MYANMAR

COUNTRY PROFILE: STATUS OF CLIMATE CHANGE AND ENVIRONMENTAL ACTIVITIES

The climate of Myanmar is strongly influenced by the tropical monsoon system. It has a southwest monsoon(wet) season and a northeast monsoon (dry) season. Compared with other neighbouring countries, Myanmar enjoys a benign climate. Traditionally, droughts and floods are rare, and the incidence of natural hazards like cyclones and earthquakes are minimal.

Although Myanmar has not encountered serious environmental problems yet, the consequences of climate change have become noticeable recently. Records compiled by the Department of Meteorology and Hydrology indicate that the rainfalls in the 1980s are at a record low for the past 100 years. There are also fewer depressions in the Bay of Bengal than in recent history. The average temperature is 0.7 degrees Celsius higher than the average recorded temperature over the last two decades in most towns and cities of Myanmar. Just recently, in 2006 and 2007, there were more than two storms hit the coast of Myanmar in each year. In 2006, there were five incidents of tornados in the country, and in 2007 the total incidents were more than ten compared to the long-term average of one in fifteen years. Incidents of thunderclouds formation had increased by more than 60% in 2006 and 2007. More than one hundred people died due to hit by thunderstrikes.

Due to low population pressure and relatively low level industrialization, the state of the environment in Myanmar is comparatively better than many of its neighbours. However, there is a need to develop a national program of environmental management to prevent environmental deterioration ad pollution. Although, modern guidelines for the preservation of environmental quality are being introduced in the country, a coordinated and integrated system is needed for managing the environment.

The Government of Myanmar established I n 1990 the National Commission for Environmental Affairs (NCEA) as a policy body for environmental protection. NCEA has developed the Myanmar National Environment Policy, which was promulgated in December 1994. The National Environment Policy provides general guidelines for management of the environment in Myanmar.

Policies have also been established in various sectors of the economy that relate to the management and conservation of the environment. An example is that Myanmar Forest Policy (1995).

Myanmar does not yet have a national environmental law. NCEA is presently engaged in the formulation of this legislation. Sectoral rules and regulations relating to environmental protection are currently formulated by the ministries and departments concerned. This sectoral management approach means that sectoral environmental issues are managed by the ministries concerned. For example, the Ministry of Forestry addresses the issue of deforestation, while soil degradation is handled by the Ministry of Agriculture and Irrigation.

The latest initiative taken by Myanmar is the formulation of Myanmar Agenda 21. Myanmar agenda 21 seeks to strengthen and to promote systematic environmental management in the country. Specifically, the Agenda 21 calls for the integration of environmental communities, the private sector, and the Government in environmental considerations of economic development. In other words, Myanmar Agenda 21 serves as an important guideline for the protection of the environment and the sustainable development of the country.

Myanmar is now a party to several international and regional conventions and agreements relating to the environment, namely

(i) Vienna Convention for the Protection of the Ozone Layer, 1985.
(ii) Montreal Protocol on Substances that Deplete the Ozone Layer, 1987.

(iii) London Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, 1990.
(iv) United Nations Framework Convention on Climate Change, 1992.
(v) United Nations Convention to Combat Desertification in those Countries Experiencing Serious Droughts and/or Desertification, Particularly in Africa, Paris 1994.

The Government of Myanmar signed the United Nations Framework Convention on Climate Change UNFCCC) on 11 June 1992 and ratified the convention on 25 November 1994.

Myanmar commitments to the UNFCCC include the following tasks.
(i) Developing national inventories on sources and sinks of all greenhouse gases (GHGs);
(ii) Formulating, implementing, and publishing national and regional programs to mitigate climate change.
(iii) Promoting and cooperating the development, application, and transfer of technologies, practices, and processes that control, reduce, or prevent GHGs emission.
(iv) Promoting sustainable forest management practices by conserving and enhancing sinks and reservoirs of GHGs.
(v) Cooperating in the development of adaptation programs for potential impacts of climate change.
(vi) Taking climate change considerations into account in relevant social, economic, and environmental policies.
(vii) Promoting and cooperating in research and data development to help understand and reduce the potential impacts of climate change.
(viii) Promoting and cooperating in the exchange of technical, scientific, socioeconomic, and legal information related to the climate system and climate change.
(ix) Promoting and cooperating in education, training, and public awareness campaign related to climate change.
(x) Communicating to the Conference of the Parties information related to implementation of the Convention's commitments.

1990 National Inventory of GHGs Sources and Sinks
Myanmar has established the following regulations and programs to support the national climate change objectives.

(i) Nationwide Tree Planting Programme
At present the Myanmar Government is implementing a program of vegetating the arid zones in the 13 districts of the central part of Myanmar. Since 1977/78, a nationwide tree planting program has been conducted with the participation of local communities, and non-governmental and governmental organizations.

(ii) Afforestration Programme
The deforestation rate of Myanmar in 14 years (1975-1989) was 218,800 hectares per annum. The Forestry Department is now promoting forestry plantation to enrich and reforest these denuded areas. A total of 294,200 ha had been planted from 1963 to 1995, and the current annual planting target is approximately 33,000 ha.

Under the ALGAS Project, Myanmar conducted the first inventory of greenhouse gases emissions. The 1990" base year" inventory of GHGs is already identified.
The following are the key findings of the emissions inventory.

(i) The agriculture sector is the dominant source sector. Methane emissions from enteric fermentation and rice cultivation account for 94 percent of the national CO_2 – equivalent emissions.
(ii) The forestry sector is a net carbon sink (-9,402 Gg of CO_2)
(iii) The energy sector contributions to national GHGs emissions are marginal.

2. MYANMAR NATIONAL GHGS INVENTORY FOR 1990, GG

Source and Sink	CO_2 Emissions	CO_2 Removal	Net CO_2	CH_4	N_2O
Total Net National Emissions	**67078.25**	**72988**	**-5909.75**	**2484.111**	**8.3665**
All Energy (Fuel Combustion+Fugitive)	**3311.81**		**3311.81**	**119.786**	**0.8349**
Fuel Combustion	3311.81			111.546	0.8349
Energy and Transformation Industries	1414.32			0.036	0.005
Industry	528.31				
Transport	1005.02			0.16	0.008
Commercial Institutional	234.16			0.022	0.0008
Residential					
Traditional Biomass Burned for Energy				111.31	0.82
Others	130.00			0.018	0.0011
Fugitive Fuel Emissions				**6.24**	
Oil and Natural Gas Systems				7.80	
Coal Mining				0.44	
Industrial Processes	**180.44**		**180.44**		
Cement Production	180.44				
Others	-		-		
Agriculture				**1767.73**	**6.7116**
Enteric Fermentation				396.22	
Manure Management				43.58	
Rice Cultivation				1327	
Agriculture Soils				NE	6.7
Prescribed Burning of Savannas				0.88	0.01
Field Burning of Agriculture Residues				0.05	0.0016
Others					
Land-use Change and Forestry	**63,586**	**72,988**	**-9,402**	**118.67**	**0.82**
Changes in Forest & Other Woody Biomass Stocks		46,698			
Forest and Grassland Conversion	63,586				
Abandonment of Managed Lands		26,290			
On Site Burning of Forest				118.67	0.82
Waste				**127.92**	
Solid Waste Disposal on Land				123.72	
Waste water Treatment				3.25	
Others				0.955	
Bunker Fuel Emissions					

Source and Sink	NO_x	CO	CO_2 Equivalent	Percent of Total CO_2 Equivalent
Total (Net) National Emissions	71.4578	1119.6782	41500.20	100
All Energy (Fuel Combustion + Fugitive)	**71.01**	**1095.49**	**6086.14**	**14.67**
Fuel Combustion	71.01	1095.49	5913.10	
Energy and Transformation Industries	3.80	0.45	1416.83	
Industry			528.31	
Transport	9.87	54.84	1010.86	
Commercial Institutional	0.22	0.14	234.87	
Residential				
Traditional Biomass Burned for Energy	56.94	1040.02	2591.71	
Others	0.18	0.04	130.72	
Fugitive Fuel Emissions			**173.04**	
Oil and Natural Gas System			163.80	
Coal mining			9.24	
Industrial Processes			**180.44**	**0.43**
Cement Production			180.44	
Others				
Agriculture	**0.4478**	**24.1882**	**39,202.922**	**94.47**
Enteric Fermentation			8320.62	
Manure Management			915.18	
Rice Cultivation			27,867	
Agriculture Soils	NE	NE	2077	
Prescribed Burning of Savannas	0.39	23.17	21.58	
Field Burning of Agriculture Residues	0.0578	1.0182	1.54	
Others				
Land-use Change and Forestry			-6,655.73	-16.04
Changes in Forest & Other Woody Biomass Stocks				
Forest and Grassland Conversion				
Abandonment of Managed Lands				
On Site Burning of Forest				
Waste			2,686.43	6.47
Solid Waste Disposal on Land			2598.12	
Waste water Treatment			68.25	
Others			20.06	
Bunker Fuel Emissions				

BASELINE PROJECTIONS OF NATIONAL GHGS INVENTORIES TO 2020

Projections of national GHGs emissions to year 2020 indicate that the emissions will continue to increase. The agriculture sector will continue to be the predominant source of GHGs, and the forestry sector will remain a net sink, but to a lesser degree, through the period.

The energy sector GHGs emissions were projected using the Long range Energy Alternative Planning (LEAP) Model. The projection is a business-as-usual one, where energy intensities have been kept constant and activities were projected according to government plans, past trends, or expected growth in the demand for different end uses or devices. The assumptions of the projection included annual GDP growth rates ranging from 6.2 percent in the year 2000 to 7.4 percent in the year 2020. The population was projected to grow from 41 millions in 1990 to 68 millions in 2020. Electricity generation was assumed to be split evenly between hydropower and natural gas.

Options for mitigation of GHGs emissions were identified for each of the three sectors that were studied in the ALGAS Project for Myanmar. Fifteen options were selected for analysis for the energy sector. The forestry sector analysis considered five options. The agriculture sector analysis was conducted applying two options for GHGs mitigation from rice cultivation and two options from livestock management.

Energy

Mitigation options were identified by expert judgement based on the GHGs emissions inventory of the year 1990 and projections to 2020. The 2020 GHGs projections by the LEAP Model gave a clear indication of the subsectors to target. For Myanmar, the transport and residential subsectors were clearly significant. The relevance and appropriateness of each option were carefully studied before it was selected for analysis. The mitigation opportunities considered and their cost-effectiveness from the GHGs mitigation, financial, and economic standpoints are summarized in Table(*)

Summary of Potential GHGs Mitigation Options for the Energy Sector in Myanmar

Description of GHGs Emissions Reduction Option	Estimated Investment Cost of Option,S/Typical sIze	Estimated GHGS Emissions Reduction, tonnes of CO_{2-} equivalent/yr	Cost Effectiveness $/per tones of CO_{2-}	Potential CO_{2-} Abated , million tonnes
Residential				
Compact Fluorescent Lamp	9	0.06	-33.79	1.05
Biomass Cockstoves	10	0.05	-87.82	6.92
LPG Cockstoves	20	0.88	-17.21	4.16
Improved Kerosene Lamp	1.8	0.02	-42.01	0.08
Commercial				
Compact Fluorescent Lamp	9	0.12	-41.21	0.75
Efficient Air Conditioners	1,000	1.36	-18.94	0.51
Cogeneration	40,000	44.22	0.45	1.22

[*] *The estimated investment cost shown for the vehicle maintenance option is operation and maintenance cost only.*

Description of GHGs Emissions Reduction Option	Estimated Investment Cost of Option,S/Typical sIze	Estimated GHGS Emissions Reduction, tonnes of CO_{2-} equivalent/yr	Cost Effectiveness $/per tones of CO_{2-}	Potential CO_{2-} Abated , million tonnes
Industry				
Cogeneration	720,000	5214	-24.43	3.72
Efficient Motor & Drive	900	0.7	-21.38	3.28
Efficient Boiler	8,400	145.19	-19.95	2.61
Transportation				
Mass Transit System	40,000	51.92	-11.09	1.29
Vehicle Maintenance	200[*]	2.01	-17.58	2.03
Supply Side Option				
Combined Cycle	140,000,000	246,840	-4.16	9.32
Bioelectricity	750,000	5,578	5.83	1.73
T & D Losses	423,465,000	4,278,747	-13.18	5.75

A late start, coupled with a lack of previous modeling experience, prevented Myanmar from undertaking an optimization modeling exercise for the ALGAS study. For the Myanmar study, the cost-effectiveness of the options was calculated by a pair-wise comparison where a baseline option was compared with the mitigation option. Fifteen options have been identified for the energy sector, of which twelve are in the demand side and three are in the supply side.

Land-use Change and Forestry
The following mitigation options exist in the forestry and land-usechange sector in Myanmar

(i) Reforestation with short rotation (10 years).
(ii) Reforestation with long rotation (40 years).
(iii) Natural Regeneration.
(iv) Reforestation for Bioelectricity Production.
(v) Forest Protection.

The reforestation and natural regeneration options will be focused on the critical land, cultivable waste land, degraded forest land, and forest land with shifting cultivation.

Three scenarios were considered for the implementation of the forestry options. The Comprehensive Mitigation Analysis Process (COMAP) Model was used to assess the options in a programmatic scenario, a biomass demand based scenario, and a technical potential scenario.

Mitigation Potential and Investment Costs of Forestry Sector Scenarios

Mitigation Option	Area to be Dedicated, mha	Total Mitigation Potential, mt of Carbon	Total Investment Cost, $ million
Mitigation potential of programmatic scenario (BAU)			
Reforestation with long rotation (LR)	0.138	21.4	17
Reforestation with short rotation (SR)	0.149	8.2	31
Total	**1.712**	**126**	**351**
Biomass demand based scenario			
Industrial wood plantation (SR)	0.240	33	51
Swan wood (LR)	0.122	19	15 285
Total	**1.712**	**126**	**351**
Mitigation potential of Technical potential scenario			
Reforestation with short rotation (SR)	1.06	58	224
Reforestation with long rotation (LR)	1.36	211	166
Natural regeneration (NR)	4.35	144	44
Reforestation with Biomass electricity (RB)	0.18	14	292*
Forest Protection (FT)	3.31	156	255
Total	**10.26**	**583**	**981**

Agriculture

Mitigation Option	Area of Livestock Population to be Covered	Total Mitigation Potential, Gg	Total Investment Required for the Area, $ million
Feasible Scenario			
Biogas sludge fertilizer	200,000 ha	30	18
Increased application rate of urea	4,000	17	172
Using urea molasses mineral block	0.075 million heads of cattle	1.2	2.3
Using urea treated straw	1.1 million heads of non dairy cattle and buffalo	3.70	3.8
Technical Scenario			
Biogas sludge fertilizer	1 mha	150	90
Increased application rate of urea	1 mha	4,250	43
Using urea molasses mineral block	0.3 million heads of dairy cattle	4.8	9.2
Using urea treated straw	8.87 million heads of non-dairy cattle and buffalo	29.57	30.7
Total		**4,434**	**72.9**

Four agriculture sector GHGs mitigation options were identified as appropriate for implementation in Myanmar. Two options were assessed for each of the two major subsectors: rice cultivation and livestock management. The rice cultivation options are focused on reduction in use of high methane-generating unfermented organic fertilizers. The livestock options relate to improvement of feed materials to reduce methane produced in the electric fermentation process. All of the agriculture sector options are consistent with the national goals in that they increase production while reducing GHGs emissions.

Rice cultivation

Option 1: Use of biogas sludge as fertilizer in drought-prone and irrigated areas.
Option 2: Increasing the application rate of urea fertilizer in rainfed and water area.

Livestock

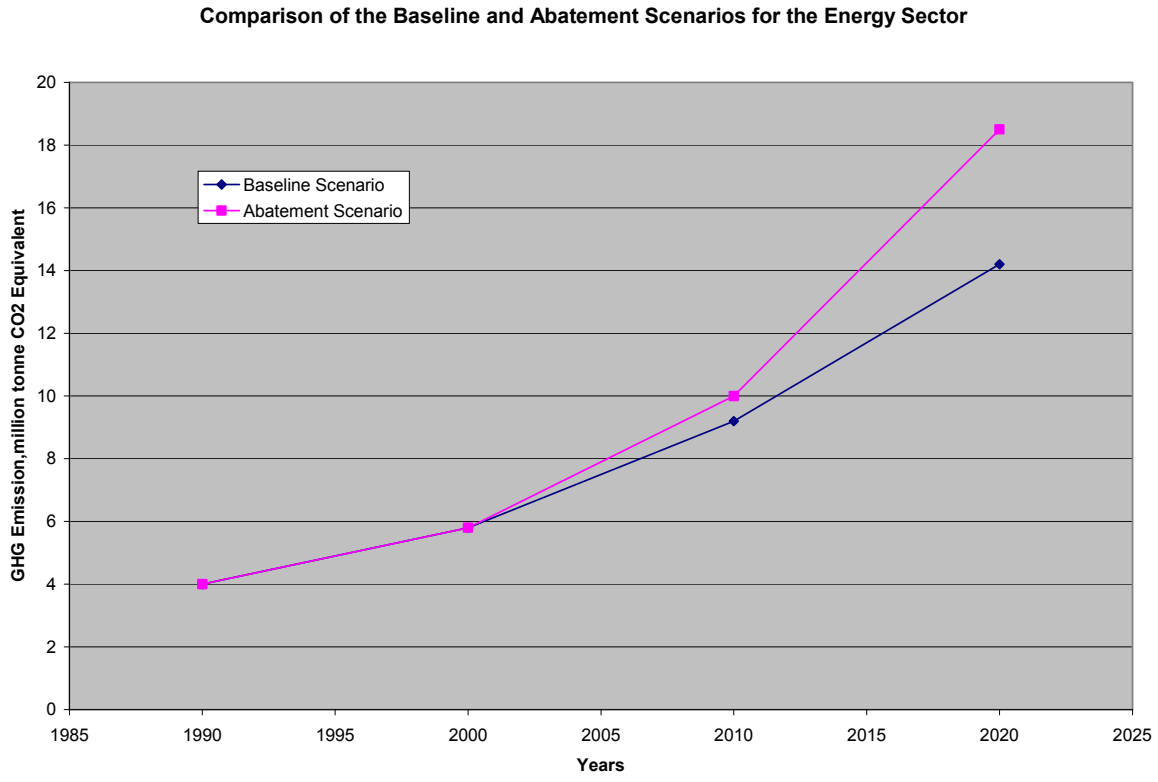
Option 3: Supplementing ruminant feed with area molasses mineral block
Option 4: Pre-treatment of paddy straw feed with urea.

Mitigation Potential and Investment Costs of Agriculture Sector Abatement Scenarios
The mitigation options were assessed under two implementation scenarios. The Feasible Scenario assumes application of the options in rates that are both technically and financially feasible in Myanmar. The Technical Scenario represents application rates that are technically possible but are not financially feasible.

Mitigation Potential and Investment Costs of Agriculture Sector Abatement Scenarios
In developing the Baseline Scenario, the annual economic growth rate was assumed to be 5.7 percent on the period 1990 to 2000, 6.5 percent in the period 2000-20102, and 7.1 percent in the period 2010-2020. The population growth rate is expected to drop from 1.88 percent in the base year 1990 to 1.56 percent in the year 2020. Both GDP and population were assumed to remain unchanged in the mitigation scenario.

BASELINE AND ABATEMENT SCENARIOS TO 2020

The Baseline Scenarios was developed using the accounting-type-non-optimizing energy modeling software called LEAP, which computes the total energy requirement for a scenario. The Baseline Scenario for Myanmar is identical to the Business-as-usual (BAU) scenario. The energy sector Abatement Scenario was developed by implementing the fifteen mitigation options listed in table, through assumed penetration curves over the period 2000-2020.



The above figure shows the comparison between the Baseline and Abatement Scenarios for the energy sector. In the mitigation scenario, the commercial and traditional energy demands have been projected to come down in 2020 by 19percent and 17 percent, respectively. On the demand side, the improved biomass cookstove has the highest potential for GHGs reduction, followed by industrial cogeneration. In the supply side, combined cycle and bioelectricity have considerable potential for reducing CO_2 emissions. The transmission and distribution (T&D) loss reduction is also a very significant mitigation option in the supply side. At this point it is worth emphasizing that in the supply side for Myanmar, hydroelectricity is a baseline option, while it is a mitigation option in many countries. More than 50 percent of the 2020 electricity needs will be met by hydropower. In Myanmar, therefore, the supply side is a considerable environment friendly.

Forestry Sector

Baseline Scenario

The net emission from the forestry sector in 1990 were estimated to be negative, an estimated 8.6 mt CO_2 were sequestered. Thus, ***the forestry sector is a net sink in Myanmar. Projections to 2020 also show that the forests are estimated to remain a net sink in Myanmar.***

At present the Myanmar Government is implementing a program of vegetating the arid zone in the thirteen districts in the central part of Myanmar. In those areas, cutting of wood is restricted and fuelwood substitutes such as liquefied petroleum gas (LPG) and improved firewood and charcoal stoves are being introduced to the public. These measures would mitigate GHG emissions in the future.

Under the Baseline Scenario, the total area projected for reforestation with short rotation (10 years) for community plantations and fuelwood supply is 1.06 mha. The area projected for reforestation with long rotation (40 years) for commercial plantations and watershed management is 1.36 million hectors. Natural regeneration is projected to be applied to 4,350 ha. Reforestation for bioelectricity will be applied to 1.09 mha, and forest protection for reforestation will be applied to 3.31 mha.

Mitigation Scenario

Two abatement scenarios were assessed for the forestry sector: the Biomass Demand-based Scenario and the Technical Potential Scenario. The Technical Potential Scenario assumes that all of the areas actually available are considered for mitigation analysis.

According to projections, demand for sawn wood will reach 926,000 m^3 in year 2010. Demand for industrial roundwood will reach 4 million m^3, and the demands for fuelwood and charcoal would be 25 million m^3. Under the Biomass Demand-based Scenario, the area needed for industrial wood plantation with short rotation is 240,000 ha. The area needed for sawn wood with long rotation is 122,000 ha. Plantation with short rotation is 1.35 million hectares (mha) are needed for fuelwood and charcoal.

Under the Technical Potential Scenario, the total available land for short rotation plantation is 1.06 mha. Short rotation plantations could meet fuelwood and industrial wood requirements and these would be a surplus. The total land available for the long rotation option is 1.36 mha. An area of 4.35 mha is considered for natural regeneration under the potential technical scenario. A total potential area of 3.31 mha is available for forest protection under the potential technical scenario. The bioelectricity option would require 175,000 ha.

Agriculture Sector

Baseline Scenario

In the baseline scenario, the area for rice growing will be limited in future years. The projected areas under rice cultivation are 4.8 mha, 6,5 mah, 6.5 mha, and 6.5 mha for 1990,2000,2010 and 2020, respectively. The projected methane estimates for these years are 1,328 Gg, 1,512 gg, 1,512 Gg, and 1,512 Gg, respectively.

The projected daily cattle population for the years 1990, 2000, 2010 and 2020 are 179,000 heads, 214,000 heads, 271,000 heads, and 344,000 heads, respectively. Thus, methane emissions from dairy cattle are expected to grow from 10.31 GG IN 1990 TO 19.3 Gg in 2020. The estimated non-dairy cattle populations for 1990, 2000, 2010, and 2020 are 9.w million heads, 11.26 million heads, 14.275 million heads, and 18.096 million heads, respectively, resulting in methane emissions of 150 Gg, 179 Gg, 233 Gg, and 288 Gg, respectively.

Mitigation Scenario

There will be five mitigation options implemented in the agriculture sector: three options for rice cultivation (only two were assessed for cost-effectiveness) and two options for livestock. By then, 52 Gg of methane could be reduced through implementation of these measures. By the year 2020, there will be 3,000 biogas plants, reducing 30 Gg of methane, and 4,000 ha of rice will be treated with urea fertilizer resulting in mitigation of 17 Gg of methane. Methane reduction from mitigation options in the livestock subsector is estimated to be 4.9 Gg.

Twenty-four GHGs mitigation options have been identified and assessed in the study made by NCEA and ADB, of which 15 options are from the energy sector, 5 options are from the forestry sector, and 4 options are from the agriculture sector. Due to the differences in the assessment approaches used in the three sectors, a combined National Least-cost Abatement curve could not be constructed. The Cost of Emissions Reduction Initiatives (CERI) curves for the three sectors, however, are constructed.

NATIONAL ABATEMENT ACTION PLAN AND CONLUSION

A set of five proposals, based on priority of development plans of Myanmar and feasibility of implementation are proposed. The proposed projects are summarized as given in the Table (4).

The national inventory of GHGs sources and sinks (1990) indicates that GHGs emissions from Myanmar are about 41,500 Gg of CO_2.

Equivalent per year, which is fairly small compared with the emissions from some Asian countries. The agriculture sector is the source of 94.5 percent of the total emissions from Myanmar, and methane is the largest contributing greenhouse gas. The inventory and projections indicate that the emissions from the agricultural sector will continue to increase through the year 2020. The net CO_2 emissions in 1990 totalled -5,910 Gg. This indicates that Myanmar is greater sinks than sources of CO_2. The baseline projection of the national GHGs inventory to 2020 shows that the forestry sectors' emissions amount to -5,135 Gg of CO_2. equivalent in the year 2020, indicating that forestry sector will continue to be a significant sink in Myanmar in the future.

Summary of Proposed Priority GHGs Mitigation Projects

Project Title	Sector	Key Objective of the Project	Rationale for Project Priority	Estimated Budget, $	Nonquanti - fiable Benefit
Dissemination of Biogas Technology for GHGs Emissions Reduction in Shan State of Myanmar	Agriculture	To utilize sludge as fertilizers; To reduce methane emissions from rice fields and manure; To protect the forest by conserving fuel -wood; To improve rural farm family living standard:	Improvement of rural living standard and sustainable use of fertilizer	9 million	
Developing Institutions and Capacity for Inventory of GHGs in Myanmar	Energy	To develop institution for monitoring and verification if GHGs inventory; To build capacity in Myanmar for long-term monitoring and inventory of GHGs.	Improvement of the living standards and health of Myanmar	250,000	Creating public awareness on extent and dangers of air pollution
Fuel-Efficient Cookstoves and Participatory Forestry for Carbon Emissions Reduction in Shan State of Myanmar	Forestry and Land-use Change	To achieve forest and forest carbon sink; Conservation through adoption of improved (fuel efficient) stoves and reforestation of degraded forests through participatory approach	Improvement of the life of women, through efficient cook stove program and conservation of forest carbon sinks.	10 million	Contributing to craon sinks and reducing carbon and other GHGs emissions
Rural Electrification through Bioenergy	Forestry and Energy	To electrify rural areas; To reduce GHGs emissions by adopting suitable bio - energy technology; To reclaim degraded lands and sequester carbon	Rural electrification leading to rural development	120,000	Reclamation of degraded land; Improve quality of rural women.
LPG Cookstoves to Replace Electric Cookers	Energy	To remove barriers from the use of LPG as a cooking fuel; To conserve electri -city and hence natural gas To save on electricity generation and transmission and distribution facilities.	Improvement of the living standards and health of Myanmar	225,000	

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