastructure and system changes, including greater use of and reliance on traffic and fleet management systems and modal shifts from road to rail transportation systems, in the interior of Guyana, may also be instituted as a long-term GHGM option.

As for the policy instruments that may be used by the Guyanese government to mitigate GHG emissions in the transportation sector in the short term, the alternatives are, among others: legislation of fuel economy standards, including compulsory fitting of speed limiters, the use of light-duty road vehicles in urban traffic and heavy-duty vehicles for freight traffic (See Table 7.2).

In the medium term the government of Guyana may choose to use incentives, through licensing fees for instance, to encourage the purchase of energy efficient vehicles.

Another measure may be the use of government incentives, such as price control to encourage the use of alternative fuels, such as natural gas or bio-fuels that are less polluting.

As for the long term, mitigation policies may be geared at government sponsored RD & D aimed at vehicle transport system technology.

***Residential, Commercial and Institutional Buildings***

Buildings are responsible for a significant amount of carbon emissions. Guyana can therefore also target this sector to reduce its GHG emissions. There are several easily attainable short and medium term technological options for reducing GHG emissions from buildings (See Table 7.1). This would involve greater deployment and use of technologies aimed at reducing energy use by building equipment and office appliances, including energy-efficient cooling systems such as electric air source cooling pumps, greater use of more efficient lighting systems and cooking appliances aimed at reducing energy consumption such as compact fluorescent lamps and lighting control systems.

In the medium term, mitigation options in the buildings sector may include the regulatory enforcement of energy conservation labels on equipment and appliances. Improvements in buildings thermal integrity aimed at reducing cooling energy losses may also be used to advantage.

In the long-term mitigation technological options to reduce GHG emissions from the buildings sector of Guyana may focus on the use of more energy efficient and less environmentally harmful building materials. For instance, high quality durable wood such as green-heart and purple-heart, with which Guyana is well supplied and which has a much higher thermal retention capacity than brick or concrete, not to mention the lesser energy use in the production of wood as opposed to brick or concrete and the carbon sequestration potential of wood, may prove to be an attractive building material alternative.

There are several policy instruments that Guyana may use, preferably in combination to encourage practices that would reduce GHG emissions in the residential, commercial and institutional sectors ( See Table 7.2 ).

At first, in the short term, the Government of Guyana may enact regulatory measures relating to mandatory energy-efficiency standards. The government should also facilitate these measures, including defining these standards and ensuring their cost effectiveness. Voluntary standards and measures, as a good will gesture on the part of manufacturers and builders, would greatly help to make these policies more effective.

In the medium term however, market-based programs that would provide incentives to promote increased use of energy-efficient technologies and practices may also be an attractive policy option for Guyana. For instance, utility demand side management that would provide incentives for the purchase of energy-efficient products and manufacturer incentive programs that would reward companies for the development and commercialization of high-efficiency low-energy-use products may be implemented.

Other medium-term policy alternatives that the government of Guyana may use would include procurement programs, where large purchases may make the acquisition of energy-efficient products affordable and the adoption of cost-effective energy efficiency measures in exchange for technical support and marketing assistance.

Finally, in the long term, government and large industries can encourage RD & D programs, such as the development and use of low emissive windows and high-efficiency air conditioners and refrigerator compressors.

### 7.2.2 Industrial Processes Sector

GHG emissions in the Industrial Processes sector relate to exclusively NMVOC emissions from the various food and beverages production processes, among others. In 1994, emissions of NMVOC totaled 16 Gg from this sector. GHG abatement in this sector is not viewed as an area where mitigation efforts can be pursued for Guyana.

### 7.2.3 Agriculture Sector

GHG abatement in agriculture will most certainly promote and enhance sustainable agricultural production, which will benefit the farming community and make agricultural products more acceptable to consumers. Several technological alternatives are available to the government of Guyana for mitigating the important GHG's in agriculture.

***Mitigation of $CH_4$ Emissions***

$CH_4$ emissions in the agriculture sector of Guyana are mainly attributable to the cultivation of rice under flooded anaerobic conditions, to enteric fermentation of animals and burning of biomass (refer to chapter 4.0 or summary tables for emission estimates).

There are a variety of technologies that may be used to mitigate $CH_4$ emissions from agriculture in Guyana in the short and medium term.

For rice cultivation, modified water regimes involving lesser water requirements and energy demand for short critical periods, without compromising yields, may be used. Other studies elsewhere in the Caribbean have found that maximum water levels in rice paddies may be reduced from 200 to 50 mm and minimum water levels from 150 to 25 mm, without significantly affecting rice yields.

Other shifts in cultivation techniques, such as the use of mineral as opposed to organic fertilizers, have been shown to result in higher yields while at the same time reducing $CH_4$ emissions. Alternatively, direct seeding of rice fields, which is more amenable to mechanization, albeit energy dependent causes less disturbance to the soil and reduces $CH_4$ emissions, while at the same time moving up the harvest season to two to four weeks earlier.

In the medium and long term, $CH_4$ mitigation in agriculture may be achieved through the development and use of hybrids, requiring less water and energy, which may well be required in response to the impacts of climate change and the expansion of upland rice acreages, that also require less water and energy, provided that yields are not substantially affected. Also, the introduction of new or other crops that emit less $CH_4$, provided that they are economically feasible, may also be considered as a further mitigation option.

$CH_4$ emissions from enteric fermentation in animals on the other hand, may be somewhat reduced in the short and medium term by upgrading low quality forages that produce high $CH_4$ emissions as a result of switching to rumen-resistant starches such as maize and sorghum, that cause less $CH_4$ emissions. However, this option may be limited by higher costs, more fertilizer use and hence soil and water pollution, and even by resistance based on dietary and social customs.

The various $CH_4$ mitigation options described above would have to be guided by different policy instruments that focus on agricultural reform and modernization.

In the short and medium term, such reforms may include the implementation and use of extension expertise, sensitization of farmers to the benefits of the reforms and government incentives aimed at ensuring the adoption of the policy changes being proposed.

In the medium and long term, on the other hand, the focus of government policy may shift towards modernization of agriculture in Guyana, focusing on the introduction of varieties and crops and cultivation methods that produce less $CH_4$ emissions costs and societal acceptance permitting.

***Mitigation of $N_2O$ Emissions***

The primary sources of $N_2O$ emissions from agriculture in Guyana are the use of mineral fertilizers, the cropping of nitrogen-rich legumes, animal waste and biomass burning.

The technology options that may be used to mitigate $N_2O$ emissions in the short term would include the use of controlled release fertilizers and nitrification inhibitors and the integration of nitrogen application with farm water management, such as irrigation application.

In the medium and long term, technology alternatives may focus on the use of less $N_2O$-emitting fertilizers on the one hand and on indirectly increasing the $N_2O$ sink capacity of agricultural lands on the other through reclamation and reforestation of abandoned agricultural lands and increasing the GHG sequestration of agricultural soils.

Policy instruments that may be used to mitigate GHG emissions in the agriculture sector of Guyana in the short term may be classified as, firstly market based programs, focusing on the reform and reduction of agricultural support policies and on tax disincentives aimed at limiting the use of nitrogen fertilizers, except for paddy rice cultivation. Secondly, regulatory measures aimed at limiting the use of nitrogen fertilizers for sugarcane and vegetable crops.

Other short and medium term mitigation options may include the use of a negative import list to control the importation of undesirable fertilizers. Also, policy directives to reforest abandoned agricultural lands may also be considered as a viable medium term mitigation strategy of increasing GHG sink capacity.

In the long term, policy options may shift to voluntary agreements regarding soil management practices that would enhance carbon sequestration.

### 7.2.4 Land Use and Forestry Sector

Forests act mainly as a sink for atmospheric $CO_2$ through carbon absorption and assimilation in the photosynthesis process. However, forests also emit $CO_2$ through excess carbon ejection in the respiration process and more importantly through the decomposition and burning of woody biomass.

Guyana's forests act as a tremendous reserve for the storage of carbon in live and dead vegetation and in forest soils. Mitigation of net GHG emissions from forests and forest soils should therefore be focused on methods aimed at enhancing carbon uptake. Therefore, steps must be taken to ensure that Guyana's forest protection plans do not turn out to be merely new versions of the country's forestry action plan.

Accordingly, the national tropical forest protection plans must be aimed at:

- Emphasising sustainable use of tropical forest resources.
- Ensuring the participation of local population and indigenous societies in the development of national tropical forest protection plans.
- Promoting reforestation measures.
- Exclusively implementing sustained yield management methods.

In the short and medium term, technologies that may be adopted for reducing net GHG emissions in the Land Use and Forestry sector of Guyana may include management for carbon conservation aimed at controlling deforestation and harvesting regimes through systematic monitoring, protecting forest reserves by controlling fires and pest outbreaks. Policy should also oblige concessionaires to provide in forest management plans, a component, which includes mitigation measures to enhance sinks as well as reducing emissions.

In the medium and long term, technology options may be management for carbon sequestration and storage by expanding the area of forest ecosystems and the density of forest biomass and increasing the carbon absorption capacity of forest soils and the storage of carbon in durable wood products. Also, management for carbon substitution through increasing the transfer of forest biomass into durable products rather than using fossil-fuel based energy products, such as cement-based and other non-wood building materials.

In so far as policy measures for reducing net GHG emissions in the Land Use and Forestry sector of Guyana are concerned, there are several options. Amongst these, in the short and medium term, are regulatory policy measures aimed at slowing deforestation, promoting forest regeneration and increasing the amount of carbon stored in forests by actively promoting reforestation and afforestation programs.

In the medium and long term, policy options may focus on incentives aimed at promoting substitution management whereby renewable forest carbon biomass is transferred into products that substitute for or reduce the use of fossil fuels, such as the use of bio-fuels for power generation in the energy and transportation sectors, though cost considerations may act as an impediment. Also, the lumber industry should be regulated by the EIA framework, whereby climate change impacts and mitigation may be major components.

### 7.2.5 Waste Sector

The main GHG emissions deriving from the Waste sector emanate $CH_4$ emissions from solid waste disposal and $N_2O$ emissions from human sewage.

The Waste sector is in dire need of upgrade in Guyana. Solid Waste handling and disposal should be the sector targeted for priority action both from an environmental perspective and as a means of controlling a significant $CH_4$ emission source. $CH_4$ emissions from uncontrolled dumpsites are 20 times greater than from a single engineered sanitary landfill of the same size.

***Mitigation of $CH_4$ Emissions***

Among the technical options that Guyana may choose to mitigate $CH_4$ emissions from solid waste disposal sites ( SWDS ) in the short term are firstly source reduction efforts whereby conservation and home-based garbage separation may be used to decrease the amount and types of garbage that turn up at SWDSs. This may be achieved through recycling of products such as paper, plastics bottles and metal cans, home-based composting and incineration. The problem with incineration however, may be the release of other air pollutants such as $CO_2$, which nonetheless has a lower global warming potential than $CH_4$.

The short and medium term technological options should focus on the installation of a combination of transfer stations and centralized sanitary landfills in each of the major population centers (Georgetown, Linden and New Amsterdam). Once this is done the medium-term strategies of waste segregation, waste recovery and waste recycling can be implemented.

## 7.3 SUMMARY AND CONCLUSIONS

It transpires from the above then, that Guyana should focus its GHGM efforts on: $CO_2$ emissions from the energy sector, $CH_4$ emissions from the agriculture sector and the preservation and strengthening of the $CO_2$ sink in the Land Use and Forestry sector. However, these mitigation efforts would call for resources, both technical and financial, that Guyana may not have. There would therefore be the need to actively solicit and pursue international funding agencies such as the Global Environment Facility and the World Bank.

The following projects may be identified as possible avenues to help Guyana reach its objectives insofar as GHGM is concerned.

1. The major contributor to GHG emissions in Guyana is the energy sector. In 1994, this sector emitted 1446 Gg of $CO_2$ where the energy industries sub-sector accounted for 602 Gg or 42% of emissions.

   In the short term then, Guyana should actively pursue measures aimed at retrofitting its existing power plants so as to reduce $CO_2$ emissions and trace gases from the energy industries sector.

   In the medium and long term, the development of alternative non-fossil and renewable energy sources may also be worthwhile. With its abundance of rivers and natural waterfalls Guyana has huge potentials for hydropower generation. Unfortunately, most of the potentially viable sites, such as at Moco-Moco, Tumatumari and Amaila, are located in the interior far from the coastal markets. If this sector is to be further developed projects related to transmission losses reduction or the development of new hydropower schemes closer to the Coastal Region may have to be targeted. Alternatively, projects related to the exploitation and use of other sources of non-fossil renewable energy, such as solar power and wind energy, costs permitting, in the Coastal Region may be evaluated.

2. Another major GHG in Guyana is $CH_4$ emissions from rice paddies. Guyana is an important producer of rice and it is one of the major contributors to GDP. In 1994, $CH_4$ emissions from rice paddies amounted to 22.33 Gg. Guyana may therefore choose to mitigate $CH_4$ emissions from its rice paddies by looking at hybrids or upland varieties that emit less $CH_4$. However, a pilot research project has to be

undertaken to ensure costs are not inflated and more importantly, quantity and quality of yields are not compro mised.