TECHNICAL GUIDE TO ACTIONS ON GLOBAL WARMING AND CLEAN DEVELOPMENT MECHANISM (CDM) IN SRI LANKA

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TABLE OF CONTENTS

List of figures

List of tables

List of Abbreviations

CDM	- Clean Development Mechanism
GHG	- Green House Gas
PDD	- Project Development Document
PIN	- Project Idea Notes
GWP	- Global Warming Potential
UNFCCC	- United Nations Framework Convention on Climate Change
DNA	- Designated National Authority
DOE	- Designated Operational Entity
EB	- Executive Board
COP	- Conference of Parties
CER	- Certified Emission Reduction
EIA	- Environmental Impact Assessment
LULUCF	- Land Use Land Use Change Forest
NGO	- Non Governmental Organization
CO_2	- Carbon Dioxide
CH_4	- Methane
HFC	- Hydro Fluoro Carbon
N_2O	- Nitrous Oxide
HCFC	- Hydro Chloro Fluoro Carbon
SF_6	- Sulfur Hexafluoride
CFC	- Chloro Fluoro Carbon
PPM	- Parts Per Million
IPCC	- Intergovernmental Panel on Climate Change
PFC	- Per Fluoro Compounds
JI	- Joint Implementation
TCE	- Tons of Carbon Equivalent
t-CO_2	- Tone of CO_2
TJ	- Tera Joule
KWh	- Kilowatt-hour
ET	- Emission Trading
ERU	- Emission Reduction Units
IRR	- Internal Rate of Return
US$	- United States Dollars
RMU	- Removal Units
MAC	- Marginal Abatement Cost
FDI	- Foreign Direct Investment
NEA	- National Environment Act
CEA	- Central Environmental Authority
CCS	- Climate Change Secretariat
NEC	- National Expert Committee
MW	- Mega Watt
GWh	- Giga Watt hour
ECF	- Energy Conservation Fund

Preface

The Ministry of Environment and Natural Resources of the Government of Sri Lanka is the apex body under which all environmental issues and policy matters are addressed. The Global Affairs Division of the Ministry of Environment and Natural Resources is tasked with formulating policy and strategic planning and liaise with the international organizations dealing with global environmental issues and is the Designated National Authority (DNA) for matters arising out of the Kyoto Protocol. Under the Kyoto Protocol, the Clean Development Mechanism (CDM) provides for Green House Gas (GHG) mitigation projects that contribute towards sustainable development in developing nations and the net emission reductions can be traded to a developed nation to meet its Kyoto obligations. Although the other developing nations have already taken advantage of this mechanism and thus earning valuable foreign exchange, Sri Lanka is yet to embark on such projects in a significant manner due to a number of constraints and barriers at policy, institutional, organizational and individual level. This publication is intended to address such limitations and help expedite CDM projects in Sri Lanka so that the country could benefit from the first crediting period which is due to end in 2012. This book is intended for the general reader to gain awareness on CDM and related projects, for technical personnel who are involved in preparation of Project Development Document (PDD), for CDM and policy makers who are concerned with strategic planning and for institutional capacity building.

The report begins with green house effect with GHG emissions and their contributions to global warming. To highlight the gravity of the problem various projections are presented on future climate change, extreme weather events, sea level rise and their impact on developing countries. It describes the global initiative to tackle climate change and specifically details the Kyoto Protocol. The CDM and the project design is elaborated with all the terminology used defined so that it gives a clear understanding to the interested reader. The current international carbon market status is presented with an economic analysis to highlight the marginal abatement costs and project transaction costs involved with an analysis of CER buyers and sellers. The policies, issues and barriers for CDM project development in Sri Lanka are identified with related legislation that will help project proponents to identify specific sectors that contribute towards sustainable development. Sectoral baselines are presented in detail with accepted methodologies as given by the UNFCCC. Details of calculation of national baseline for renewable energy projects are presented with data and information as applicable for power generation in Sri Lanka. Most of the CDM projects in Sri Lanka come under the “small-scale” category due to the size of projects and detailed methodologies as described by UNFCCC are presented with hypothetical examples to aid PDD developers. Finally sectoral potentials are identified that have CDM opportunities both in state sector and private sector.

This information and analysis is current up to the date of publication and project developers and others are advised to use the latest methodologies and data as applicable to their projects through sources referenced here. The information presented here may not be adequate for PDD preparation for specific projects as this book is intended only as a guiding reference.

This work was funded by the Carbon Finance Assist program of the World Bank. We express our sincere appreciation to all those who provided data and information for this publication. We thank the country representatives of the World Bank for facilitation of this work with financial assistance and the Ministry of Environment and Natural Resources for the guidance. We sincerely hope this book will be useful to the targeted readers and help encourage application for CDM projects in Sri Lanka.

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CHAPTER 1 - INTRODUCTION TO CLIMATE CHANGE UNFCC, KYOTO PROTOCOL AND CDM RULES IN RELATION TO SRI LANKA

1.1. Introduction

The Earth is getting warmer and over the past 100 years, the average temperature on the Earth has increased by more than half a degree Celsius. The 1980s and 1990s were the warmest decades on records, and the 20^{th} century the warmest in the past 1000 years. According to the Intergovernmental Panel on Climate Change (IPCC), average global temperatures are expected to rise by 1.4 to 5.8 Celsius over the next century. To understand what this means that today's average global temperatures are only about 5^0 Celsius warmer than they were during the last Ice Age. Global mean sea levels are set to rise by 9 - 88 cm by 2100, flooding many low-lying coastal areas. Changes in rainfall patterns are also predicted, increasing the threat of drought or floods in many regions. Overall, the climate is likely to become more variable, with a greater threat of extreme weather events, such as intense storms and heat waves. The Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), released in 2001, confirms that "an increasing body of observations gives a collective picture of a warming world" with "new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities". The IPCC updated the findings of its 1995 Second Assessment Report and projects that the climate will change more rapidly than previously expected. While the world's climate has always varied naturally, the vast majority of scientists now believe that rising concentrations of "greenhouse gases" in the Earth's atmosphere, resulting from economic and demographic growth over the last two centuries since the industrial revolution, are overriding this natural variability and leading to irreversible climate change.

1.1.1 Greenhouse effect

Gases in our atmosphere, including water vapour, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs) and perfluorocarbons act like a greenhouse to keep the sun's heat in and help make our planet livable. Greenhouse gases (GHGs) control energy flows in the atmosphere by absorbing infra-red radiation. These trace gases comprise less than 1% of the atmosphere. Their levels are determined by a balance between "sources" and "sinks". Sources are processes that generate greenhouse gases; sinks are processes that destroy or remove them. Humans affect greenhouse gas levels by introducing new sources or by interfering with natural sinks. Without this natural insulation, the Earth's surface would be much colder than it is now. In fact, the average temperature on Earth would be –18 Celsius, too cold to support the diversity of life we have today. Water vapour is the most common greenhouse gas. Carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_20) are particularly important to climate change because they are closely associated with human activities.

Carbon dioxide is currently responsible for over 60% of the "enhanced" greenhouse effect, which is responsible for climate change. Carbon dioxide is released to the atmosphere through natural processes of plant and animal life. Photosynthesis is the process in which plants take in carbon dioxide and remove carbon dioxide from the atmosphere. Burning coal, oil, and natural gas is releasing the carbon stored in these "fossil fuels" at an unprecedented rate. Deforestation releases carbon stored in trees. Current annual emissions amount to over 7 billion tones of carbon, or almost 1% of the total mass of carbon dioxide in the atmosphere. Methane (CH_4) is not as abundant as carbon dioxide, but is a powerful greenhouse gas and more effective in trapping heat. It is created when vegetation is burned, digested, or rotten in an oxygen-free environment. Wetlands, rice fields, animal digestive processes, and decaying garbage are the greatest sources of methane in our atmosphere. Nitrous oxide (N_2O) occurs naturally in the environment, but human activities increase the quantities. Nitrous oxide is released when chemical fertilizers and manure are used in agriculture.

Since the Industrial Revolution, developed countries produced increasing quantities of greenhouse gases, due to burning of fossil fuels such as coal, oil, and natural gas to drive our vehicles and power our industries. Our human activities, such as the clearing of land for agriculture and urban development, land filling and other waste disposal methods, are also adding to the concentration of greenhouse gases in our atmosphere. As a result, concentration of greenhouse gases particularly, carbon dioxide in the atmosphere has increased by 31 percent since 1895. Atmospheric carbon dioxide concentration during the pre-industrial period was 280 ppm (parts per million), which is now about 380 ppm. Concentration of methane and nitrous oxide has increased by 151 percent.

1.2 Global Climate in the 20th Century

Climate Change according to the IPCC[1] refers to "a statistically significant variation in either the mean state of the *climate* or it is variability, persisting for an extended period (typically decades or longer). Climate change may be due to natural internal processes or external forcing or to persistent a*nthropogenic* changes in the composition of the *atmosphere* or in *land use".* The *United Nations Framework Convention on Climate Change* (UNFCCC) defines climate change as " a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over a comparable time period" (Article 1, UNFCCC). Climate variability refers to variations in the mean state and other statistics (such as standard deviation, the occurrence of extremes etc.) of the *climate* on all *temporal* and *spatial scales* beyond that of individual weather events. Variability may be due to natural internal processes within the *climate system* (internal variability) or to variations in the natural or *anthropogenic external forcing* (external variations) (IPCC, 2001).

[1] Unless otherwise acknowledged, the information provided here is based on IPCC

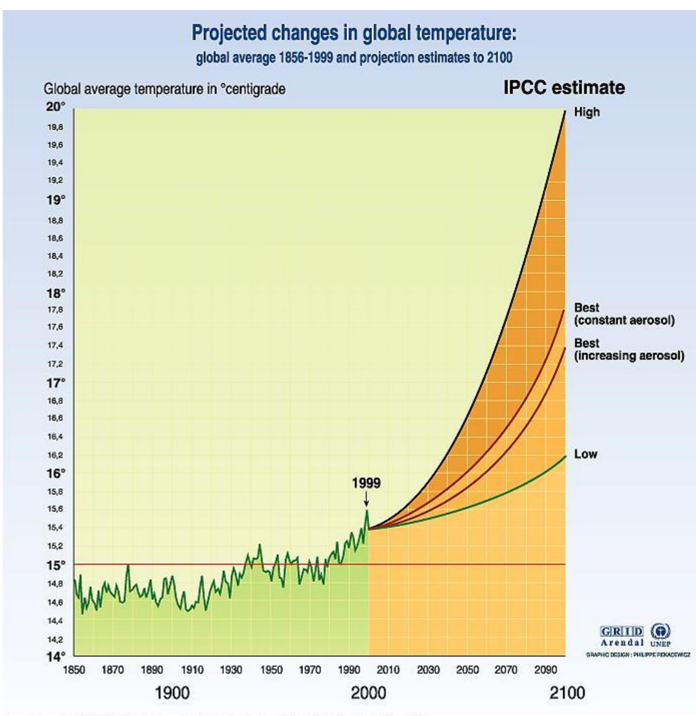
1.3 Temperature Changes

Observed changes in the earth's surface temperature indicate that during the 20th century, the global mean temperature had increased by 0.60C +/- 0.2 ^{0}C (Table 1). The IPCC publications state that it is 'likely'[2] that the 1990's has been the warmest decade and that it is 'likely', that 1998 was the warmest year since 1861. Temperature increases were greater over land than over oceans.

The diurnal surface temperature range had decreased over land but the nighttime daily minimum temperatures had increased, at twice the rate of daytime maximum temperature, i.e. at the rate of about 0.2^{0}C per decade.

Concentration of greenhouse gases such as carbon dioxide (CO_2), Methane (CH_4), nitrous oxide (N_2O), and ozone (O_3) had been increasing during the 20th century. Strong evidence from observations indicates that global warming during second half of the 20th century can be attributed to anthropogenic activities that had increased greenhouse gas concentrations (Fig 1).During the pre-industrial era (between 1000-1750 AD), for example, the CO_2 concentrations had amounted to 280 ppm (parts per million) but had increased by 31 +/-4% to 368 ppm in 2000 (Table 1 and Table 2). The growth rates of CO_2 concentrations had accelerated after the Industrial Revolution due mainly to fossil fuel emissions although clearing of forest cover had contributed to 1/3 of the emissions in the past.

Figure 1- Predicted changes in global temperature



[2] Likelihood refers to judgmental estimates of confidence used by TAR WG1 (IPCC,2001).
*Likely- (66-90% chance) ** Very likely- (90-99% chance)

Table 1 - 20th century changes in the Earth's atmosphere and climate *

Indicator	***Observed Changes***
1.Concentration Indicators	
Atmospheric concentration of CO_2	280 ppm for the period 1000-1750 to 368 ppm in year 2000(31+/_ 4% increase)
Terrestrial biospheric CO_2 exchange	Cumulative source of about 30 Gt C between the years 1800 and 2000; but during the 1990s, a net sink of about 14+/-7 Gt C.
Atmospheric concentration of CH_4	700 ppb for the period 1000-1750 to 1,750 ppb in year 2000 (151 +/- 25% increase)
Atmospheric concentration of N_2O	270 ppb for the period 1000-1750 to 316 ppb in year 2000 (17+/-5 % increase)
Tropospheric concentration of O_3	Increased by 35+/-15% from the years 1750 to 2000, and varies with region.
Stratospheric concentration of O_3	Decreased over the years 1970 to 2000, varies with altitude and latitude.
Atmospheric concentrations of HFCs, PFCs, and SF_6	Increased globally over the last 50 years.
2. Weather Indicators	
Global mean surface temperature	Increased by 0.6+/-0.2^{0}C over the 20th century; land areas warmed more than the oceans (*very likely*).
Northern Hemisphere surface temperature	Increase over the 20th century greater than during any other century in the last 1,000 years; 1990s warmest decade of the millennium (*likely*)
Diurnal surface temperature range	Decreased over the years 1950 to 2000 over land: night time minimum temperatures increased at twice the rate of daytime maximum temperatures (*likely*)
Hot days / heat index	Increased (*likely*)
Cold / frost days	Decreased for nearly all land areas during the 20th century (*very likely*)
Continental precipitation	Increased by 5-10% over the over the 20th century in the Northern Hemisphere (*very likely*), although decreased in some regions (e.g., north and west Africa and parts of the Mediterranean).
Heavy precipitation events	Increased at mid-and high northern latitudes (*likely*).
Frequency and severity of drought	Increased summer drying and associated incidence of drought in a few areas (*likely*). In some regions, such as parts of Asia and Africa, the frequency and intensity of droughts have been observed to increase in recent decades.

Likelihood refers to judgmental estimates of confidence used by TAR WG1
*Likely- (66-90% chance)
** Very likely- (90-99% chance)
Source: IPCC (2001)

Table 2 - 20th century changes in the biophysical system 1

Indicator	***Observed Changes***
1. Biological and Physical indicators	
Global mean sea level	Increased at an average annual rate of 1 to 2 mm during the 20th century
Duration of ice cover of rivers and lakes	Decreased by about 2 weeks over the 20th century in mid - and high latitudes of the Northern Hemisphere (*very likely*)
Arctic sea-ice extent and thickness	Thinned by 40% in recent decades in late summer to early autumn (*likely*) and decreased in extent by 10-15% since the 1950s in spring and summer.
Non-polar glaciers	Widespread retreat during the 20th century.
Snow cover	Decreased in area by 10% since global observations became available from satellites in the 1960s (*very likely*)
Permafrost	Thawed, warmed, and degraded in parts of the polar, sub-polar, and mountainous regions.
El Nino events	Became more frequent, persistent, and intense during the last 20 to 30 years compared to the previous 100 years.
Growing season	Lengthened by about 1 to 4 days per decade during the last 40 years in the Northern Hemisphere, especially at higher latitudes.
Plant and animal ranges	Shifted poleward and up in elevation for plants, insects, birds and fish.
Breeding, flowering and migration	Earlier plant flowering, earlier bird arrival, earlier dates of breeding season, and earlier emergence of insects in the Northern Hemisphere.
Coral reef bleaching	Increased frequency, especially during El Nino events.
2. Economic Indicators	
Weather-related economic losses	Global inflation- adjusted losses rose an order of magnitude over the last 40 years. Part of the observed upward trend is linked to socio-economic factors and part is linked to climatic factors.

This table provides examples of key observed changes and is not an exhaustive list. It includes both changes attributable to anthropogenic climate change and those that may be caused by natural variations or anthropogenic Climate Change. Confidence levels are reported where they are explicitly assessed by the relevant Working Group.

Source: IPCC (2001).

The average rate of concentration in the past 2 decades was at the rate of 1.5 ppm (0.4%) per year but large annual fluctuations in the rate of increase of CO_2 concentrations can be observed. For example, in the 1990's, the annual rate of growth of CO_2 in the atmosphere varied between 0.9 ppm (0.2%) – 2.8 ppm (0.8%) with the highest increase coinciding with strong El Nino years.

Methane concentrations which account for 13% of the anthropogenic greenhouse effects, have increased from 770ppb (parts per billion) during the pre industrial era to 1610 ppb in 1983 and to 1745 ppb in 1998. The rate of concentration is estimated at 7.0 ppb/year, 50% of which is attributed to anthropogenic sources such as burning of biomass fuels, breeding of animals, wetland paddy cultivation and landfills.

Similarly, the atmospheric concentration of nitrous oxide (N_2O) is produced by the combustion of biomass and fossil fuels, chemical industries, increasing application of nitrogen fertilizers and eutrophicated water. The concentration of N_2O which was 270 ppb during the period 1000-1750, had increased to 316 ppb in 2000. It is a long lived GHG which increases at the rate of 0.2-0.3% per year in the lower atmosphere. The atmospheric concentrations of halocarbons are entirely anthropogenic and contain chloroflurocarbons (CFCs) and bromine (e.g. halons) that lead to the depletion of ozone layer in the stratosphere but after 1994, the rate of concentration has declined. However, substitutes for CFCs such as hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs) have been increasing. Further, current atmospheric concentrations of sulfer hexafluorides (SF_6) have also increased at the rate of 0.24ppt /yr. Although current concentrations are low, they have long atmospheric residence time. Hence, they have the potential to influence future climate. The radiative forcing (the change in the net vertical irradiance [expressed in Wm^{-2}] at the *tropopause* due to an internal change or a change in the external forcing of the *climate system*, such as, a change in the concentration of CO_2 or the output of the Sun) due to the increase of the well-mixed greenhouse gases for 1750-2000, was estimated to be $2.43Wm^{-2}$.

1.4 Changes during the 20th century due to global warming

Changes observed during the 20th century, as a consequence of global warming are indicated in Tables 1 and 2 including,

a) A rise of global sea level by an average annual rate of 1-2 mm during the 20th century
b) Decrease of snow cover by 10%.
c) Intensification of the hydrological cycle and the increase of precipitation by 0.5 – 1.0 % per decade over most mid and high latitudes in the Northern Hemisphere.
d) Decrease of rain fall by 0.3 % per decade on the average, over much of the subtropical land areas. Over tropical lands, rainfall is likely to increase by 0.3% per decade.
e) Increase in the frequency and severity of drought in recent decades in parts of Asia and Africa.
f) Increase in the frequency and intensity of *El Nino* events during the last 2-3 decades (e.g. the 1997-1998 *El Nino* event had caused considerable damage to human and physical systems).
g) Lengthening of the growing season by about 1-4 days per decade, during the last 4 decades in the Northern Hemisphere.

h) Earlier plant flowering, bird arrival, emergence of insects and earlier dates of the breeding season.
i) Increased frequency of coral reef bleaching, especially during *El Nino* events.

1.5 Projected climate change in the 21st century

All Special Report of Emission Scenarios (SRES) and IS92a project the globally averaged temperature to increase by from 1.4^{o}C to 5.8^{o}C between 1990 and 2100. The projected increase from 1990- 2025 and 1990-2050 is 0.4-1.1^{o}C and 0.8^{o}C to 2.6^{o}C respectively. The projected rate of warming is likely to be without precedent. CO_2 levels are projected to range between 540 ppm to 970 ppm. Uncertainties cause a variation of about –10% to +30% (Fig.6). Hence the total range is expected to vary from 490-1260 ppm. CO_2 emissions from fossil fuels would be the dominant factor in emission increases. The stabilization of atmospheric CO_2 concentration at 450 ppm, 650 ppm or 1000 ppm world require global anthropogenic CO_2 emissions to drop below 1990 levels within (a) a few decades, (b) about a century or (c) about 2 centuries respectively and continue to decrease steadily thereafter. The model calculations of abundances of primary non-CO_2 greenhouse gases by 2100 also vary considerably across the 6 illustrative SRES scenarios.

1.6 Projections for future changes in precipitation and sea level

The global average precipitation is projected to increase in South and East Asia in summer, in northern and mid latitudes in tropical Africa and Antarctica in winter and in the high latitude regions in both summer and winter. Decreases in winter rainfall are projected in Australia, Central America and Southern Africa in winter. It is *likely*, that there will be an increase in the Asian summer monsoon precipitation variability.

The global mean sea level is projected to increase by 0.09m – 0.88m between 1990 and 2100 for the full range of SRES scenarios. The projected figures for 1990-2025 and 1990 and 2050 are 0.03-0.14m and 0.05-0.32m respectively.

1.7 Projections of extreme climate and weather events

Higher maximum temperatures, more hot days and heat waves are *very likely* to occur over most land areas. Higher (increasing) minimum temperatures are *very likely*. The hydrological cycle would be most intense and more intense precipitation events (increase in amplitude and frequency of extreme precipitation events) are *very likely* over many areas while it is likely that there would be increased precipitation variability of the Asian Summer monsoon.

1.8 Potential impacts of climate change on developing countries

If no climate policy interventions are implemented, future climate changes would have adverse impacts on developing countries such as Sri Lanka. As indicated in IPCC publications, both natural and human systems are sensitive to, and sometimes highly vulnerable to climate change. Some of the adverse consequences of climate change in developing countries by 2025, if climate policy interventions are not adopted, are summarized below in Table 3.

Table 3 - Adverse consequences of climate change in developing countries by 2025 – if no action taken

	Potential Impacts in 2025 if no action is taken
Physical and Human Systems	Since there is a close interrelationship between climate change and hydrological cycle, warmer temperatures could lead to the intensification of the hydrological cycle. These changes in turn - would affect water supply, river runoff, ground water recharge and storage. - degrade water quality. - would lead to increases in extreme hydrological events such as floods and droughts. - would increase the water demand from agriculture, - power generation, domestic and industrial uses. - sea level rise could cause increase saline intrusions into coastal aquifers.
Biological Systems	- Changes in species distributions, population sizes, timing of reproduction or migration. - Risks to unique and threatened systems. E.g. loss of biodiversity; increased frequency of coral bleaching and death ; loss of coastal wetlands; changes in terrestrial ecosystems; loss of unique habitats; - shifts in ranges of plant and animal species; - increased frequency of ecosystem disturbance by fire and insect pests.
Agriculture and food security	- Adverse impacts of increased temperature on annual and perennial crops and livestock. eg. increase in temperature (greater than 350C for more than 1 hour) could cause spikelet sterility in rice and reduced formation of tubers and tuber bulking in potatoes. - Increased demand for irrigated water in areas where rainfall is expected to be reduced. - Increased CO_2 concentrations can stimulate crop growth and yield but will not be able to compensate for adverse effects of heat and drought. Further, yield gains are said to be smaller under field conditions. Higher yields further offset by increases in weeds and pests. - Destruction of crops by extreme events, declining incomes of farmers. Increases in food prices and malnutrition. - Declines in agricultural exports, fishing and agro-based industries.
Energy	- Increased energy demand for space cooling. - Reduced energy supply reliability of counties that are dependent on hydro electricity and biomass.
Human settlements	- Direct impacts on impacts on health, buildings and infrastructure. - Indirect impacts on productive capacity. The most vulnerable settlements would be where people are heavily dependent on natural resources or those located along the coast or in areas subject to landslides, droughts and floods.

Health	- Increase in heat related deaths and illnesses due to exposure to urban heat island effect. - Loss of life, injuries and psychological trauma in cyclone, landslide and flood affected areas. - Adverse effects of UV-B radiation on eyes and skin. - Expansion of areas of potential transmission of malaria, dengue and other vector borne diseases. - Increase in numbers affected by water borne and water washed and respiratory diseases. - Increase in malnutrition
Industry	- Agro-based industries and the tourist industry would be affected by electricity fluctuations and water shortages. - Natural hazards would lead to loss of infrastructure and access to shipments.

Adapted from IPCC (2001)

1.9 Convention on Climate Change

Scientists during the 1970s warn governments that increased concentration of greenhouse gases in our atmosphere is enhancing the natural greenhouse gas effect, causing the Earth to become warmer if current pattern of emission of greenhouse gas continues. Fortunately, the world community took this seriously and decided to investigate the problem and appointed the intergovernmental negotiating body to develop an international policy instrument to address the issue of global warming. The international negotiating body developed the United Nations Framework Convention on Climate Change (UNFCCC), which was adopted at the Rio Summit in 1992. It entered into force on 21 March 1994, after receiving the requisite 50 ratifications. Sri Lanka became a party to it in 1994. The Convention now has **186** parties and is approaching universal membership.

The objective of the UNFCC is to stabilize atmospheric green house gas concentration at a level that will prevent dangerous human interferences with the climate system. In developing the UNFCC it was found that there is a vast regional and country differences in the per capita emission of greenhouse gases. When looking at the per capita emission of different countries, the difference is sometimes 50 times higher (Table 4). Per capita CO_2 emissions in metric in 1991 in Brazil 1.6, China 2.7, Czech Republic 10.9, Japan 9.0, Russian Federation 12.2, Swaziland 0.5, India 1.0, Malaysia 5.3, UK 9.3, USA 20.5, Sri Lanka 0.11. The USA emits 25% of total annual global emission, which is equivalent to`36% of the total emission of all industrialized Countries. Therefore the UNFCCC was negotiated with the “Common but differentiated responsibility” principle. This means that those countries that emit more emission should do more than less emitting countries. Since the adoption of the UNFCCC in 1992, parties have continued to negotiate in order to agree on decisions and conclusions that will reduce global greenhouse gas emissions. Adoption of the Kyoto Protocol in 1997 is a landmark event in such negotiations.

Table 4– Per capita emission in South Asian Countries compared to USA

Country	Per capita carbon emissions in	
	1990	**1996**
USA	5.18	5.37
Bangladesh	0.04	0.05
Bhutan	0.02	0.04
India	0.22	0.29
Maldives	0.19	0.31
Nepal	0.01	0.02
Pakistan	0.16	0.18
Sri Lanka	0.06	0.11

1.10 Kyoto Protocol

The Kyoto Protocol to the United Nations Framework Convention on Climate Change strengthens the international response to climate change. Adopted by consensus at the third session of the Conference of the Parties (COP-3) in December 1997 in Kyoto, Japan, it contains legally binding emissions targets for 39 developed countries (Annex 1 countries) for the post-2000 period. By arresting and reversing the upward trend in greenhouse gas emissions that started in these countries 150 years ago (Figure 1), the Kyoto Protocol promises to move the international community one step closer to achieving the Convention's ultimate objective of preventing "dangerous anthropogenic [man-made] interference with the climate system".

Under the Kyoto Protocol, developed countries commit themselves to reducing their collective emissions of six key greenhouse gases by at least 5.2% from their total GHG emission in 1990. This group target will be achieved through emission cuts of 8% by most Central and East European states and the European Union (the EU will meet its target by distributing different rates among its member states); 7% by the US; and 6% by Canada, Hungary, Japan, and Poland. Russia, New Zealand, and Ukraine are to stabilize their emissions, while Norway may increase emissions by up to 1%, Australia by up to 8%, and Iceland 10%. Table 5 gives the emission reduction targets of 39 countries.

Table 5 – Emission reduction targets under the Kyoto Protocol

Country	**Total Emissions (Gg) 1n 1990**	**Emission Reduction % from total (Percentage of base year or period)**
Australia	59,200	+8
Austria	288,965	-8
Belgium	113,405	-8
Bulgaria	82,990	-8
Canada	457,441	-6
Croatia	-	-5
Czech Republic	169,514	-8
Denmark	52,100	-8
Estonia	37,797	-8
European Community	-	-8
Finland	53,900	-8
France	366,536	-8
Germany	1,012,443	-8
Greece	82,100	-8
Hungary	71,673	-6
Iceland	2,172	+10
Ireland	30,719	-8
Italy	428,941	-8
Japan	1,173,360	-8
Latvia	22,976	-8
Liechtenstein	208	-8
Lithuania	-	-8
Luxemburg	11,343	-8
Monaco	71	-8
Netherlands	167,600	-8
New Zealand	25,530	0
Norway	35,533	+1
Poland	414,930	-6
Portugal	42,148	-8
Romania	171,103	-8
Russian Federation	2,388,720	0
Slovakia	58,278	-8
Slovenia	-	-8
Spain	260,654	-8
Sweden	61,256	-8
Switzerland	43,600	-8
Ukraine		0
United Kingdom of Great Britain and	584,078	-8
Northern Ireland		
United States of America	4,957,022	-7

Note: countries with – sign should reduce their emissions while countries with + sign can increase by that percentage.

The six gases, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6) are to be combined in a "basket", with reductions in individual gases translated into "CO_2 equivalents" that are then added up to produce a single figure. Each country's emissions target must be achieved by the period 2008-2012. It will be calculated as an average over the five years. "Demonstrable progress" must be made by 2005. Cuts in the three most important gases – carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) - will be measured against a base year of 1990 (with exceptions for some countries with economies in transition). Cuts in three long-lived industrial gases – hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6) - can be measured against either a 1990 or 1995 baseline. (A major group of industrial gases, chlorofluorocarbons, or CFCs, are dealt with under the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer.) There are no emission reduction commitments for developing countries. Therefore Sri Lanka has no commitment under the Kyoto Protocol.

On 16 February 2005 the Kyoto Protocol entered into force after it receiving the threshold number of ratifications. All member countries of European Union, Japan, Norway, Iceland, South Africa, Brazil, India, Sri Lanka and Russia have ratified the protocol by February 2005. The United State of America has withdrawn from the Kyoto Protocol stating that it does not have scientific base.

1.11 Flexibility mechanism

The Kyoto protocol introduced three flexibility mechanisms for developed countries to implement their emission reduction targets. They are Clean Development mechanism (CDM), Joint Implementation (JI), and Emission Trading (ET).

Clean Development mechanism (CDM) is defined in the Kyoto Protocol (Article 12) as a mechanism for North- South cooperation. The objective of the CDM is to "assist parties included in Annex 1 in achieving compliance with their quantified emission limitations and reduction commitments under Article 3" and to support "sustainable development" in developing countries. The Clean Development Mechanism (CDM) and associated carbon trading between developed and developing countries have received great international attention since it is the only mechanism that both developed and developing countries can participate. Under Article 6 of the Kyoto Protocol, Jointly Implemented projects that limit or reduce emissions or enhance sinks are permitted among developed countries.

Joint Implementation (JI) would allow developed countries and their companies to cooperate on projects that reduce GHG emissions and share the Emission Reduction Units (ERUs). Only developed countries can implement JI projects and developing countries cannot participate.

Article 17 of the Kyoto Protocol allows developed countries (Annex B) to exchange emissions obligations, leading to **Emission Trading (ET**). Emission Trading is "a market-based approach to achieve environmental objectives that allows those reducing Green House Gas (GHG) emissions below what is required to use or trade the excess reductions to offset emissions at another source inside or outside the country. Trading can occur at local, international and intra - company levels" but only developed countries can participate.

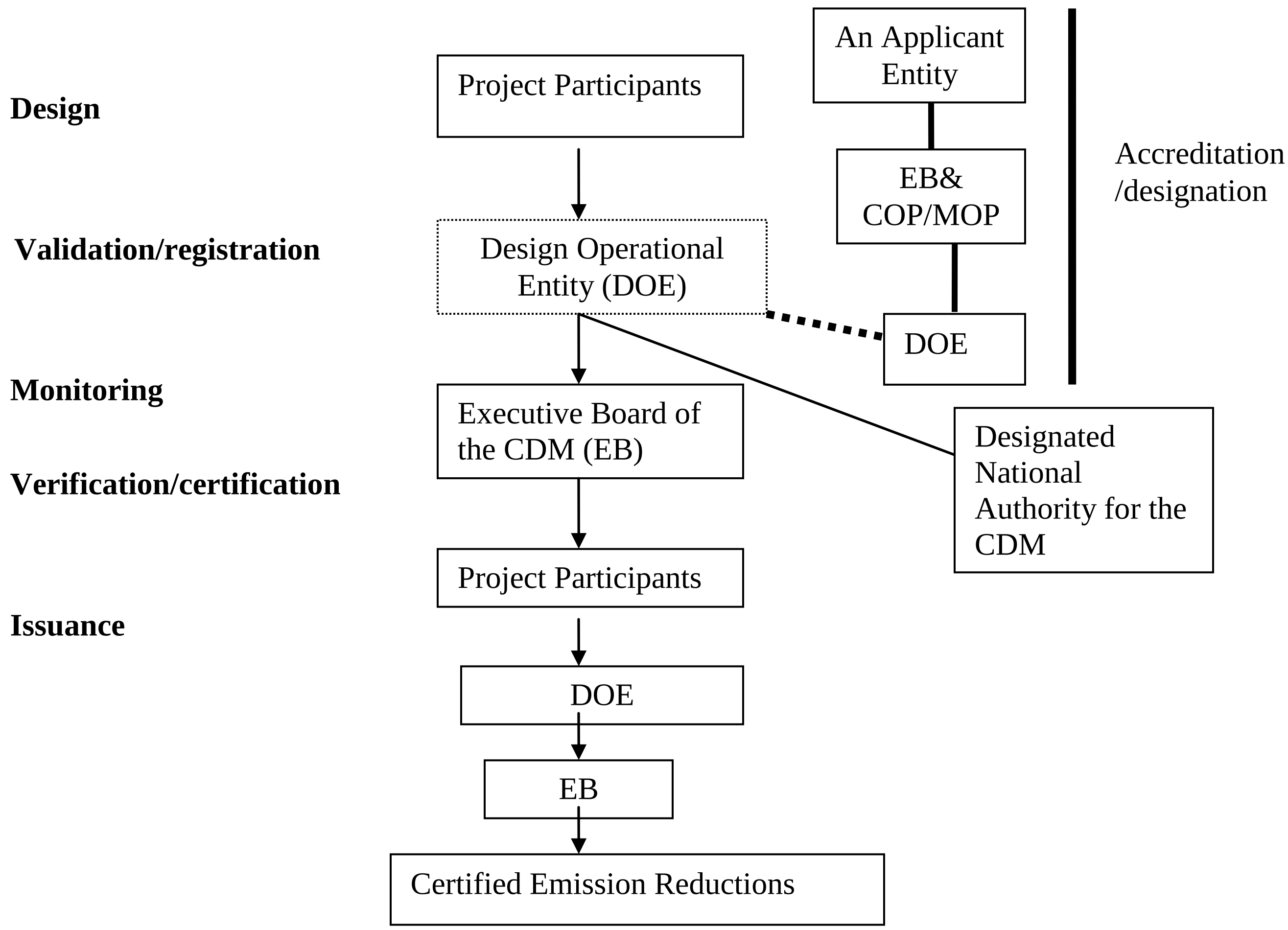
1.12 Modalities, Rules and Guidelines for Clean Development Mechanisms

Since the adoption of Kyoto Protocol at the COP 3 held in Kyoto, Japan it took many years for parties to develop the CDM rules and procedures to the level sufficient to implement. The rules and procedure of the CDM have been now mostly finalized with the adoption of Marrakech Accord, the decision 17/CP.17 by the COP 7 and the decisions of the first COP/MOP meeting, 2/CMP.1, 9/CMP.1, 11/CMP.1, 13/CMP.1, 15/CMP.1, 16/CMP.1, 19/CMP.1, 20/CMP.1, 22/CMP.1 by the COP/MOP1. Yet, there are enormous ambiguities in interpretation and lack of clear guidance. The CDM Executive Board under the COP/MOP is continuously find solutions to most unresolved issues.

At COP 4 held in Buenos Aires, in November 1998, Parties adopted the so-called “Buenos Aires Plan of Action", setting out a program of work both to advance the implementation of the Convention and to flesh out the operational details of the Kyoto Protocol particularly carbon trading and CDM. This program of work was concluded at COP 5 held in Bonn in October/November 1999. At COP 6 held in The Hague, November 2000, Parties were unable to reach agreement on a package of decisions on all issues under the Buenos Aires Plan of Action at that session mainly due to the USA withdrawing from the Kyoto Protocol. Nevertheless, they decided to meet again in a resumed session of COP 6 to try once more to resolve their differences. At COP 6 part II (Bonn, July 2001), Parties finally succeeded in adopting the Bonn Agreement on the Implementation of the Buenos Aires Plan of Action, registering political agreement on key issues under the Buenos Aires Plan of Action which resolved most of the issues on carbon trading and CDM. At the COP 7 held in Marrakech in November 2001 adopted the Marrakech Accord Declaration which further clarified issues related to CDM and Kyoto Protocol as a whole. The first session of the COP/MOP1 held from 28 November to 10 December 2005 by adopting decisions 2/CMP.1, 9/CMP.1, 11/CMP.1, 13/CMP.1, 15/CMP.1, 16/CMP.1, 19/CMP.1, 20/CMP.1, and 22/CMP.1 has given further guidance to implement the CDM activities.

The Marrakech Accord agreed the CDM Project Cycle for the implementation purpose (Figure 2). The figure 3 presents the CDM project development cycle for Sri Lanka.

Figure 2 - CDM Project Activity Cycle



1.13 Project Design

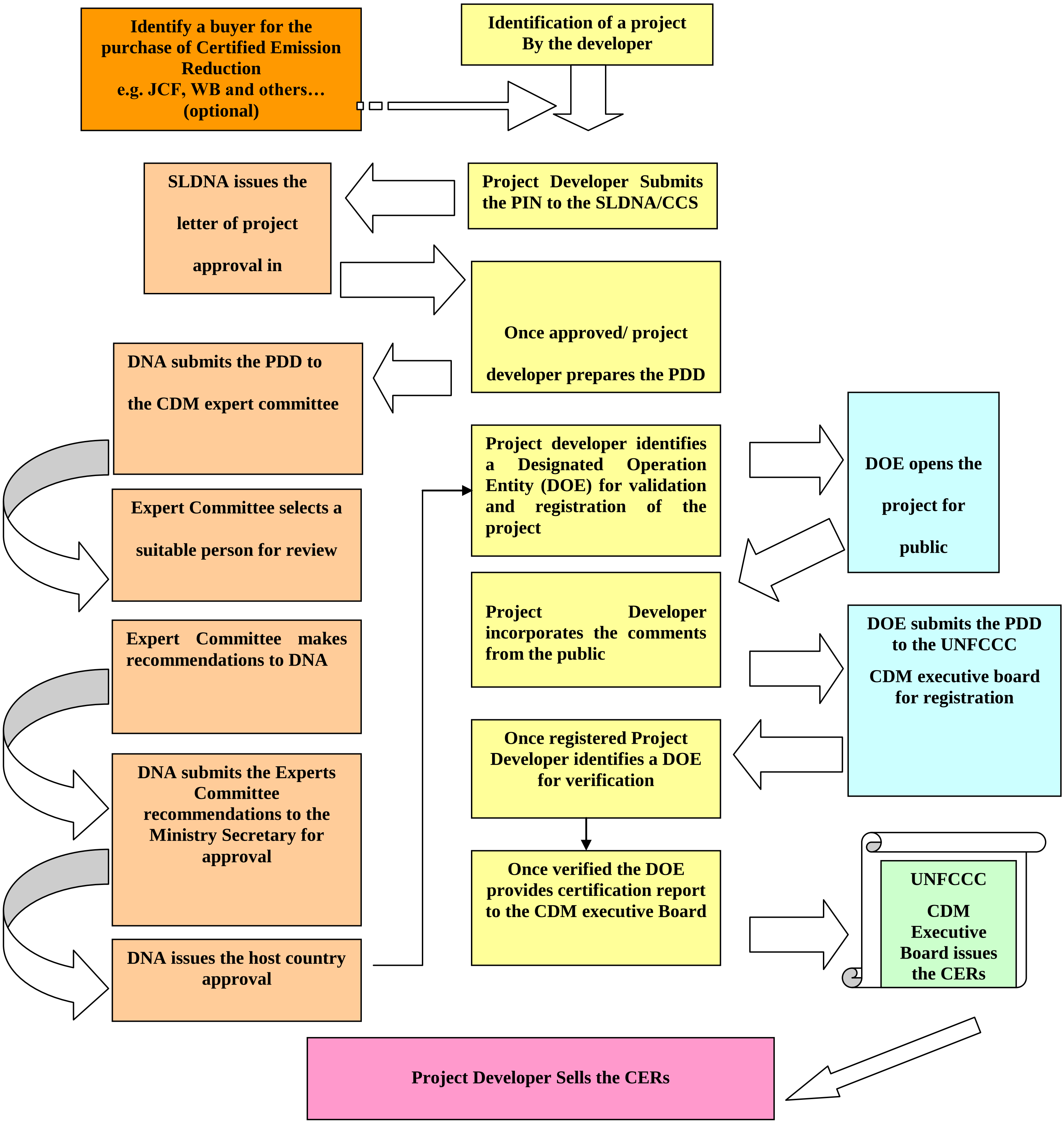
1.13.1 CDM eligibility requirements for Sri Lanka

A developing county is eligible for participation of CDM if following requirements are met:

- Voluntary participation
- The establishment of Designated National Authority
- Ratification of the Kyoto Protocol and become a Party to the Protocol

Since all these requirements have been met Sri Lanka is eligible for participation of CDM project activities.

Figure 3 CDM Project Development Process in Sri Lanka



1.13.2 Project Identification

A project that should result in emission reductions or emission avoidance that would not have happened otherwise can be eligible as CDM projects. The project that has been identified as a CDM project should generate real, measurable and long-term climate change benefits and should contribute to the sustainable development of the host country. Parties involved should approve the project and credits potentially earned from 2000 onward (through 2008-2012).

1.13.3 Project Idea Note (PIN)

The first step of project design is the preparation of a Project Idea Note (PIN) or Project Concept Note (PCN). This is the preliminary step to the Project Design Document (PDD). Though this is not a statutory requirement most project developers prepare a concise project idea note with two objectives. One is to make sure the project concept is eligible for a CDM project. The other objective is to find a buyer for CERs before further investing on the project development. The PIN can be used to market the project. Different CERs buyers use different format for PIN preparation. The format for PINs can be obtained form the DNA and other CERs buyers such as the World Bank and Japan Bank for International Cooperation (JBIC).

1.13.4 Project Design Document (PDD)

In order to get a CDM project approved and registered by the Executive Board (EB), the project participants must prepare a Project Design Document (PDD). This is a mandatory requirement under the UNFCCC CDM guidelines. The PDD should be prepared using the outline and format approved by the CDM Executive Board. This format is being continuously improved and changed so that developers should make sure to use most recent version of PDD format shown on the CDM website of UNFCCC Secretariat (http://cdm.unfccc.int/Reference/Documents)

The table 6 presents the contents of the PDD for the small scale CDM projects according to the recent version of the PDD guideline. For large scale CDM PDD there are two additional annexes. The CDM Executive Board provides guidelines for completing the PDD. Separate guidelines have been developed for completing small scale PDDs, large scale PDDs and Afforestation and reforestation sector PDDs. While project developers themselves can prepare PDDs using these guidelines, it is advisable to obtain the services of an experience person in preparing PDDs.

Table 6 -Contents of Project Design Document (CDM-SSC-PDD)

	Sections
A.	**General description of the small-scale project activity**
B.	**Application of a baseline methodology**
C.	**Duration of the project activity/Crediting period**
D.	**Application of a monitoring methodology and plan**
E.	**Estimation of GHG emissions by sources**
F.	**Environmental impacts**
G.	**Stakeholders' comments**
Annex 1:	**Contact information on participants in the project activity**
Annex 2:	**Information regarding public funding**

The UNEP has identified several key pitfalls of PDDs that delay the process as follows:

- Lack of logic and consistency in PDD
- Deviations from selected calculations methodology not justified sufficiently or incorrect formulas applied
- Compliance with local legal requirements not covered sufficiently
- Insufficient information on the stakeholder consultation process
- Project participants not identified clearly
- The modalities of communication with Executive Board in terms CERs issuance and allocation instructions not stated clearly, or not signed by all project participants.
- Insufficient description on the technology
- Insufficient explanation of baseline scenario
- Insufficient explanation of project additionality
- Baseline information not sufficiently supported by evidence and/or not referenced sufficiently
- Major risks to the baseline not identified//described
- The project boundaries not identified clearly
- Project and/or crediting start date unclear
- Deviations from monitoring methodology not justified sufficiently
- Monitoring and project management procedures not defined

Project developers must make sure these pitfalls are addressed when developing PDDs.

1.14 Additionally

Additionally: Article 12 of the Kyoto Protocol states that projects must result in "reduction in emissions that are additional to any that would occur in the absence of project activity". The CDM project must lead to real, measurable, and long-term benefits related to the mitigation of climate change. Additional emissions reductions are calculated against the defined baseline. In order to qualify for a CDM project, the project proponent should prove that the project is additional to business as usual scenario. In other word, the project proponent must prove that in the absence of CDM, the project would not have occurred. A CDM project activity is additional if anthropogenic emissions of greenhouse gases by sources are reduced below those that would have occurred in the absence of the registered CDM project activity.

At its 15th meeting, the CDM Executive Board adopted "Tool for Demonstration of Additionally" (Annex 3 to the report). This document was amended at the Executive Board's 16th meeting and further amended at its 17th meeting. Decision 12/CP.10, Guidance relating to the clean development mechanism points out, in paragraph 9, as indicated by the Executive Board in paragraph 3 of the "Tool for Demonstration and assessment of Additionally" (Annex 1 of the Report of the Executive Board on its 16th meeting), the said tool is not mandatory for project participant. However, it is advisable to follow the latest "Tool for Demonstration and assessment of Additionally" version 2 dated 28 November 2005. In the case of small scale CDM projects, Attachment A to Appendix B to the simplified modalities and procedures for small scale CDM project activities should be followed. These documents may be revised frequently. Therefore most recent version should be downloaded from the CDM website, www.unfccc.int/cdm.

The latest version of the "Tools for the demonstration and assessment of additionally", version 2 dated 28 November 2005 recommends following steps to demonstrate project additionally:

Step 0 – Preliminary screening based on the starting date of the project activity
If project participants wish to have crediting period starting prior to the registration of the project activity, the step 0 is relevant.

Step 1 – Identification of alternatives to the project activity consistence with current laws and regulations
Sub-step 1a - Define alternatives to the project activity:
Project developer should define credible alternatives to proposed project including in situation when a project activity is not undertaken. If there is no alternative, the project is not additional.
Sub step 1b – Enforcement of applicable laws and regulations:
The alternatives identified should comply with all applicable legal and regulatory requirements. Otherwise the proposed project activity is not additional.

Step 2 - Investment analysis

This is to prove that the proposed project activity is economically or financially less attractive than other alternatives. If at least one alternative identified is economically or financially less attractive than the proposed project, the project is not additional.

Sub-step 2a - Determine appropriate analysis method

Simple cost analysis, investment comparison analysis, or benchmark analysis can be used.

Sub-step 2b – Option 1 - Apply simple cost analysis

If the project produces no economic benefits other than CDM related income, simple cost analysis can be used. Otherwise other investment analysis methods should be used.

Sub-step 2b – Option II - Apply investment comparison analysis

Use appropriate financial indicators, such as Internal Rate of Return (IRR), Net Present Value (NPV), cost-benefits ratio or unit cost of service, etc.

Sub-step 2b – Option III – Benchmark analysis

Financial indicators may be used to represent the standard returns in the market.

Sub-step 2c - Calculation and comparison of financial indicators (only applicable to option II)

Compare other alternatives using the selected financial indicators.

Sub-step 2d - Sensitivity analysis (only applicable to option II and III)

Sensitivity analysis is undertaken to show whether the conclusion regarding the financial attractiveness is robust to reasonable variations so that the financial argument is in favor of additionality.

Step 3 – Barrier analysis

This step demonstrates that the project faces some barriers and these barriers do not prevent other alternatives.

Sub-step 3a - Identify barriers that would prevent the implementation of type of the proposed project activity:

This includes investment barriers, technology barriers, etc. that prevent the proposed project.

Sub–step 3b – Demonstration that the identified barriers would not prevent the implementation of alternatives

Above barriers to the project should not prevent at least one alternative identified.

Step 4 – Common practice analysis

This is a credibility check to complement investment analysis through investigating whether similar project are common in the country or in the region.

Sub-step 4a – Analyze other activities similar to the proposed project activity

This should provide an analysis of any other activities implemented previously or currently that are similar to the proposed project activity.

Sub-step 4b – Discuss any similar options that are occurring

If similar activities are common in the area how the proposed project faces barriers.

Step 5 – Impacts of CDM registration

This step demonstrates how by registering this project as a CDM project can remove the barriers proposed above.

1.15 Sustainable development criteria

The Kyoto Protocol specifies that the purpose of the CDM is to assist developing countries in achieving sustainable development. The Protocol does not provide a guideline to define sustainable development. It is up to the developing countries to determine their own criteria and assessment process for sustainable development. In general many countries use three main criteria for defining sustainable development: Social criteria, Economic criteria and Environmental criteria. The criteria approved by the government of Sri Lanka can be obtained from the Ministry of Environment and Natural Resources which is the DNA.

1.16 Baseline scenario

The baseline for a CDM project activity is the scenario that reasonably represents the anthropogenic emissions by sources of greenhouse gases that would occur in the absence of the proposed project activity. A baseline shall cover emissions from all gases, sectors and source categories listed in Annex A within the project boundary. A baseline shall be deemed to reasonably represent the anthropogenic emissions by sources that would occur in the absence of the proposed project activity if it is derived using a baseline methodology referred to in paragraphs 37 and 38 of the CDM modalities and procedures (17/CP.7). Simplified baseline scenarios for a small-scale CDM project activity has been specified in Appendix B to the simplified modalities and procedures for small scale CDM project activities.

A baseline shall be established: (a) By project participants in accordance with provisions for the use of approved and new methodologies, contained in decision 17/CP.7; (b) In a transparent and conservative manner regarding the choice of approaches, assumptions, methodologies, parameters, data sources, key factors and additionally, and taking into account uncertainty; (c) On a project-specific basis; (d) In the case of small-scale CDM project activities which meet the criteria specified in decision 17/CP.7 and relevant decisions by the COP/MOP, in accordance with simplified procedures developed for such activities; and (e) Taking into account relevant national and/or sectoral policies and circumstances, such as sectoral reform initiatives, local fuel availability, power sector expansion plans, and the economic situation in the project sector.

1.17 Baseline approach

The baseline may include a scenario where future anthropogenic emissions by sources are projected to rise above current levels, due to the specific circumstances of the host Party. The baseline approach shall be defined in a way that CERs cannot be earned for decreases in activity levels outside the project activity or due to force majeure. A baseline approach is the basis for a baseline methodology. In choosing a baseline methodology for a project activity, project participants shall select from the following approaches as identified in sub-paragraph 48 (a) to (c) of the modalities and procedures of CDM, the one deemed most appropriate for the project activity, taking into account any guidance by the executive board, and justify the appropriateness of their choice: (a) Existing actual or historical emissions, as applicable; or (b) Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment; or (c) The average emissions of similar project activities undertaken in the previous five years, in similar social, economic, environmental and technological circumstances, and whose performance is among the top 20 per cent of their category.

1.18 Baseline methodology

A methodology is an application of an approach as defined in paragraph 48 of the CDM modalities and procedures, to an individual project activity. In developing a new methodology, the first step is to identify the most appropriate approach for the project activity and then applicable methodology.

Project baselines are described as the amount of Green House Gas (GHG) emissions (or sequestration) in a given time and a place, in absence of CDM/ JI project, against which the emission reduction (or GHG sink) benefits achieved by the project would be measured.

The major practical challenge associated with baseline determination is the hypothetical nature of the baseline and some unavoidable uncertainties associated with it. Any emission reduction (due to a CDM project) should be "additional" to those that would occur in the entire economy, in the absence of the project (i.e. "Emissions Additionality" or "Environmental Additionality"). A primary challenge under the environmental additionality requirement is to consider the indirect emission effects of a specific CDM/JI investment of project, such as leakage. Therefore CDM/JI projects needs to identify suitable system boundaries within which all direct GHG emissions both in the CDM project and baseline case should be measured and direct leakage should be avoided.

1.19 Baseline for small-scale CDM project activities

A small-scale CDM project can use the approved baseline methodology by the Executive Board and included in an indicative list of simplified baseline and monitoring methodologies for selected small-scale CDM project activity categories. The list of approved methodologies is contained in the Appendix B to the simplified modalities and procedures for small-scale CDM project activities (Table 7). This can be found at the website (http:/cdm.unfccc.int/methodologies/SSCmethodologies/approved).

Table 7 - Approved small scale methodologies

Reference	Methodologies Title (including baseline and monitoring methodologies)	Sectoral Scope
AMS-I.A.	**Electricity generation by the user**	**1**
AMS-I.B.	**Mechanical energy for the user**	**1**
AMS-I.C.	**Thermal energy for the user**	**1**
AMS-I.D.	**Grid connected renewable electricity generation**	**1**
AMS-II.A.	**Supply side energy efficiency improvements – transmission and distribution**	**2**
AMS-II.B.	**Supply side energy efficiency improvements – generation**	**1**
AMS-II.C.	**Demand-side energy efficiency programs for specific technologies**	**3**
AMS-II.D.	**Energy efficiency and fuel switching measures for industrial facilities**	**4**
AMS-II.E.	**Energy efficiency and fuel switching measures for buildings**	**3**
AMS-II.F.	**Energy efficiency and fuel switching measures for agricultural facilities and activities**	**3**
AMS-III.A.	**Agriculture**	
AMS-III.B.	**Switching fossil fuels**	**1**
AMS-III.C.	**Emission reductions by low-greenhouse gas emitting vehicles**	**7**
AMS-III.D.	**Methane recovery in agricultural and agro industrial activities**	**10 , 13**
AMS-III.E.	**Avoidance of methane production from biomass decay through controlled combustion**	**13 , 15**
AMS-III.F.	**Avoidance of methane production from biomass decay through composting**	**13**
AMS-III.G.	**Landfill methane recovery**	**13**
AMS-III.H.	**Methane recovery in wastewater treatment**	**13 , 15**
AMS-III.I.	**Avoidance of methane production in wastewater treatment through replacement of anaerobic lagoons by aerobic systems**	**13 , 15**

1.20 Crediting period

The crediting period is the period for which the credits for emission reductions are expected.

Project participants shall select a crediting period for a proposed project activity from one of the following alternative approaches: (a) A maximum of seven years which may be renewed at most two times, provided that, for each renewal, a designated operational entity determines and informs the Executive Board that the original project baseline is still valid or has been updated taking account of new data where applicable; or (b) A maximum of ten years with no option of renewal.

1.21 Leakage

Reductions in anthropogenic emissions by sources shall be adjusted for leakage in accordance with the monitoring and verification. Leakage is defined as the net change of anthropogenic emissions by sources of greenhouse gases which occurs outside the project boundary, and which is measurable and attributable to the CDM project activity. For example, if a project displaces a group of people who started to cut forest elsewhere, this increases GHG emissions. Though this forest clearance is not a part of the project activity, it is an indirect outcome of the project. Therefore these type of indirect impacts should be estimated as leakages. Leakage should be added to the project emissions.

1.22 Validation

Validation is the process of independent evaluation of a project activity by a designated operational entity (OE) against the requirement of the CDM as set out in decision 17/CP.7, the CDM modalities and procedures and relevant decisions of the COP/MOP, on the basis of the project design document. Independent Operational Entity (OE) validates the PDD and will issue a letter to the CDM executive board certifying that t the project meet the requirement of CDM.

Written confirmation from each national authority should be obtained before validating a project. The operational entity will make the project documents publicly available for public comments for a period of 30 days. After 30-day posting for public comments OE makes a decision on validation, and submits a report to the Executive Board, requesting validation and registration of the project.

1.23 Registration

Registration is the formal acceptance by the Executive Board of a validated project activity as a CDM project activity. Validation is a prerequisite for the registration. Registration by the Executive Board will be completed in 8 weeks after receiving the validation report and registration request from OE. If there is an objection or clarification raised by a member this can delay. Registration is the prerequisite for the verification, certification and issuance of CERs related to that project activity. A registration fee should be paid at the time of registration as a share of proceeds to cover administrative expenses (SOP- Admin) of clean development mechanism. This is equivalent to USD 0.10 per certified emission reduction issued for the first 15,000 tones of CO_2 equivalent in a given calendar year. USD 0.20 per certified emission reduction issued for any amount in excess of 15,000 tones of CO_2 equivalent in a given calendar year. However, the maximum registration fee payable based on this calculation shall be USD 350,000. No registration fee has to be paid for CDM project activities with expected average annual emission reduction over the crediting period below 15,000 t CO_2 equivalent.

1.24 Verification

Verification is periodic independent review by OE of monitored reductions in emissions. After the emission reduction has taken place, the OE inspects and verifies how much emissions have been actually reduced. Operational entity should provide verification report to project participants, Parties involved, and Executive Board.

1.25 Certification

Having verified the emission reductions, Operational Entity provides certification report to Executive Board, requesting issuance of Certified Emission Reduction (CERs). Within 30 days, Executive Board informs project participants of its decision regarding issuance of CERs. Based on certification report of the OE, the Executive Board issues the CERs.

1.26 Monitoring and Verification Plan

CDM project proponent must develop a plan to measure emissions within the project boundary and a plan to measure emissions outside the project boundary that are significant and reasonably attributable to the project activity. These monitoring plans must be approved by CDM Executive Board. The OE uses the information in the monitoring pan for verification of emission reductions.

1.27 Designated operational entity

The Designated Operation Entity (DOE) is an independent agency accredited by the Executive Board for independent validation, verification and certification of CDM projects. The DOE are accredited to validate or verify CDM projects in 15 sectoral scopes. A DOE can be accredited for one or several scopes or specific to a particular region depending on its technical capability. The table 8 presents the list of DOEs accredited and their sectoral scopes.

The designated operational entity selected by project participants to validate a project activity, being under a contractual arrangement with them, shall review the project design document and any supporting documentation to confirm that the following requirements have been met: The baseline and monitoring methodologies comply with requirements pertaining to: (i) Methodologies previously approved by the executive board; or (ii) Modalities and procedures for establishing a new methodology. If the designated operational entity determines that the project activity intends to use a new baseline or monitoring methodology, it shall, prior to a submission for registration of this project activity, forward the proposed methodology together with the draft project design document, including a description of the project and identification of the project participants to the Executive Board for review. The Executive Board shall expeditiously, if possible at its next meeting but not later than four months, review the proposed new methodology in accordance with the modalities and procedures of the present annex. Once approved by the Executive Board it shall make the approved methodology publicly available along with any relevant guidance and the Designated Operational Entity may proceed with the validation of the project activity and submit the project design document for registration. In the event that the COP/MOP requests the revision of an approved methodology, no CDM project activity may use this methodology. The project participants shall revise the methodology, as appropriate, taking into consideration any guidance received.

Table 8 – List of Designated Operation Entity and their Sectoral Scope

Ref. Number	Entity Name (short name)	Sectoral scopes for validation	Sectoral scopes for verification and certification
E-0001	Japan Quality Assurance Organization (JQA)	1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 13	
E-0002	JACO CDM.,LTD (JACO)	1, 2, 3	
E-0003	Det Norske Veritas Certification Ltd. (DNVcert)	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15
E-0005	TUV Industrie Service GmbH TUV SUD GRUPPE (TUV Industrie Service GmbH TUV)	1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 13, 14, 15	1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 13, 15
E-0006	Tohmatsu Evaluation and Certification Organization Co., Ltd. (TECO)	1, 2, 3	
E-0007	Japan Consulting Institute (JCI)	1, 2, 13	
E-0009	Bureau Veritas Quality International Holding S.A. (BVQI Holding S.A.)	1, 2, 3	1, 2, 3
E-0010	SGS United Kingdom Ltd. (SGS)	1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 13, 15	1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 13, 15
E-0011	The Korea Energy Management Corporation (KEMCO)	1	
E-0013	TÜV Industrie Service GmbH, TÜV Rheinland Group (TÜV Rheinland)	1, 2, 3, 13	
E-0014	KPMG Sustainability B.V. (KPMG)	1, 2, 3	
E-0018	British Standards Institution (BSI)	1, 2, 3	
E-0021	Spanish Association for Standardisation and Certification (AENOR)	1, 2, 3	1, 2, 3
E-0022	TÜV NORD CERT GmbH (RWTUV)	1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 13	1, 2, 3

E-0025	**Korean Foundation for Quality (KFQ)**	**1, 2, 3**
E-0029	**PricewaterhouseCoopers - South Africa (PwC)**	**1, 2, 3**

1.28 CDM in forestry sector

Forest sector accounts for 20% of the global CO_2 emissions at 1.6 GtC annually. Therefore Land Use Land Use Changes and Forestry (LULUCF) sector has potential to mitigate 2 GtC per year. However, only afforestation and reforestation projects are eligible for CDM according to Bonn Agreement. Marrakesh Accord sets limits on CERs from Afforestation and Reforestation activities at 1% of the base year emission of the Party times five. So far only 4% of total CERs are coming from LULUCF sector. Most of the LULUCF projects are outside the Kyoto mechanism.

1.28.1 Afforestation

Direct human induce conversion of land that has not been forested for a period of at least 50 years to forested land through planting, seeding and/or the human induced promotion of natural seed sources.

1.28.2 Reforestation

Direct human induced conversion of non-forested land to forested land through planting, seeding or human induced promotion of natural seed sources on land that was forested but that has been converted to non-forested land prior to 31st December 1989. For the first commitment period (2008 –2012), reforestation activities will be limited to reforestation occurring on those lands that did not contain forest on 31st December 1989.

1.28.3 Non-permanence

Forestry CDM project should address the issue of non-permanence. This means that forest absorbs carbon temporarily. Once forest is destroyed the carbon will be released to the atmosphere. In order to address the non-permanence issue, system of temporary Certified Emission Reductions tCERs and long-term Certified Emission Reductions (lCERs) have been introduced.

1.28.4 Eligible forest CDM Projects under Bonn Agreement

- Establishment of woodlots on communal lands.
- Reforestation of marginal areas with native species eg: riverine areas, steep slopes, around and between existing forest fragments (Through planting and natural regeneration).
- New large-scale, industrial plantations.

- Establishment of biomass plantations for energy production and the substitution of fossil fuels.
- Small-scale plantations by landowners
- Introduction of trees in to existing agricultural systems (agroforestry).
- Rehabilitation of degraded areas through tree planting or assisted natural regeneration.

1.28.5 Major decisions in the Marrakech Accords related to CDM

- Fungibility, allowing emissions units under all three mechanisms to be treated equally. This allows for a more liquid market in emissions units, making it more viable and enhancing opportunities for cost-effectiveness.

- Creation of a new removal unit (RMU) to represent sinks credits (including through JI). RMUs can be used only to meet a party's emissions target in the commitment period in which they are generated. They cannot be banked for future commitment period.

- Banking on any remaining emissions allowances beyond those needed to meet a party's target is permitted. Banking of credits generated under CDM or JI is limited to 2.5% of a party's initial assigned amount.

- Unilateral CDM is allowed, enabling developing countries to undertake CDM Projects without an Annex I partner and market the resulting emissions credits in the world market.

- Annex I parties that cannot meet the Protocol's inventory requirements can still host JI projects through a project design and approval process similar to the CDM.

- The CDM Executive Board is authorized to approve methodologies for baselines, monitoring plans and project boundaries; accredit operational entities; and develop and maintain the CDM registry. The COP/MOP will oversee rules of procedure for the executive board; accreditation standards for, and designation of, operational entities; and a review of regional/sub-regional distribution of CDM project activities.

CHAPTER 2 - REVIEW THE INTERNATIONAL CARBON MARKET AND PROGRESS OF VARIOUS FLEXIBLE MECHANISMS UNDER KYOTO PROTOCOL TO IDENTIFY SPECIFIC NICHES FOR SRI LANKA

The Kyoto Protocol has been designed to reduce combined GHG emissions by 5.2 % below 1990 levels in the commitment period 2008-2012. This has created the demand for total GHG reductions up to 5.0 to 5.5 billion CO_2e. Thirty eight developed countries and countries in economies in transition have agreed to make these reductions.

The regulatory framework of the carbon market has established considerably with the entry into force of the Kyoto Protocol on February 16, 2005. With the registration of more than 300 Clean Development Mechanism (CDM) projects by the CDM Executive Board, the approval of climate mitigation plans in Japan and Canada, and the allocation plans under the European Union Emission Trading Scheme (EU ETS) for the 2008-2012 period, the very existence of policies constraining GHG emissions up to 2012 is no longer in doubt. The CDM market is now certain. However, there is still uncertainty regarding the size of the market which is decided by the marginal abatement cost (MAC) of emission reduction.

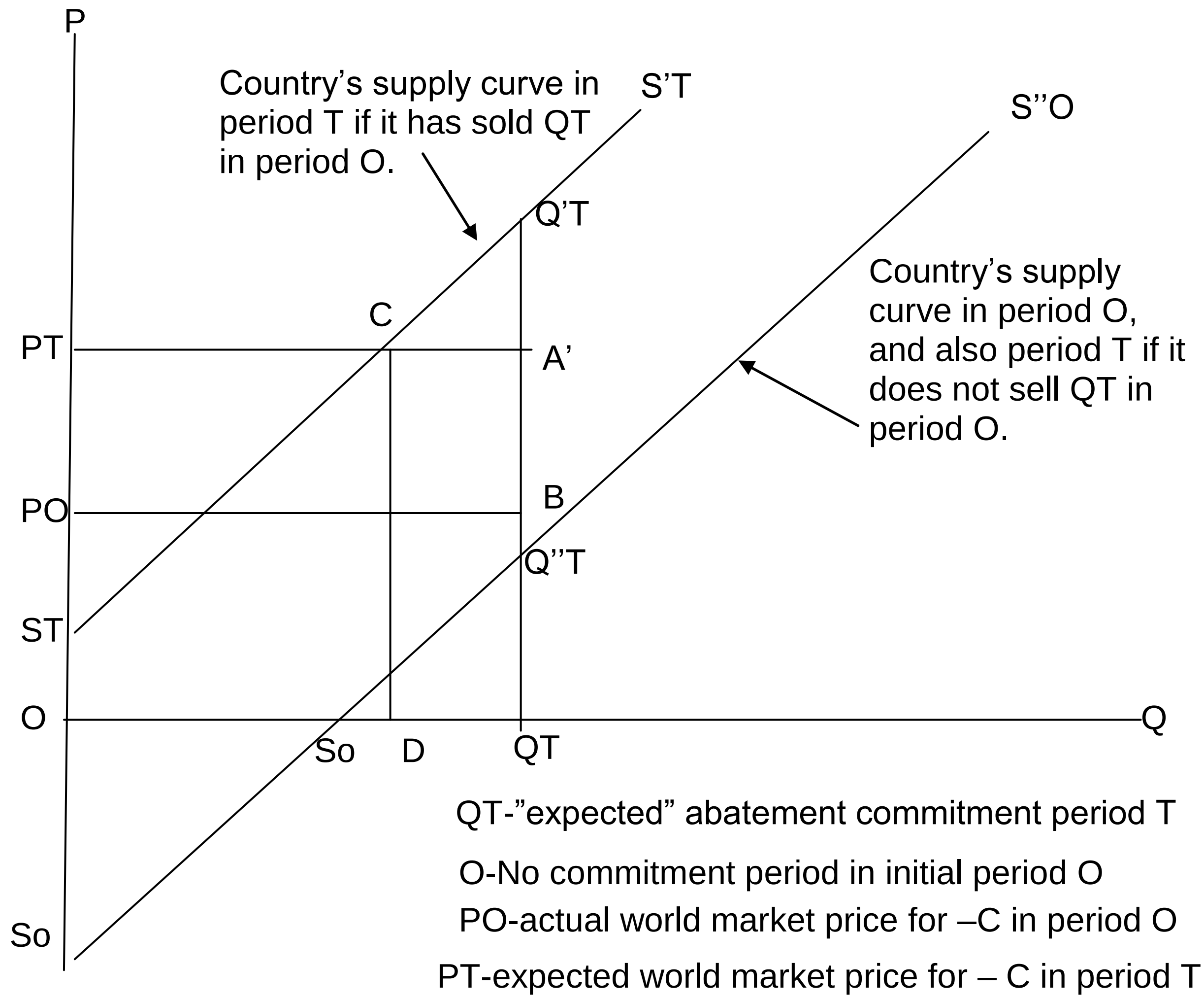
2.1 Economic Theories of flexibility mechanisms

Emission trading is possible because the marginal Green House Gas abatement cost (MAC) varies from one country to another and one region to another this means that emission trading cannot be implemented if MAC of all polluting firms were equal. If a country A is required to abate emission by law, it can either abate emission itself or purchase emission abatement from country B whose MAC is lower than firm A. This provides the least cost option to produce emission abatement for the world as a whole.

When a product (e.g. electricity) is supplied at least cost by a given technical option (e.g. coal based power generation) which emit GHGs, then the replacement of this option to supply the same quality of electricity by another option (e.g. natural gas based power generation) that emit less GHG will involve extra cost. Since both technical options produce same quantity of electricity, the difference between the quantity of GHG emitted by the coal based option and the quantity emitted by the gas based option (abatement option) is the quantity of abatement produced. The difference in the MACs of two options is the marginal abatement cost of GHG abatement, and it is expressed in terms of Rupees per tone of emission abated.

There are instances where GHG abatement can be undertaken at negative cost, for example incandescent bulbs due to technological efficiency. This improved systematic efficiency of two commodities can be used to produce GHG abatement. This would result in GHG abatement at negative cost, because the abatement option can be profitable to undertake without considering the GHG abatement released. In the figure 4, the supply curve SO – S'O illustrates the negative cost abatement options.

Figure 3 - Abatement cost emission reduction in different time period



It is also possible to undertake GHG abatement taking the advantage of regional cost differences. For example GHG abatement may be undertaken in Sri Lanka at cheaper rate than in United States even using same technology.

2.1.1 Marginal abatement costs (MAC)

If we take the world situation, there are negative GHG cost abatement options and positive GHG cost abatement options. The demand and supply of GHG under negative and positive cost options are different. When the GHG abatement requirement increases, the negative cost options can be expected to exhaust first, then other positive cost option in order of increasing marginal abatement cost. Then the marginal abatement cost curve shift to the left (Figure 1). Similarly low cost region draws higher GHG abatement activities than high cost regions. In all these situations MAC plays a significant role. Figure 1 illustrates that if abatement is not done today and keep those options for future abatement the MAC curve will shift to right. This may increase the over all cost in the future. Table 9 presents some abatement cost estimates of selected power sector CDM projects.

Table 9 - Marginal abatement costs estimates of selected power projects

Country/Region	**Candidate CDM Projects**	**Increase in abatement cost (10^6US$)**	**Marginal abatement cost (US$/tonne)**	Emission reduction		
				CO_2 (10^6 tons)	**SO_2 (10^3 tons)**	**NO_X (10^3 tons)**
Indonesia	Geothermal Solar PV	27.0 106.0	21.1 60.0	15.7 20.6	-5.1 -18.0	0.1 0.03
NERB-India	BIGCC Solar PV	1,884.6 -254	346.3 1336.1	55.5 13.5	26.4 -21.8	47.9 25.4
Sri Lanka	IGCC PFBC CC-LNG Wind Dendro	63.0 39.9 149.9 78.8 88.5	303.0 422.0 112.0 133.0 176.0	2.0 0.8 15.3 5.9 6.2	48.7 42.8 68.4 12.0 11.9	164.2 167.5 145.0 180.9 181.1
Thailand	IGCC PFBC BIGCC Mini- hydro	35.0 77.0 137.0 -23.0	44.8 368.1 11.0 8.0	10.0 4.0 101.0 12.0	224.0 140.0 868.0 172.0	73.0 53.0 159.0 17.0
Vietnam	PFBC Hydro Geothermal	288.8 23.2 33.5	18.0 339.0 268.8	12.2 10.3 1.3	6.0 9.0 0.0	36.0 35.0 5.0
Vietnam	IGCC CFBC Wind Geothermal	78.5 52.3 87.7 61.7	59.0 57.2 41.4 18.0	9.2 6.1 10.4 19.6	184.7 183.1 75.3 140.0	42.0 30.7 22.9 42.4
	Solar PV	94.8	43.6	10.2	73.1	22.7

Source: ARRPEC 2002

2.1.2 CDM transaction costs

CDM projects incur relatively large fixed transaction costs prior to registration. This means that projects must be relatively large to be economically viable. Analytical studies suggest a minimum project size of 50,000 tCO_2eq per year. It has been suggested that the *minimum* size should be about 100, 000 tCO_2e per year. The *average* size of existing and identified projects is over 150,000 tCO_2e per year. The minimum size of an economically viable project may decline over time as more approved baseline and monitoring methodologies become available. Those methodologies will reduce the fixed component for the transaction costs. However, the minimum size is likely to remain above 50, 000 tCO_2e per year for regular CDM projects.

The simplified methodologies adopted by the Executive Board for small-scale CDM projects may reduce the transaction costs for those projects enough to make such projects economically viable. Small-scale CDM projects are likely to have annual emission reductions of less than 50, 000 tCO_2e. At present there is no information on the potential number of small-scale projects nor on the aggregate emission reductions might those projects achieve.

The market rates of the fees charged by the CDM facilitators are as follows:

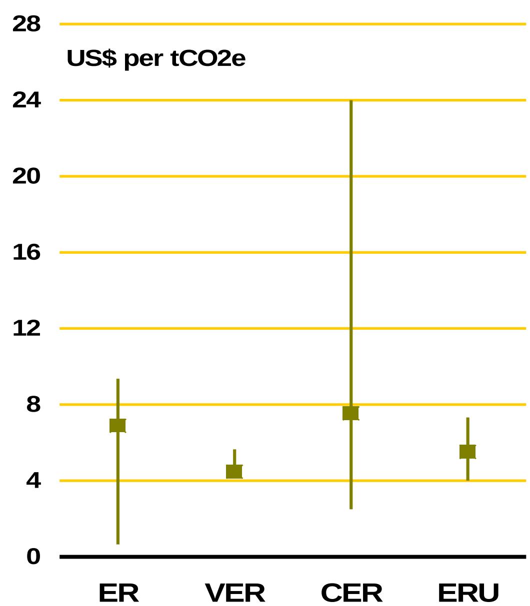
Baseline Study	- US $ 18,000 – 23,000
Monitoring plan	- US $ 7,000 – 15,000
Validation	- US $ 15,000 – 30,000
Legal and contractual agreement	- US $ 23,000 – 38,000
Verification	- US $ 7,000 per audit

Source: UNEP (2003)

2.1.3 Prices of CERs

The viability of small scale project therefore depends on the prices of CERs (figure 5 and 6).

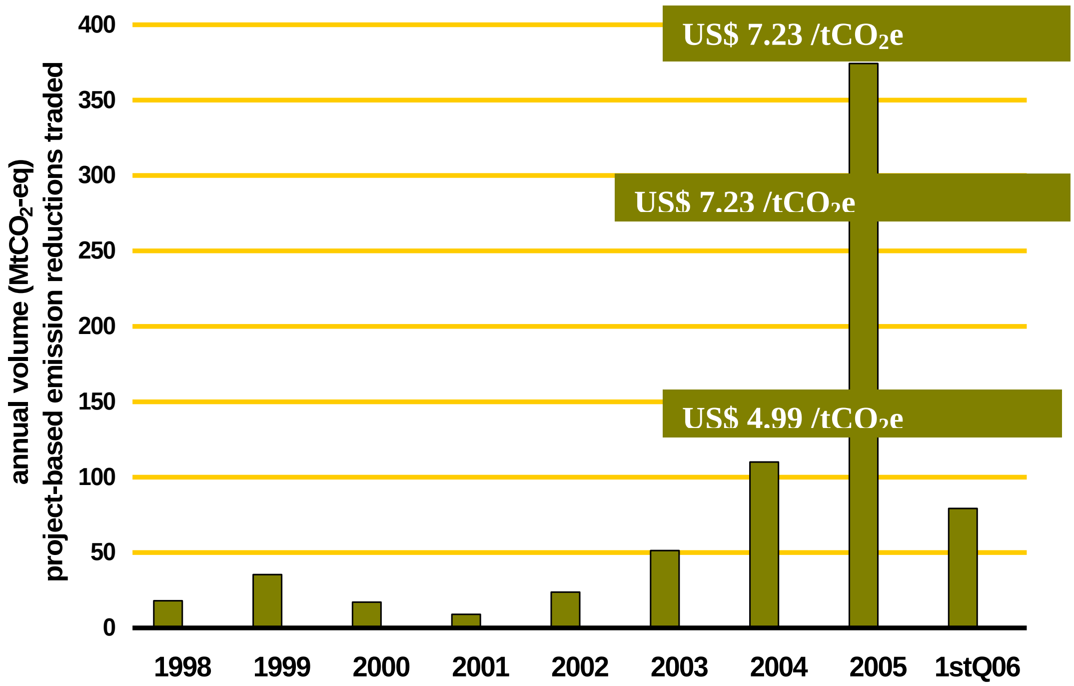
Figure 4 - Prices of emissions reductions (Jan 2005 – March 2006)



Source:

Source: The World Bank

Figure 5 - Increase of Traded emission reductions and prices



Source: The World Bank

2.1.4 Impacts of CDM on project IRR

The impacts of CERs revenue on the total project investment vary by project types. Table 10 presents the results of sensitivity analysis of the contribution of CERs revenues.

Table 10 - Summary Sensitivity Analysis - Incremental IRR Results – Contribution of Carbon Finance

Sector	Impact (%) Price = \$6.5/ton CO_2e				CF Impact (% range)
	Purchase 7y	Purchase 10y	Purchase 14y	Purchase 21y	
Landfill	**5.5 – 46.8%**	**13.9 - 48.8**	**17.6 - 49.3**	**20.3 - 49.3**	**5.5 - 50**
CH_4 from coal	**7.6**	**9.7**	**10.8**	**11.5**	**7 - 12**
Bio mass	**1.9 – 3.5**	**2.3 – 5.1**	**2.6 – 6.3**	**2.9 – 7.1**	**2 – 8**
Forestry	**0.4 – 4.6**	**0.9 – 5.7**	**1.7 – 6.3**	**2.6 – 6.8**	**0.5 - 7**
Renewable Energy	**0.2 – 1.7**	**0.3 – 2.2**	**0.5 – 2.6**	**0.6 – 2.9**	**0.2 - 3**
District Heating	**0.5**	**0.6**	**0.6**	**0.7**	**0.5 - 1**

2.2 Global carbon market potential under the Kyoto Protocol

A review of National Communications submitted by Annex I countries indicates that the total demand for Annex I countries is 846 MtCO_2eq per year, with an uncertainly range of 415 – 1,250 MtCO_2eq per year (Grubb et al. 2003). According to this analysis, the supply potential for hot air and joint implementation emission reduction units has been estimated to range from 365 – 1,070 MtCO_2eq per year. Based on these results, the global CDM market potential can be estimated to be between 50 MtCO_2eq and 180 MtCO_2eq per year.

According to some analysis, the entire Annex I demand could be met from the Hot air (surplus GHG offsets) from Russia and Eastern European Countries. However, of the total of 127.2 MtCO_2eq transacted in 2004, 82 MtCO_2eq were from CDM, which have been contracted at a weighted average price of 4.2 euros per tCO_2eq.

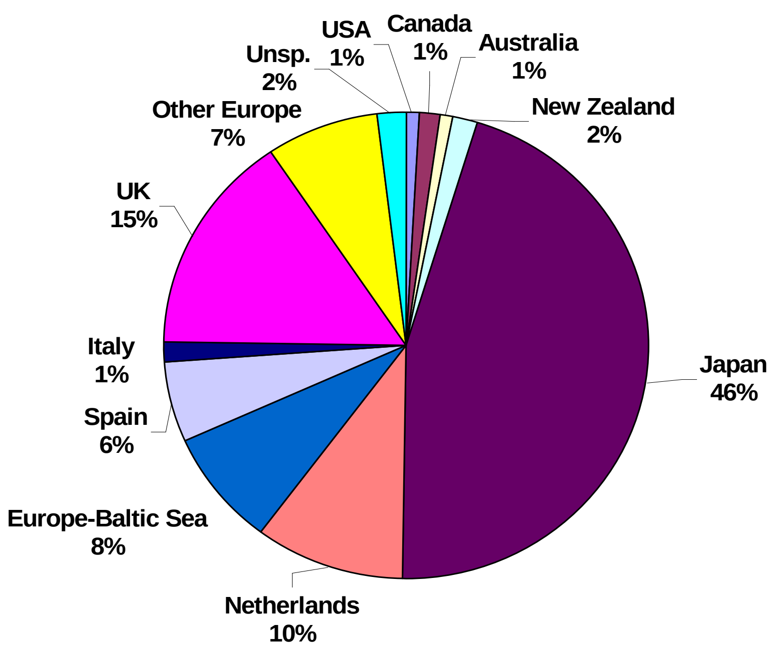
The estimated market potential of the CDM is a demand for CERs in 2010 of 250 Mt$C0_2$e (range 50 to 500 Mt$C0_2$e) at a price of \$11.00 *$ItC0_2e$* (range ± 50%). This represents a total demand of 1,250 MtC02e by 2012. The minimum demand by industry in Europe and the planned purchases by governments yield an annual demand of at least 100 Mt$C0_2$e for CERs and ERUs. The median demand by industry in Europe combined with estimated government purchases by Annex B governments yields a potential demand for CERs and ERUs of roughly 230 Mt$C0_2$e in 2010.

The market for project-based ERs is still growing steadily: 107 million metric tons of carbon dioxide equivalent ($tC0_2e$) have been exchanged through projects in 2004, a 38% increase relative to 2003 (78 $mtC0_2e$). We estimate that the volume exchanged so far in 2005 (January to April) is 43 $MtC0_2e$, most of which under either Joint Implementation (JI) or the CDM. In the past 12 months, the number of JI and CDM projects under development has also increased substantially, with notably a large supply of unilateral CDM projects.

2.2.2 CERs buyers

New buyers of emission reduction have emerged. Private and public entities in Europe now represent 60% of the volume of ERs purchased through project-based transactions (Jan. 2004 to April 2005), against 21 % for private and public entities in Japan and 4% for private entities in Canada. The figure 7 illustrates the market share by buyers in 2005.

Figure 6 - Market share by buyers in 2005 (374.3 MtCO2e)



2.2.2 CERs sellers

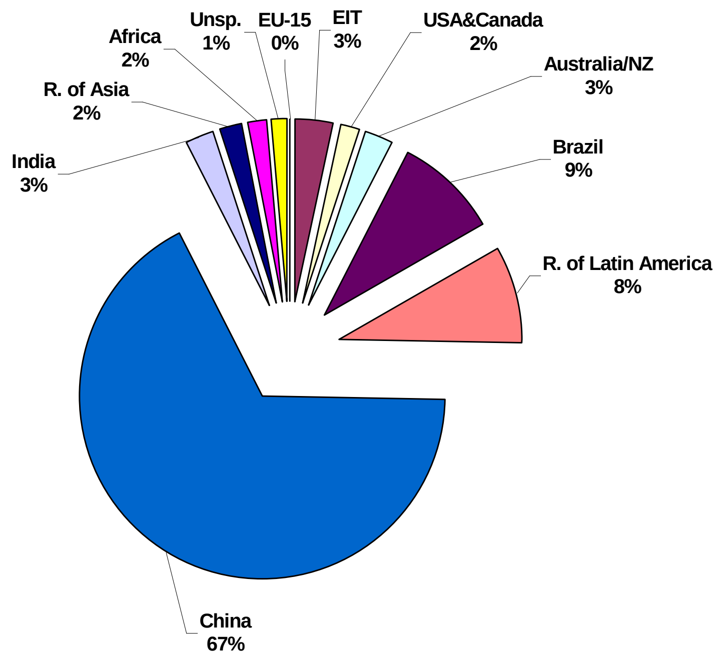
The geographic distribution of the estimated CDM potential is similar to the distribution of projected energy investment to 2010, projected energy-related CO_2 emissions in 2010 and projected growth of energy-related CO_2 emissions between 2000 and 2010. But it differs somewhat from the historic patterns of foreign direct investment (FDI) and official development assistance (ODA).

Latin America currently has more CDM project activity relative to its estimated potential than any other region, consistent with the pattern of FDI. Project activity relative to estimated CDM potential is low in all other regions. Due to its large share of the global CDM potential, the scale of CDM activity in Asia, and in particular China, could have a substantial impact on the total supply of CERs (figure 8).

Annual emission reductions in 2010 of 400 $MtC0_2e$ would require an annual investment of about $10 billion. Foreign direct investment (FDI) in developing countries averaged $140 billion per year during 1997-2002 and often varied by more than $10 billion from one year to the next. The projected energy investment required for developing countries between 2001 and 2010 is $192 billion per year.

The supply of emission reductions has remained heavily concentrated in a few countries: notably India (by far the largest supplier of project-based ERs on the market), Brazil and Chile. Apart from a few small-scale deals, poorer or smaller countries have seen limited activity since January 2004. As at 12 September 2006, the expected CERs form registered projects during the first commitment period is 82 $MtCO_2eq$ (UNFCCC CDM website).

Figure 7 - Market share by seller in 2005



2.2.3 CDM projects registered up to September 2006

Up to September 2006, 306 CDM projects have been registered which are expected to reduce 570 M t/CO_2 e. So far, 15.4 t/CO_2 e CERs have been issued. Table 11 presents the distribution of registered CDM projects by countries.

Table 11 -Expected annual CERs from registered projects by host country as at 12/09/2006

Country	Average Annual Reductions t/CO_2 e
Argentina	**1,765,007**
Armenia	**197,832**
Bangladesh	**169,259**
Bhutan	**524**
Bolivia	**82,680**
Brazil	**14,163,224**
Cambodia	**51,620**

Chile	**2,183,123**
China	**36,665,416**
Colombia	**66,180**
Costa Rica	**162,515**
Ecuador	**258,261**
El Salvador	**360,268**
Fiji	**24,928**
Guatemala	**142,245**
Honduras	**205,251**
India	**10,566,516**
Indonesia	**271,938**
Israel	**93,452**
Jamaica	**52,540**
Malaysia	**1,615,972**
Mexico	**4,003,888**
Mongolia	**11,904**
Morocco	**223,313**
Nepal	**93,883**
Nicaragua	**336,723**
Panama	**60,343**
Papua New Guinea	**278,904**
Peru	**199,265**
Philippines	**56,788**
Republic of Korea	**11,075,612**
Republic of Moldova	**47,343**
South Africa	**25,739**
Sri Lanka	**104,130**
Viet Nam	**681,306**

2.2.4 Sector distribution of CDM projects

HFC_{23} destruction is still the dominant type of emission reduction projects in terms of volumes supplied (25% from January 2004 to April 2005). Projects capturing methane and N_2O from animal waste now rank second (18%), ahead of hydro, biomass energy and landfill gas capture (about 11 % each). Projects abating non-CO_2 emissions account for more than half of the total volume supplied, while traditional energy efficiency or fuel switching projects, which were initially expected to represent the bulk of the CDM, account for less than 5%.

Due to the heterogeneity of the underlying projects and contracts terms, the spread of prices of project-based emission reductions at any given time is very large. The whole spread has also moved substantially upward since last year's report.

Certified Emission Reductions have traded between $3 and $7.15/tCO,e over the same period of time, with a weighted average of $5.63/tCO$_z$e. The decline of the dollar relative to the Euro can explain only part of the observed increase relative to last year

The large projects that account for most of the potential CDM supply have a lead time of four or five years. Thus new project ideas initiated now would only yield emission reductions after 2007. This means that emission reductions beyond those from currently identified projects depend heavily on new project ideas initiated now and implemented during 2008-2012. That could lead to a significant acceleration in the flow of new projects in 2008, which could strain the capacity of the designated operational entities and the Executive Board.

The project types that have an average size sufficiently large to be economically viable account for most of the CDM potential. These project types include: energy efficiency measures in the residential, commercial and institutional sectors; energy efficiency in industry; landfill gas capture and utilization; methane reductions in the oil and gas industry; renewable electricity generation; and afforestation and reforestation. Other project types, such as recovery of coal-bed methane and reduction/destruction of non-methane GHGs, appear to be economically viable, but do not represent a large share of the total potential.

At present energy efficiency projects are under-represented relative to their estimated potential. This suggests the existence of factors, such as high administrative costs or other barriers that are not fully reflected in analyses of the achievable potential for these projects. On the other hand, renewable electricity generation and projects that involve non-CO_2 gases, such as methane, are over-represented. The higher global warming potential values of nonCO_2 projects tend to improve the project economics.

Figures 9 and 10 illustrate the sectoral distribution of CDM projects registered with the CDM executive board. The energy sector has contributed to 50% of the projects.

Figure 8 - Sector distribution of CDM projects

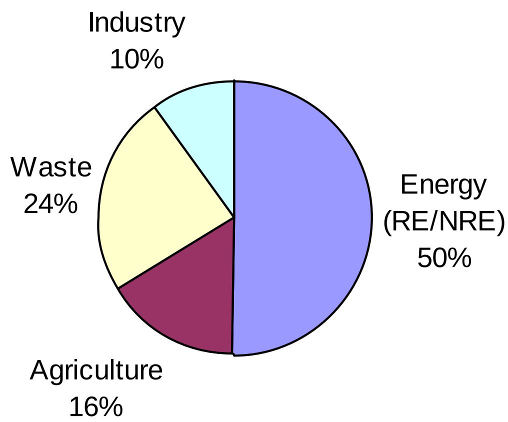
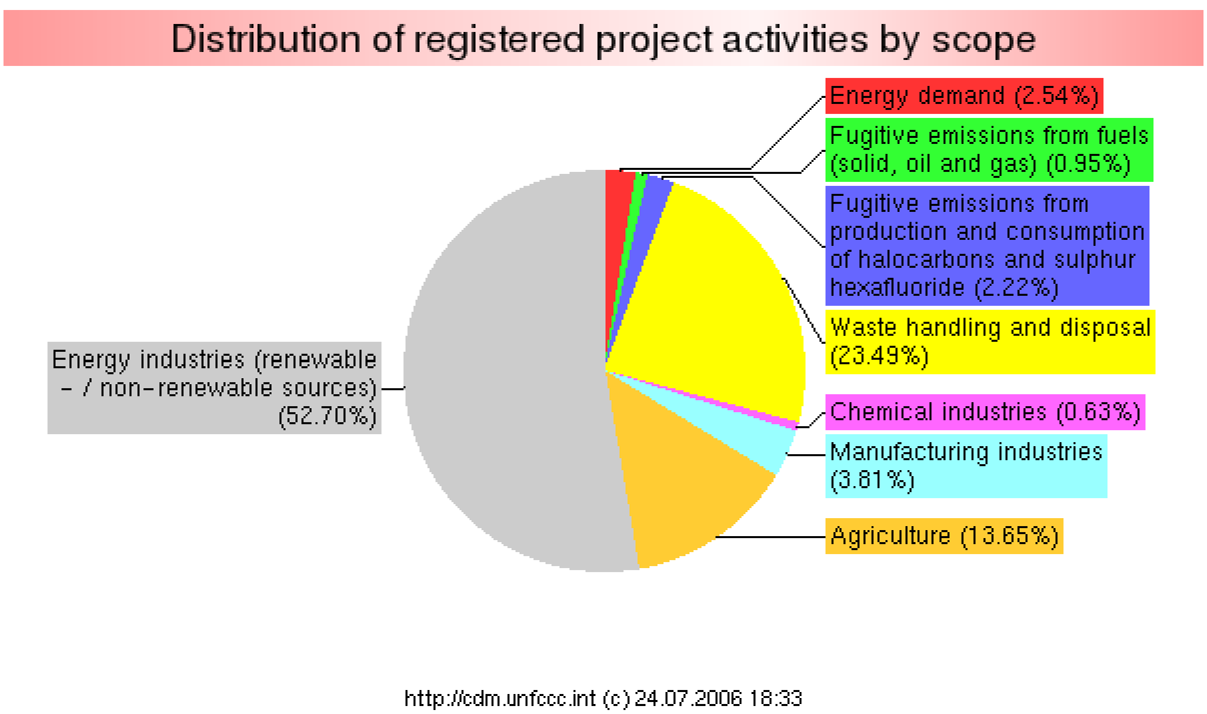


Figure 9 - Sector distribution of registered projects by scope



2.3 Impacts of emissions trading on CDM

Emission Trading (ET), although it is described under a separate Article (Article 17) in the Kyoto Protocol, is closely linked with the Clean Development Mechanism (CDM) and Joint Implementation (JI), the two project-based mechanisms adopted by the Kyoto Protocol to the UNFCCC. Therefore the global potential of Emission Trading is also related to the potential of implementation of CDM and JI, which are the important flexible mechanisms in achieving the common goal of the UNFCCC.

Size of the potential market for the three flexibility mechanisms under the Kyoto Protocol during the first commitment period 2008-2012, both on demand side and supply side has been estimated. Annex 1 countries must reduce GHG emissions about 620.6 MtC in 2010, in order to meet the Kyoto targets. This will take place domestically, through emission trading, JI with other Annex 1 countries, and acquisition of certified CDM credits from non-Annex 1 countries. For countries whose Kyoto targets are higher than the anticipated emissions, even in the absence of any limitation, they will have surplus assigned amounts of 105 MtC available for sale.

Because energy efficiency in countries with economies in transition is very low in comparison to OECD countries, in addition to the supply of hot air, these countries could make 25% of their projected baseline emissions in 2010 available for sale through improving energy efficiency. This will lead to a supply of 348 MtC. Projected baseline emissions of the developing countries will be 4,000 MtC in 2010, and CDM credits will be 800 MtC (Zhang draft report, 1999). By adding the supply from each mechanism, the aggregate potential supply for GHG offsets is estimated to be 1,253 MtC, which is substantially larger than the estimated aggregated demand of 620.6 MtC. The price of a carbon ton and total demand and supply will be highly uncertain and difficult estimate.

CHAPTER 3 - OVER ALL SRI LANKAN CDM OPPORTUNITIES AND POTENTIAL

3.1 National Potential of CDM

The developmental sectors that emit most of CO_2 include industrial, power, transport, and agriculture sectors. Potential CDM projects that can lead to emission trading can be projects that involve CO_2 emission avoidance and those with emission sinks. Therefore the Forestry sector and Power sector, agriculture, waste, and transport sector were identified as the potential sectors in Sri Lanka for carbon emission trading. In general energy sector has been identified as key sector for CDM projects in Sri Lanka. Projected electricity demand in 2010 – 18,800 GWh and additional energy requirement is13,200 GWh . Some of these energy may be produced as CDM projects. The studies suggest that the abatement cost of green house gas under CDM projects in Sri Lanka is very high in case of solar and wind options as green house gas abatement alternatives, so that they are not viable as CDM projects (Batagoda et al. 1999). However other renewable energy options such as hydro, and biomass power projects are viable as CDM project.

The country's existing 1.7 million hectares of scrub and chena lands in the country can be used for reforestation or energy plantations as CDM project. The study revealed (Batagoda et al. 1999) that if 10% of the available open land area is reforested as CDM projects, Sri Lanka can earn Rs. 5740 per tonne of carbon.

In the field of Energy, the report prepared by Nexus for the Ministry of Power and Energy in April 2004 summarizes the scope for renewable energy in Sri Lanka. Table 12 provides a summary of the potential for CDM projects by sector, described in the following sections.

Table 12 -Summary of National CDM Potential by Sector (Not Necessarily by 2012)

Sector	Annual Energy Reduction/Substitution potential/ year		Annual CO_2 Reduction Potential tons CO_2/year
Hydro Power	**250 MW**	**(35% p.f.)**	**613,200 tCO_2/y**
Wind	**480 MW**	**(20% p.f.)**	**672,768 tCO_2/y**
Solar PV	**0**		**0**
Biomass (Grid Power)	**300 MW**	**(80% p.f.)**	**1,680,000 tCO_2/y**
Biomass (Industrial Heat)	**162 toe**		**512,000 tCO_2/y**
Biomass (Absorption Refrigeration)	**100 MW**	**(60% p.f.)**	**400,000 tCO_2/y**

Energy Conservation: Electricity (Industry)	**20,400 toe**		**64,700 tCO_2/y**
Energy Conservation: Petroleum (Industry)	**36,000 toe**		**113,800 tCO_2/y**
Transport	**206,000 toe**		**600,000 tCO_2/y**
Agro Residue-Rice Husk	**20 MW**	**(80% p.f.)**	**112,000 tCO_2/y**
Agro Residue-Sawdust	**20 MW**	**(80% p.f.)**	**112,000 tCO_2/y**
Municipal Solid Waste			
Forestry	**52,000 ha**		**520000 tCO_2/y**

Note: p.f. (plant factor). Total number of hours in a year is 8,760 hours; therefore if a 1 kW plant operates on 100% p.f. it would generate 8,760 kWh. If it operates at x% it would generate x% of 8,760 for each kW of capacity.

3.2 Hydro Power (Mini and Micro-hydro)

The Ceylon Electricity Board considers all hydro power projects above 10 MW as Conventional Hydro Power (large hydro). All such projects, including the Upper Kotmale Project, totalling 411 MW in capacity and with annual average energy potential of 1,434 GWh/y have been included in the Long Term Generation Plan 2005-2019 prepared by the CEB in November 2004. Conventional Hydro Power plants, being part of the National Baseline Generation Plan and being financially viable on their own without any additional financial inputs, do not qualify for CDM benefits due to "additionality".

The Upper Kotmale project could fulfill the "additionality" condition due to the fact that it took many years to finalize the project due to concerns raised by stakeholders in the vicinity of the power project. In fact, some groups are still protesting and attempting to prevent the start of the project. A CDM project for this power project could be formulated on the condition that the bulk of the CDM monetary benefits are used to socially develop the stakeholders living in the vicinity of the project.

The total mini hydro potential (grid-connected power plants with capacities less than 10 MW) is estimated as 300 MW. Around 70 MW are already commissioned. Only about 30 MW have completed CDM projects. Thus, effectively 250 MW of potential is available for CDM in this respect.

In respect of micro hydro, (also known as “village hydro”) usually less than 1 MW, but always of the off-grid type, the potential in Sri Lanka has been estimated as nearly 200 MW. These projects are all too small and even the outputs are not metered. The village community benefiting from these projects is charged according to the installed load in each household. Due to the low generation capacity such projects would need to be bundled to qualify for CDM. However, practical problems with bundling many such diversely located projects, and the difficulty in monitoring their performance makes it unlikely that they would qualify for CDM.

3.3 Wind and Solar Power

According to the study done by the National Renewable Energy Laboratory (NERL) USA, the total potential under the category “Good & Excellent” condition with over 7 m/s wind amounting to 24,000 MW is available in “on shore”. In view of the high foreign cost and low annual plant factor only a tiny fraction of this would be developed in the foreseeable future. Only about 480 MW (2% of total potential) has the potential to be developed.

There is already a 3 MW wind power project, with 6 wind mills each of 500 kW, located in the southern part of Sri Lanka commissioned and operating for the past few years. This project was implemented by the Ceylon Electricity Board with part funding from the Global Environmental Facility. The capital cost at the time of commissioning was around US$ 1,200 per kW. The overall performance of this facility has been very disappointing. The annual units generated by this 3 MW facility have been around 3 GWh per year. This amounts to an annual plant factor (p.f.) of 11%. In neighbouring India, the average annual plant factor (p.f.) of wind mills is around 20%, and in Europe this is over 30%.

The following reasons are attributed to the poor performance of this facility:

- This facility is located near the end of a long distribution network. Due to many natural causes, very frequently this power line gets cut-off from the grid. During such times, the wind generating system cannot export the power generated. Moreover, as the line is very long, depending on the variations in the load connected to this line, the voltage level at the point of interconnection varies very widely. As the wind mills do not have the capability to accommodate such variations, the interconnection gets disconnected very frequently.
- The actual location of this wind power facility is different to the site identified by the CEB. This change of location was brought about by environmental groups, on the ground that this power plant would be located in the path of migratory birds. From the point of view of wind availability, the change of location has resulted in lower power output.

For solar power, towards the end of 2004, over 63,000 Solar Home Systems with capacities varying from 30 watts to 100 watts have been installed in Sri Lanka. The total capacity of these projects amounts to 3 MW. These projects cover the whole of Sri Lanka. These projects are installed by around 6 solar power private sector companies. It is not practical to bundle such a large number of small projects installed in many different locations, owned by different private sector companies. Moreover, due to the high transaction costs of CDM projects, usually projects with capacities less than 30,000 of CO_2 per year of emission reductions are not considered. The cumulative capacity of the solar power panels installed in Sri Lanka up to date amounts to 3 MW. The emission reductions achieved by these solar panels amount to 4,000 tons of CO_2 per year. This is far short of the 30,000 per year cut-off limit. Hence solar power projects in Sri Lanka have a minimal opportunity in qualifying for practical CDM projects.

3.4 Biomass

The potential and economic viability for sustainable biomass production and conversion to energy in Sri Lanka are very good. Around 40% of the total land area amounting to 2.4 million hectares is under-utilized. (Session Paper No. III-1990: Report of the Land Commission – 1987). Moreover, even traditional crops such as coconut, tea, etc. also have intercropping potentials for sustainable energy plantations. For electricity generation purposes, as an initial estimate a total of 100 MW is expected by the year 2010 (Report of the Inter-Ministerial Working Committee on Dendro Thermal Technology, June 2005). A further 200 MW could be expected for the year 2012. Unlike hydro or wind projects, biomass power projects are flexible with regards to location and size of the power plants. The resource for biomass power plants, the biomass fuel supply can be transported within reasonable distances to power plants. This enables the developer to choose the location and capacity of the power plant based on a number of alternative criteria. Unlike hydro power projects, there are no predefined names or capacities for biomass power plants. Three applications where biomass fuel may be used as an alternate energy source are discussed briefly below.

3.4 1. Industrial Heat

The opportunity exists for the replacement of fossil fuel with biomass fuel for industrial thermal applications. In the short term, approximately 162 toe of fossil fuel may be replaced with sustainable biomass. This would amount to an abatement of 512,000 tCO_2 per year. This topic is further discussed in the following section.

3.4.2 Absorption Refrigeration

Biomass fuel could also be used to replace electrically driven vapour compression based refrigeration and air-conditioning systems to steam driven vapour absorption systems. Ice manufacturing plants, large hotels and large commercial buildings could adopt this system. The initial cost of replacing the electrical driven machinery to steam driven machinery is very high. However, the operating costs are very much lower. Lack of project capital at affordable financing cost is the primary reason for the failure to adopt this technology. It is difficult to provide an accurate assessment of the national potential for biomass fuel in absorption refrigeration. As an initial target, approximately 100 MW of electrical power at a plant factor of 60% could be replaced with a biomass fuelled steam system. The potential for GHG emission reduction is estimated as 400,000 tons CO_2 per year.

3.4 4. Household Sector

Although over 80% of the households use biomass as the cooking fuel, almost all of this biomass fuel comes from renewable sources such as home garden, agro residues, or rubber and cinnamon plantations. Hence any efficiency improvements carried out in this sector would not have any impact on the GHG emission level. However, due to urbanisation and improvement in the standard of living among the population, there is a tendency among the population to switch from biomass fuel to LPG (liquid petroleum gas) as the cooking fuel. The price of LPG has been increasing steadily in the last decade, much faster than the rise in prices of other petroleum fuels. To some extent, this sharp increase in the price of LPG has helped reduce the number of customers switching from fuel-wood to LPG.

An attempt is being made in the country to provide a cheaper alternative to LPG. A new stove developed by the National Engineering Research and Development Centre (NERDC) has to some extent fulfilled this need. It is reported that around 200 such stoves are being marketed daily by a private sector manufacturer (Spectra Industries, Kurunegala). Application of this process as a CDM project is not practical from the point of view of bundling, monitoring and verification. Hence this option is not included in this report.

3.5 Energy Efficiency

Energy efficiency in all business sectors in Sri Lanka is very low and therefore government assistance to invest on efficiency improvement and modernization is important to face the energy crisis. Conventional energy inefficient systems are still widely used in Sri Lankan industry. It is timely that these systems are restructured to use technologically advanced energy efficient systems. Some of the areas that could be developed include:

- **Reduction of transmission losses of power**:
  Losses due to transmission inefficiencies are estimated to be significantly high. This translates to higher energy tariffs to the consumer as well as calls for the use of additional sources of energy to supplement the losses.

- **Introduction of energy efficient systems for industry:**
  Industry, including the plantation industry uses a significant number of highly energy inefficient production systems. This situation brings about higher cost of production and which translates into reduction of social benefits in terms of benefits for the workers and the economy as a whole. Investment on energy efficiency improvements have a very short payback period. For example, a tea factory which spent Rs 450,000 – 500,000 on fuel and electricity per month reduced its energy bill by around Rs 100,000 after improving its energy efficiency. The pay back period was one year for the investment of Rs 1 million.

- **Water supply schemes:**
  Conventional water pumping mechanisms used by the water supply systems could be transformed into energy efficient systems using newer technology.

- **Conventional building technology:**
  The conventional buildings in Sri Lanka use very high amounts of energy due to their energy inefficient architecture. The Green building technology standards should be adopted in the future buildings (making use of natural sunlight and ventilation). It is also important to maximize the energy efficiency in the older buildings.

- **Energy saving bulbs:**
  The vast majority of the households consume electricity for lighting applications. The national average consumption of electricity for the household sector alone is 900 kWh per household per year. The introduction of Compact Fluorescent Lamps (CFL) has reduced the consumption slightly. Due to the extremely low electricity tariff applicable for the low-end households and the relatively high prices of CFL have been the reasons for the slow progress in this programme. The impracticality of bundling such large number of households and to monitor their performances and certifying the actual GHG reductions makes this option not feasible as a CDM project.

The energy efficiency aspect in the transport and industrial sector are discussed in the respective sections.

3.6 Industry

The annual consumption of electricity and petroleum in the year 2003 by the industrial sector amounted to 204,000 and 360,000 tons of Petroleum Equivalent respectively. These figures are increasing annually at a rate of 6% and 5% respectively. In addition the industrial sector also consumes approximately 1,236,000 tons of Petroleum Equivalent of bio fuels annually. As most of the bio fuels are from renewable resources such as rubber plantations or dedicated woodlots and any reduction in the consumption of bio fuels would not result in CO_2 emission reductions. Hence bio fuels consumption by the industrial sector is not considered for CDM application.

Emission reduction of GHG in the industrial sector could be achieved by two different approaches: (a) Efficiency improvements to reduce consumption and (b) Substituting fossil with sustainable biomass fuels.

3.6.1 Efficiency Improvements

Energy conservation and efficiency improvement is pursued by two independent Government organizations and a professional association in Sri Lanka. The Government organizations are the Sri Lanka Sustainable Energy Authority (SLSEA), formally Energy Conservations Fund (ECF) under the Ministry of Power and Energy and the National Engineering Research and Development (NERD) Centre under the Ministry of Science and Technology. The professional association promoting energy conservation is the Sri Lanka Energy Managers Association (SLEMA).

Although many options to reduce energy consumption have been identified, very little progress towards energy conservation has been achieved due to the high initial capital cost needed to implement these proposals, and the prevailing high interest rates in the commercial banking sector. In order to resolve this issue the Government has introduced a fund called Energy Conservation Guarantee Fund (ECGF). Under this scheme, an energy conservation project evaluated and recommended by the ECF could utilize the ECGF as collateral to obtain a loan at a lower interest rate to implement the proposal.

The industrial sector could make use of the CDM opportunity to enhance the financial benefits from such energy conservation activities. A 10% reduction in both petroleum and electricity consumption would result in a GHG emission reduction of 64,700 tons of CO_2 reduction for electricity consumption and 113,800 tons of CO_2 reductions for petroleum consumption.

3.6.2 Substitution of Fossil Fuels by Fuel-wood

Petroleum fuels consumed by the industrial sector are utilized entirely for industrial heat applications. These could be replaced by sustainable fuel-wood from dedicated energy plantations. In fact one industry has already implemented a scheme to replace part of the furnace oil consumed for industrial drying with sustainable fuel-wood. In order to implement this proposal, the industry concerned could introduce a biomass gasifier to convert fuel-wood into a combustible gas and use this gas in the equipment (furnace or boiler) that earlier consumed petroleum fuels or replace the equipment (furnace or boiler) with one suitable for fuel-wood directly. The former option is lower in capital cost but cannot be implemented in all situations. The second option is applicable to all cases, but has a much higher capital cost. Moreover, switching from petroleum fuels to fuel-wood may not be feasible in congested urban locations.

From a technical and economical point of view almost all the heat energy requirement of the industrial sector could be met from renewable resources, particularly by the use of bio fuels. The only exceptions are applications where electrical heating is the only option due to hygienic conditions. At the prevailing costs of fossil fuels and fuel-wood from sustainable energy plantations, on an energy equivalent basis, fuel-wood costs one fourth to one seventh the cost of fossil fuel (depending on which fuel- furnace oil, diesel or LPG is used).

Assuming 10% of the present fossil fuel consumed by the industrial sector is reduced by energy conservation measures, and 50% of the balance is replaced by bio fuels, the potential for GHG emission reduction amounts to 512,000 tons of CO_2. One practical difficulty anticipated in this venture is the task of bundling the many small scale industrial applications. The DNA should address this issue.

Thus, the CDM potential for industry is significant. The projects that can be adopted include:

- Fuel switching projects
- Increasing energy efficiency (refer section 5.1.4)
- Use of green building technology

3.7 Transport

According to the Energy Balance 2003 provided by the SLSEA, the transport sector consumed 2,060,000 tons of petroleum fuels in 2003. This is growing at around 8% per annum. Emissions from the above quantities of fuels amount to 6.5 million tons of CO_2 per year. If this could be reduced by 10%, 600,000 tons of CO_2 reductions could be sold as CERs.

In dealing with CDM activities in the transport sector, we need to recognize the difficulty in bundling a large number of users in the transport sector. One option is to focus on few selected large users such as the railway sector. Policy CDM also provides an opportunity in this sector. CDM project activities in the transport sector could arise from the following three approaches: (a) Policy initiatives to change transport modes; (b) Introduction of energy efficiency improvements to the transport fleets; (c) Switching from fossil fuels to sustainable bio fuels, which are carbon neutral. These issues are discussed below.

3.7.1 Policy Initiatives to Change Transport Modes

At present a substantial number of travelers use individual motor cars. This mode of travel is very costly, utilizes fuel very inefficiently and causes traffic congestion on roads thereby reducing the efficiency of other modes of transport such as travel via bus. Switching the mode of transport from car to bus would bring substantial benefits particularly in the form of better fuel efficiency. However, the quality of the public transport system in Sri Lanka would need to be improved significantly to convince commuters who travel by car to ride the bus.

In respect of transport of goods, only a small percentage of the goods are transported by rail. A bulk of the goods is transported by road. Transporting goods by road is very inefficient from a fuel utilization perspective. Switching from road transport of goods to rail transport would result in less fuel consumption.

3.7.2 Enhancing Energy Efficiency in Transport Fleets

A large section of the buses purchased in Sri Lanka have been used previously in other countries. The engines and transmission systems of these vehicles are very inefficient and thus consume more fuels and cause increased pollution. The efficiencies of these systems could be improved by proper maintenance and replacement of engines where necessary.

A large number of 2-stroke engine based motor cycles, and three-wheelers are in operation in Sri Lanka. This type of engine consumes more fuel and emits more pollution particularly in the form of un-burnt hydrocarbons. The operation of such 2-stroke engines is no longer permitted by law in many countries. Similar legal measures are necessary to be introduced to gradually phase out 2-stroke engines and introduce 4-stroke engines. Such measures would result in lesser fuel consumption and lead to better air quality.

3.7.3 Production and Use of Alternate Fuels such as Bio Fuels

Use of bio fuels as substitutes for fossil fuels would result in substantial emission reductions. Bio diesel (treated vegetable oil), bio ethanol (ethyl alcohol) and bio methane (from anaerobic digestion of perishable biomass) are being used in varying extent in many countries as substitutes for fossil fuels in transport application. These exercises are carried out not for economical reasons but as strategies to ensure energy security and for environmental considerations.

In Sri Lanka, all three options of bio diesel, bio ethanol and bio methane could be applied in varying extent. Bio diesel and bio ethanol production would compete for land for food and solid fuel production. On the other hand, the vast amount of agro residues such as straw, animal dung, perishable municipal wastes, etc. could be deployed to generate bio methane and utilized as fuel for the transport sector. The bio residues produced annually in the country could generate 3,200 cubic meter of biogas equivalent to 1.6 million tons of diesel. This is nearly 75% of our national fossil fuel used in the transport sector. As mentioned earlier, Sri Lanka could target a 10% reduction of the transport sector emissions, which amounts to approximately 600,000 of CO_2 emission reductions under CDM.

The Ministry of Science and Technology is carrying trials on yield determination on Jatropha, an oil producing crop. This Ministry is also examining the demonstration of utilizing bio methane from municipal waste disposal as transport fuel.

3.8 Agriculture

The agricultural sector in Sri Lanka is an important sector as far as climate change is concerned for many reasons. Any change in the climate would directly affect the agricultural output. Moreover, in the event of a rise in sea level, agricultural lands near the coastal areas would be adversely affected. As far as GHG emissions are concerned, rice cultivation under flooded condition emits substantial quantities of methane, a potent GHG. The agricultural sector is also susceptible for land use changes, particularly in the dry zone, where large extent of forest lands have been converted into scrub land by slash and burn shifting cultivators.

In terms of energy consumption, the contribution from the agriculture sector is insignificant in Sri Lanka. There is not much scope for fuel switching or energy conservation. However, the possibility exists to reduce methane emissions from rice fields, through better water utilization. Further research is required to realise better water utilization techniques in paddy cultivation in Sri Lanka.

The carbon sequestration potential in the agricultural sector may be enhanced by encouraging energy plantations such as *Gliricidia sp.* in the marginal plantation lands, scrubland and also planting it as an intercrop.

3.9 Waste Disposal

There are two major types of waste are generated in Sri Lanka. The first category generated by the agro-industrial sector, essentially consists of rice husk, rice straw and saw dust. The second type of waste is from the household wastes generated mostly from the urban sector. Most of the surplus rice husk are dumped into water bodies or are incinerated in open piles. Similarly, most of the surplus rice straw is incinerated in the rice fields. Saw dust generated in saw mills located in selected areas are dumped into water bodies. Municipal waste disposal poses a huge problem to all local bodies in Sri Lanka.

3.9.1 Agro-Residues

Surplus quantities of rice husk produced in the country amounting to 160,000 tons per annum could be used to generate electrical energy with an output of 20 MW or 140 GWh/year. This would lead to a GHG emission reduction of 112,000 tons of CO_2 per year. The projects would generally have capacities of 5 MW and therefore would qualify for CDM by themselves.

The total quantity of saw dust generated also amounts to around 160,000 tons per annum. This too could be used for electricity generation, generating 20 MW of power with an annual energy of 140 GWh/year. A GHG emission reduction of 112,000 tons of CO_2 could be achieved under CDM projects.

Rice husk and saw dust could also be converted into briquettes for urban household cooking. As far as GHG emission reduction potentials are concerned household cooking or electricity generation would not make any difference.

3.9.2 Municipal Solid Waste

The average quantity of municipal solid waste generated is estimated to be 0.5 kg/person/day. The total tonnage of municipal waste generated in Sri Lanka is estimated as 2,838 tons per annum. Direct burning of municipal garbage is not appropriate for two reasons. Firstly the moisture content of garbage as received is very high, resulting in very little net energy out put. Secondly, some of material in the waste such as plastics and nitrogenous materials are not suitable for combustion. The average composition of Sri Lankan municipal garbage is as follows:

Combustibles (wood etc.):	25%
Organic (vegetable wastes, leaves etc.):	59%

Attempts made to dispose municipal garbage in sanitary land-fills have not materialised due to failure to identify suitable land fill sites which could be acceptable to the surrounding communities. A project has been initiated to utilize the Colombo garbage to extract methane and to utilize it to generate electricity to be sold to the national grid. Garbage landfills emit methane and carbon dioxide by the anaerobic decomposition of organic materials, and contribute to GHG in the atmosphere. By inserting pipes of appropriate sizes at appropriate locations in the garbage pile, it is possible to capture these gases and utilize it to generate electricity and feed it to the national grid. The initiated project has a capacity of 244,000 of CO_2 emission reduction per annum.

3.10 Forestry

A study on CDM sink projects, revealed that if 10% of the available open land area of Sri Lanka is reforested as CDM projects, Sri Lanka has the potential to earn approximately Rs 4,100 - 10,700 million per year (market price for 1 ton carbon sequestered was considered as $ 90 in this study) within the next 10 years. The profits per ton of carbon sunk through CDM reforestation projects were estimated as Rs 5,740 (Batagoda 2000). However, it should be noted that the current market value of CERs range from $5 - $15.

Forest Department believes that the forestry sector could play a vital role in CDM projects as carbon sinks. In Sri Lanka, the Forest Department is a state institution entrusted with the task of conserving the natural forests as one of its primary objectives. This department is also entrusted with the task of establishing and maintaining commercial forest plantations to meet a part of the national timber requirements. Extraction of timber from such commercial forest plantations is entrusted to the State Timber Corporation, another state institution. The Forestry Sector Master Plan developed in 1990 stipulates that natural forests would not be deployed to meet timber requirements; consequently all natural forests in Sri Lanka are preserved in tact without any extraction.

The Forest Department plans to establish around 1,000 ha of commercial plantations annually, including any land handed back to the Forest Department by the State Timber Corporation after timber extraction. According to the Deputy Conservator General of Forest the activities of the Forest Department in respect of forest plantations would not qualify for CDM projects for two reasons: (a) part of Forest Department's base-line activity would be disqualified from the point of view of "additionality; and (b) prior to establishing plantations, these lands were cleared of all existing tree covers, either by the State Timber Corporation for extraction of commercial timber or by other contractors of Forest Department.

Although, the plantation activities of the Forest Department may not qualify for CDM, the activities of private developers and other state institutions would qualify for CDM. Two such projects which are in the pipelines are listed below:

1) Expansion of Rubber Cultivation into Marginally Dry Region (Monaragala).

- Land area: 4,000ha
- Project start date: 2006
- Expected CER delivery - 1st year: 106,000 tCO_2 - up to 2012: 640,000 tCO_2

1. Baseline scenario: exclude C fixing by covers – 86t

- Additionality: no tree crops, only grasses and bushes

2) Planting Rubber in Marginal Tea Lands

- Land area: 5,000ha
- Project start date: 2007
- Expected CER delivery - 1st year: 90,750 tCO_2 - up to 2012: 453,750 tCO_2
- Baseline scenario: exclude C fixing by tea
- Additionality: introduce into existing tea lands

According to a recent survey, at least 38,000 hectares of land in the dry zone are available for reforestation, while 14,000 hectares are available in the hill country. Based on the above, and on an estimate of 26 of CO_2 sequestration per ha/year, the national CDM potential for other projects of this nature is estimated as 1,352,000 CO_2 per year.

3.11 The potential state sector CDM projects

3.11.1 Replacing old refineries

Refineries of the Ceylon Petroleum Board (CPB) are outdated and as a result they are inefficient. Though there is a need for the replacement of these old refineries, due to financial, economic and political situation of the country there is no possibility to replace these old refineries with new efficient refineries. However, there is a possibility to replace these old refineries under the CDM project activity if CDM revenue can meet a percentage of total investment. According to past experience, CDM projects can provide up to 20% of the total investment depending on the total volume of GHG saved. At this point it is difficult to estimate the total CDM revenues that can be earned from replacing old refineries with new technologies.

Baseline emissions for this project are the GHG emissions emitted from the old refinery (old technology) including any fugitive emissions. The difference between the emissions from old refinery and emissions from new technology can be estimated as carbon credits. Further analysis is required to estimate the total carbon trading potential of this project.

The important factor here is the ability to prove or demonstrate that if there is no CDM money, this project will not happen and CPB will continue to use the old refineries. Therefore in the government decision to replace these old refineries there should be a reference that the project will be implemented as a CDM project. This is important to demonstrate that under business as usual scenario this project will not be implemented and only under CDM project activities the government is planning to undertake this project.

For this project new methodology has to be approved by the CDM Executive Board so that it takes around one year to complete the CDM project development process. This also depends on how fast the actual implementation can be taken place.

3.11.2 Replacing outdated bus fleet of Ceylon Transport Board

The Ceylon Transport Board (CTB) has many fleets, numbering over 8,900 buses that are fuel hungry. These buses consume considerably higher volume of fuel than new buses. Due to economic and financial situation of the CTB and the country it is unlikely that these old fleet is replaced with new fleet in the near future. The business as usual scenario is that the CTB continues to use this old fleet owing to the financial and economic situation of the organization. However, there is a possibility to replace this old fleet under the CDM project activity if CDM revenue can meet a percentage of total cost of the project. At this point it is difficult to estimate the total CDM revenues that can be earned from replacing old fleet with a new fleet.

Baseline emissions for this project are the carbon dioxide (CO_2) emitted from the old fleets. The difference between the emissions from old fleet and emissions from new fleet can be estimated as carbon credits under CDM. Further analysis is needed to estimate the total potential of this project.

The important factor here is that we should be able to prove or demonstrate that if there is no CDM money this project will not happen and we will continue to use the old bus fleet with minimum repairs even through it emits higher emissions. Therefore in any government decision to replace this old fleet, there should be a reference that the project will be implemented only as a CDM project. This is important to demonstrate that under business as usual scenario this project will not be implemented and only under CDM project activities the government is planning to undertake this project. This is because the business as usual projects are not eligible as CDM projects.

For this project, CDM project development process will take around 6 months. This also depends on how fast the project can be implemented.

3.11.3 Improvement of Sri Lanka Railway replacing old engines and possibly introducing electric trains

Sri Lanka Railway has very old diesel engines that pollute the environment. There is a lot of potential to improve the train service by putting new trains and adding new railway lines which attract new commuters to railway. There is a potential to increase commuters by 200,000 a day and increase to over a 1.4 million per day in few years. This will reduce great deal of CO_2 emission through fuel saving. However due to various technical, financial and economic barriers this project is not possible in the near future. These barriers can be removed through developing this project as a CDM project since the CDM revenue can meet part of the investment costs.

The difference between the emissions due to present railway system and emissions from the improved railway system which can be estimated as carbon credits under CDM. The total revenue from the sales of carbon can be estimated after project components are decided.

In order to implement this project as a CDM project we should be able to prove or demonstrate that if there is no CDM money this project will not happen and we will continue to maintain the existing railway system even though it has higher emissions. Therefore in any government decision to improve the railway system introducing electric trains there should be a reference to CDM that the project will be implemented only as a CDM project. This is important to demonstrate that under business as usual scenario this project will not be implemented and only under CDM project activities the government is planning to undertake this project.

CDM project development process will take around 6 months. This also depends on how fast the project can be implemented.

3.11.4 Cleaning the Sri Lanka Power system - Ceylon Electricity Board

Sri Lanka has a large CDM potential in the power sector. Some of these old diesel and fuel oil plants can be converted to combined cycle plants (the CEB officials can decide on which plants to replace). The proposed 900 MW of coal power plant could be converted to more advanced coal processing technologies with clean coal. Proposed new gas power plants can be developed as CDM project. Even Upper Kotmale Hydro Power Project can be converted to a CDM project through interpretation of CDM rules for our benefits and getting further clarifications from the Executive Board. There are some barriers for this. There is some room for manipulation and to make the Upper Kotmale a CDM project. However, these projects should be evaluated case by case for their CDM eligibility.

If the government gives its priority, this will be the largest CDM sector in the country.

3.11.5 Introducing nationwide CFL bulb system - Ceylon Electricity Board

The Ceylon Electricity Board has been promoting the use of CFL bulbs in residential and commercial premises many years on a voluntary basis. CFL bulbs consumes considerably lower amount of energy than normal incandescent bulbs so that this will GHG emissions. With the government intervention a nationwide CFL bulb introduction program can be undertaken as a CDM project.

The total CDM revenue and potential is dependent upon the how fast this project can be implemented.

In order to implement this project as a CDM project we should be able to prove or demonstrate that this project will be possible only if CDM funds are made available otherwise the business as usual scenario will continue.

3.11.6 Reduction of transmission loss - Ceylon Electricity Board

Sri Lanka power system experience around 17% transmission loss. This can be reduced considerably through technical and management interventions. Through proper designing, Sri Lanka electricity transmission loss reduction project can be undertaken as a CDM project. The total potential of CDM earning depends on the total possible reduction of transmission loss.

3.11.7 Improvement of efficiency of industrial process

Some state owned industries such as Paper Company still use old boilers and other equipment in the production process. These old industries can be replaced with new energy efficient technologies under CDM project activities. The total number of possible industries that can be converted and their total CDM potential need to be estimated.

3.11.8 Introducing water pumping efficiency improvement - NWSDB

National Water Supply and Drainage Board (NWSDB) consumes a considerable amount of energy for pumping water. Introducing efficient system the NWSDB can save energy. Through implementing this project as a CDM project, the country can earn foreign exchange by selling carbon credits. The total foreign exchange earning potential can be estimated after consultation with NWSDB officials.

3.11.9 Bus Rapid Transit (BRT) Project

Bus Rapid Transit (BRT) is a bus based mass transit system that delivers past comfortable and cost effective urban mobility. The Urban Development Authority (UDA) has initiated a BRT project starting from Dematagoda to Battaramulla to reduce traffic congestion to Battaramulla from various places introducing new dedicated bus line along the Dutch canal.

This BRT will reduce green house gas emissions via:

- Improved fuel use efficiency through new and large buses
- Mode switching due to availability of a more efficient and attractive public transport system
- Load increase by centrally managed organization dispatching vehicles
- Potential fuel switch to low carbon emissions

BRT system replaces the conventional public transport system. The new bus system transport passengers, who in the absence of the project would have used the conventional public transport system or other modes of transport such as passenger cars. As a part of the project a reduction or retirement of some of the conventional buses through scraping and reduction of route permit could be taken place, which reduce green house gas emissions.

The estimation of the total carbon credit earning potential of this project needs more detail information.

3.11.10 Reforestation and afforestation projects in Sate lands

There is a potential for forest plantation in the marginal areas of the Janatha Estates Development Board (JEDB), State Plantation Cooperation (SPC), National Livestock Development Board (NLDB) and other state own coconut, rubber and tea estates including pasture lands. This degraded or abandoned land can be reforested as CDM projects and earn carbon credits. Forest Department can undertake forestry projects as CDM projects.

Estimation of total potential needs further analysis with detail project information.

3.12 Limitations

a. The first commitment period for CDM is between 2008 and 2012. Therefore we have only few years left to develop CDM projects. All of the above identified CDM projects require at least 3-year lead time. This means that during the first commitment period, these projects can earn credits only for a few years. However, there is a strong possibility to extend this period and have a second commitment period. We must prepare for the second commitment period as well.

b. Lead time for a large CDM project is around 3 – 5 years.

c. The other issue is that the business as usual projects are not eligible for CDM. In other words, if a project can happen under the business as usual scenario without the CDM benefits, that project is not eligible for CDM. The government should indicate some where in policy decisions that these projects will be implemented as CDM projects since given the financial situation these projects will not be undertaken under the business as usual scenario.

d. This needs government commitment

e. The CDM project development cost is very high and it ranges from Rs. 3 million to Rs. 20 million.

CHAPTER 4 - ANALYSIS OF THE CURRENT POLICIES, AND THE BARRIERS (LEGAL, FINANCIAL, TECHNICAL AND INSTITUTIONAL) THAT HINDER ITS DEVELOPMENT

4.1 Institutional Structure of Sri Lanka

The institutional and administrative structure of the Democratic Socialist Republic of Sri Lanka is based on its republican constitution. The Executive President of the Republic is elected by the people and holds office for a term of six years. Parliament, which consists of 196 members elected by the people and 29 members from the national lists, also continues for six years. The President appoints the Prime Minister and the Cabinet of Ministers and is the Head of the Cabinet. The country is divided into nine provinces for administrative purposes. Power has been devolved to the provinces and the unit of devolution is the Provincial Council comprising a number of members elected by the voters of each province. A Governor appointed by the President heads the province and a Chief Minister appointed from amongst the elected members heads the Provincial Council. A separate Ministry was created for the subject of Environment in 1990 and the Central Environmental Authority which was established in 1981 was strengthened to effective enforcement of the environment related laws and regulations.

Sri Lankan Environmental Management Policy originates from the country's supreme law that is the Constitution. The 1978 constitution recognizes that the state shall protect, preserve and improve the environment for the benefit of the community (Article 24(14)), as principle of state policy. The constitution also recognizes that it is the duty of every person in Sri Lanka "to protect nature and conserve its riches" (Article 28 (f). The pledge given in the 1978 constitution to safeguard the environment was formally institutionalized with the enactment of the National Environmental Act No. 47 of 1980. This Act established the Central Environmental Authority (CEA) in 1981 as the premier state agency responsible for the "formulation and implementation of policies and strategies for the protection and management of environment in Sri Lanka".

The Constitutional pledge for the management of environment was further strengthened by the Thirteenth Amendment to the Constitution which dealt with the devolution of power and administrative responsibility in a number of areas including environment. The Thirteenth Amendment states that the protection of environment within the province to the extent permitted by or under any law made by parliament is the responsibility of the Provincial Council (Ninth schedule, List 1 section 37). In addition to this, the Thirteenth Amendment to the constitution lists the following areas related to environment as devolved subjects and the Provincial councils' environmental health, establishment and maintenance of herbaria, some functions of land use and land improvement, preservation protection and improvement of stock and prevention of animal diseases, regulation of mines and mineral development, fees under the Fauna and Flora protection ordinance, land development.

Ambiguously, some important environmental subjects are listed under the concurrent list, for which, both provincial and central government had to agree on the implementation of the remaining powers which were held concurrently. Such subjects are soil erosion, social forestry and protection of wild animals and birds, and protection of the environment.

Under the Amendment each provincial council had the authority to enact and implement any statute related to their responsibilities. On the basis of these provisions, the North Western Provincial Council (NWPC) passed its own environmental statute and created its own Environmental Authority, the Wayamba Environmental Authority (WEA). Other provincial councils have not so far enacted any such statute.

The NWP environmental statute has also prescribed the projects and undertakings which are required to obtain Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA). This prescribed list does not include large development projects such as power generation and major irrigation works, etc. The event of conflicts between a provincial statute and an Act of Parliament with respect to a subject in the concurrent list, the provincial statute takes precedence within the province. This has led to a situation where large scale projects which are not prescribed by the NWP environmental statute would be exempted from the EIA requirement of the WEA.

Other constitutional provisions available for environmental protection are provisions to obtain writs from the Court of Appeal against administrative acts or omissions (Article 140). eg. the Environment Foundation Ltd. (EFL), a NGOs applied for a writ of *certiorari* to quash the decision of the secretary to the Ministry of Forestry and Environment to approve the Upper Kotmale Hydro Power Project (CA No.1023/98). The EFL also has requested a writ of *mandamus* and writ of *prohibition* from the Court of Appeal under article 140 of the Constitution to direct authorities to take action to stop disastrous sand mining (CA No. 673/97). Under the Article 126 of the constitution, a citizen sought redress from the Supreme Court for violating his right to life that include a right to an environment suitable to live in and right to breathe air of acceptable quality that supports life (SCFR *569* /98).

4.2 Supportive Policies and Acts

4.2.1 National Environmental Act No. 47 of 1980

The National Environmental Act (NEA) is the national framework legislation in the field of environment which empowers Central Environmental Authority for the implementation of policies and strategies for the protection and management of the environment in Sri Lanka (Section 10 of the NEA of 1998).

The NEA states that no person shall discharge, deposit, or emit waste into the environment which will cause pollution except under the authority of license issued by the Central Environmental Authority; and in accordance with standards and other criteria as may be prescribed under this act. It also prohibits the pollution of the atmosphere by any physical, chemical or biological condition that make the atmosphere or part of it unclean, noxious, poisonous, impure, detrimental to health, welfare, safety property of human beings, poisonous or harmful to animals and other wildlife. It also prohibits the disposal of waste and hazardous materials to the atmosphere, waters or soil. In this act it is also stated that minister may make regulations in respect to matters stated or are required by this act. For instance, regulations on the specification of ambient air quality standards and emission and specifying the maximum permissible concentration of any matter that may be present in or discharged into the atmosphere; regulations on prohibition of the discharge, emission or deposit to the environment of any matter, whether liquid, solid or gases or of radio activity and prohibition or regulating the use of any specified fuel. It also provides for the prohibition of the use of any equipment, facility, vehicle or boat capable of causing pollution or regulating the construction, installation, or operation thereof so as to prevent or minimize pollution.

Sections 23 of the NEA of 1980, which was amended in 1988, prohibit emission of pollutants into the atmosphere. Although discharge standards have been prescribed for liquid wastes, and the Sri Lanka Standards Institution (SLSI) has prescribed emission standards for sulphuric acid plants, these regulations do not address vehicular air pollution. Though the NEA has given the mandate to the CEA to regulate and control air pollution, little has been achieved in this area due to lack of appropriate regulations. Amendments to the Motor Traffic Act have given sufficient authority to the Department of Motor Traffic and Police Department to control vehicular emissions.

This Act also provide for the protection, management and enhancement of the environment, for the regulation, maintenance and control of the quality of the environment and to prevent, abatement and control of pollution. According to this Act, no one can deposit or emit waste into the inland waters of Sri Lanka and no one shall pollute the Sri Lankan waters. Offenders will be punished.

Procedures for obtaining necessary clearance for establishing new projects have been detailed. For each of the industrial sectors and the nature of the environmental impacts anticipated, a screening committee of competent personnel is established, to consider the proposal. Public is also provided an opportunity to make comments and suggestions on the project proposal. Aggrieved persons have a right to appeal against the proposal or the decision taken to establish the project. The decision of the Secretary to the Ministry, on such appeal, shall be final.

Sections 23 J and K of the NEA of 1980, which was amended in 1988, prohibit emission of pollutants into the atmosphere. Although discharge standards have been prescribed for liquid wastes, and the Sri Lanka Standards Institution (SLSI) has prescribed emission standards for sulphuric acid plants, these regulations do not address vehicular air pollution.

Though the NEA has given the mandate to the CEA to regulate and control air pollution, little has been achieved in this area due to lack of appropriate regulations. Amendments to the Motor Traffic Act have given sufficient authority to the Department of Motor Traffic and Police Department to control vehicular emissions. An increase in awareness has led to the recognition of the need for increased regulatory control and policy formulation including the formulation of the Clean Air 2000 – Action Plan.

The NEA 47 or 1980, amended by Act 56 of 1988 stated that no person shall discharge, deposit, or emit waste into the environment which will cause pollution except under the authority of license issued by the CEA; and in accordance with standards and other criteria as may be prescribed under this act.

It also prohibits the pollution of the atmosphere by any physical, chemical or biological condition that make the atmosphere of part of it unclean, noxious, poisonous, impure, detrimental to health, welfare, safety property of human beings, poisonous or harmful to animals and other wildlife. It also prohibits the disposal of waste and hazardous materials to the atmosphere, waters or soil.

In this act it is also stated that minister may make regulations in respect to matters stated or are required by this act. For instance, regulations on the specification of ambient air quality standards and emission and specifying the maximum permissible concentration of any matter that may be present in or discharged into the atmosphere; regulations on prohibition of the discharge, emission or deposit to the environment of any matter, whether liquid, solid or gases or of radio activity and prohibition or regulating the use of any specified fuel.

It also provides for the prohibition of the use of any equipment, facility, vehicle or boat capable of causing pollution or regulating the construction, installation, or operation thereof so as to prevent or minimize pollution.

4.2.2 National environmental policy

A National Environment Action Plan (NEAP) was developed to provide the policy framework for sustainable development. A participatory approach was followed in preparing this policy. National policies such as forestry, wildlife, coast conservation, several draft national policies yet to be approved by the government such as environment, lands, and long term development plans and strategies such as Forestry Sector Master Plan, NEAP, Coastal 2000, promote participatory approach in natural resource management. They advocate active public participation and the multiple stakeholder involvement in the planning, implementing, monitoring and evaluation of a development activity with full transparency and accountability on the part of all parties.

The NEAP as a national sustainable development strategy encourages the integrated approach for the management of natural resources and environment. The NEAP is a national action plan and a policy framework on environment which contain many recommendations to integrate environment and development. No single agency can take the responsibility for implementing the entire plan. Government agencies, non-government agencies and private sector are expected to implement it. Therefore, the link between central government institutions, provincial and local authorities, co-management with community organisation and NGOs are clearly recognised.

The NEAP clearly recognizes the role of private sector, role of NGOs and the role of the civil society. While recent legislations such as Fisheries Act and Amendment to the Forest Ordinance emphasize co-management, older laws such as Fauna and Flora Protection Ordinance often limit or prohibit any form of meaningful community participation.

The NEAP also recognizes the importance of public-private partnership for environmental management. Examples for the private-public partnership in the implementation of sustainable development strategies are participatory forestry projects, medicinal plant conservation project and wild life conservation and protected area management project. Co-management of natural resource has also being recognized.

National Planning Department has introduced environment screening of all public sector investment projects. EIA has been made statutory for all prescribed projects and the EIA procedures are being constantly reviewed updated. Sectoral EIA guidelines are being finalized for a number of sectors. Environment Protection Licensing (EPL) Scheme is compulsory for all projects. The EPLs has been decentralized.

There are more recent plans like the Caring for the Environment (CFE) which is now being updated, than NEAP. This section should cover that all.

4.2.3 Sustainable development policy

Sri Lanka has been implementing national strategies and plans to achieve sustainable economic growth with equitable distribution of income. These national strategies and frameworks for the protection of the environment were in place to a large extent in Sri Lanka even before the Stockholm Summit in 1972. However, there are serious anomalies in income distribution and more than 20 percent of the population (about 4 million people) lives in absolute poverty. One third of families receive poverty alleviation grants under the government's *Samurdhi* programme. National policy to solve the growing problems of poverty and unemployment compounded by population pressure was to achieve a faster growth rate through diversification of agriculture and development of industry in 1970s. The recent transformation in Sri Lanka from a traditional agricultural based rural economy with a sustainable lifetime to a more diversified and commercialised economy is an indication of the country's attempt to move away from total dependence on agriculture to solve the growing problems of unemployment and poverty.

After the Rio Summit in 1992 the government of Sri Lanka began to follow a more focused and completed policy towards sustainable development. Sri Lanka actively participated in the Agenda 21 preparation exercise. Since then, the Agenda 21 is being consulted as a guidance document by all development sectors in the Government system as well as by the private sector and the civil society. The entire government system was alerted to the need for environmental conservation particularly of natural resources and many activities and programs were launched for that purpose. Principles of sustainable development are contained and enshrined in most of the development programs. During the period of 1996-2000 the Government pursued the objectives of accelerating economic growth, while ensuring equity and a higher quality of life particularly for the poor.

During this period, the bias was towards environmental conservation more than economic development. In the second half of the 1990 decade, the government realized the need to strike a balance between environmental conservation and economic development. Principles of sustainable development were highlighted which required the Government to address not only environmental issues but also economic and social issues simultaneously. The triangular relationship between the economy, the society and the environment in the geo-political, biophysical, and socio-economic development process was brought in to strong focus of the government.

4.2.4 Policies related to Power Sector

The long awaited power sector restructuring finally got under way with the incorporation of "Electricity Reform Act No. 28 of 2002" in December 2002.

An extract of a policy statement issued by the Government soon after the incorporation of the above act reads as follows (Ref.13): "*The overall energy development goal of Sri Lanka is to meet the demand for energy services with affordable, reliable, diverse, safe and environmentally sustainable choices of people of Sri Lanka in economically and socially most efficient manner. Within this board framework, the rationale behind the reform objectives in relation to electricity is that, given proper institutional frameworks, pricing signals and regulatory regimes, markets can efficiently deliver on the economic development objectives, including adequate, high quality and reliable services*."

Accordingly, the economic and social objectives after restructuring the electricity sector in Sri Lanka are as follows:

- Increasing competition in the electricity industry to bring about more efficiency within the industry, while ensuring the provision of adequate and best possible electricity supply and services, reasonable price levels and safety standards to electricity users.
- Attracting foreign investment and mobilizing local private capital and expertise for the sector; This objective focuses on promoting investments for widening access to encouraging efficiency, increasing generation capacity including expanding the use of advanced, clean fuel technologies, and accelerating new renewable energy diffusion.
- Reducing the investment burden on the government as well as the public sector debt; with the increased private investment following to the power sector, the public funds utilized for the development of power sector will be allocated on the basic of economic and social opportunity cost.
- Promoting the more efficient use of electricity such as that demonstrated by Lanka Electricity Company Limited.
- Creating a more competitive and efficient market for the human resources in the electricity sector.
- Widening access globally competitive technology in the sector.
- Encourage general public participation in the electricity industry development in the country through the development of the capital market.
- Developing the capital market.

The following policy premises supplement these objectives:

- Since the electricity supply industry in Sri Lanka is currently a state monopoly, the increase in the role of the private sector in the industry must be to promote competition and avoid transfer of the public monopoly to a private sector monopoly.
- Markets alone cannot be expected to meet the needs of the most vulnerable electricity consumers and to protect the environment. Where markets appear to fail to protect these and other important public benefits, targeted policies such as rural electrification and consistent regulatory approaches such as tax concessions, life line tariffs and measures to ensuring an adequate supply will be given due consideration by the government.

The economic and social objectives of restructuring the electricity sector will be in conformity with the following overall energy sector development objectives:

- Providing basic human energy needs.
- Reducing dependence on imported energy.
- Diversifying energy sources.
- Choosing the optimum max of energy sources taking into consideration the ability to influence demand on source types.
- Optimisation of the operation on indigenous energy resources (hydro electricity, bio-mass, wind, solar etc.).
- Conserving and eliminating wasteful consumption in the production, distribution and use of electricity.
- Ensuring continuity of energy supply.
- Increasing the content of local manufacture, fabrication, construction and value addition in the energy supply and utilization areas.
- Establishing the capability to develop and manage the electricity sector.

4.2.5 Policy on rural off-farm employment and electrification

The policy on Rural Employment and Electrification has been spelt out in the "Regaining Sri Lanka" as described below.

Agriculture alone will not be sufficient to raise incomes in the rural areas. There is compelling evidence that those rural families that derive the greatest share of their income from off-farm income are able to work their way out of poverty the fastest. Access to electricity is necessary for practically any off-farm activity. Without access to electricity, rural areas cannot host the industries and other off-farm income-generating activities that are essential to a pro-poor process of structural change. Electric lighting, unto itself, also makes a very important contribution to the quality and effectiveness of rural education.

There are vast differences in regional access to electrification. In the Western Province, where the incidence of poverty is relatively low, nearly 80 percent of the households have access to electricity. By contrast, less than 20 percent of the households in the North-Central Province have access to electricity. In the Sabaragamuwa, Uva, North Western and Central Provinces, between 40 and 50 percent of the households are without access to electricity. But progress is being made on bringing electricity to under serviced areas. Between 1980 and 1998, the total number of village electrification schemes increased from 2,115 to 14,690. These now cover some 53 percent of all villages in the country. By 2005, the Government aims to bring electrification to some 80 percent of the nation's villages. Some 600 rural electrification schemes, covering eight provinces will provide electricity supply to about 112,500 additional households and other consumers. This will be an increase of about 5 percent in the nation's total connections (by 2005). Some 600km of 33-kv development lines will be supplied to strengthen CEBs existing distribution networks in rural areas, which are becoming overloaded, and to reduce losses on those lines. A range of alternative energy sources (solar, wind, mini-hydro) will also be developed through community-based organizations and the private sector to expand rural electricity access, particularly in the more remote, dry zone regions. Where capital costs for rural electrification are prohibitive, transparent subsidies will be provided, to expand access.

4.3 Legislation and regulations related CDM

4.3.1 Legislation on industries

Guideline for the establishment of high and medium polluting industries are in place. High polluting industries should be located only in industrial zone. A programme to introduce cleaner technologies to local industries was commenced in 1994 and continued to date. A National Industrial Pollution Management Policy was adopted in 1996, and a National Strategy for Solid Waste Management launched in 2000. Regulations for hazardous waste management were gazetted on 23rd of May 1996, as an amendment to the gazette notice on Environmental Protection Licensing Scheme (EPL) published in 1990. The Guidelines for the implementation of hazardous waste management regulations were published in 1999**,** and a Solid Waste Management Strategy was adopted in 2000. A major programme was undertaken to improve the Colombo Metropolitan Environment including rehabilitation of canals and lakes in the metropolitan area, reclaiming low-lying areas and demolishing of unauthorised structures. Work on the building of sustainable townships was undertaken to resettle people living in unauthorised dwellings within the city.

4.3.2 Legislation on energy

The power supply being the engine of growth in all other sectors of the economy, any adverse policy in the power sector will have its impact manifested in all other sectors of the economy.

The implicit national energy policy mainly discusses, the providing the basic energy needs for Sri Lanka, choosing the optimum mix of energy resources to meet the energy requirements at the minimum cost to the national economy, optimisation of available energy resources to promote socio-economic development for the country, conserving energy resources and elimination of wasteful consumption in the production and use of energy, developing and managing forest and non-forest wood fuel resources, reducing dependence on foreign energy resources and diversifying the sources of energy imports, adopting a price policy which enables the financing of energy sector development, ensuring continuity of energy supply and energy price stability, and establishing the manpower capability to develop and manage the energy sector.

There can have various policy implications when it is implementing the energy policy. Those implications can be summarized as adoption of the least economic cost approach in the power sector expansion, elimination of outside interference in decision making in the power sector, integration of environmental implications of power projects at the planning stage of the power project, the development of a rational approach in decision making on vital development projects such as power projects with regard to the environmental clearance. Environmental clearance is needed to be taken for any energy developing project under the National Environmental Act. Today most of the electricity projects find it difficult to implement those projects under the NEA until it fulfills the parameters of the environmental components.

Emissions standards for power plants have been drafted by the CEA and awaiting public comments.

4.3.3 Legislation on mines and minerals

Minerals play a significant place in the country's economy. At the same time mining operations contribute to adverse impacts on the environment, that include extensive soil erosion, health hazards, disturbing the fauna and flora and damaging natural vegetation. Air pollution, noise pollution, landslides, erosion of river beds and coastlines are also common. The statute pertaining to mines and mineral includes Mines and Minerals Act No. 4 of 1972, State Gem Corporation Act No 13 of 1971 and Radioactive Minerals Act No. 46 of 1968 and the Salt Ordinance 46 of 1890.

The Mines and Minerals Act No. 33 of 1992 made number of major changes to the earlier Act. This Act repealed the Mines and Mineral Act No. 4 of 1973 the Salt Ordinance and the Radioactive Minerals Act. This Act also established the Geological Surveys and Mines Bureau in place of the Dept. of the Geological Survey.

Section 29 imposes restrictions on issuing licenses to explore for mines, transport, processing, tendering or export to under-aged or to an applicant who does not possess necessary technical know-how. Section 30 restrict issuing licenses if the location of mining is to be in close proximity to lakes, streams or tank bund, wildlife reservations, nature reserves, forests or parks, catchments areas, foreshore and seabed. Section 35 of the Act provides provisions to check the environmental degradation resulting from the industry of mining. This Act recognizes the sustainable development having included a mandatory provision that the licensee is required to rehabilitate the land upon completion of exploration or mining.

This Act makes references to the NEA No. 47 of 1980 and requires the licensee to adhere to the standards and procedures prescribed under the said Act when carrying out activities under this Act (section 6 1(1).

The drawback of the Act is the non-introduction of 'Environmental Impact Assessment' procedure before issuing mining license.

4.3.4 Legislation on solid waste

Waste can be classified as solid waste, liquid waste which includes Hazardous and non 1-Hazardous waste. Waste Management is a major environmental problem in Sri Lanka. Hazardous waste has become an important environmental and health issue and concern in Sri Lanka as in many countries including the developing nations. There is ample evidence that the improper disposal of hazardous waste can cause serious damages to health and environment.

Solid waste is described as non liquid waste material arising from domestic, trade, commercial, industrial and agricultural activities as well as waste arising from public sectors. Solid waste comprises of various different materials such as food waste and packaging in the form of paper, metals, plastic or glass, etc. Solid waste is a growing problem in Sri Lanka aggravated in the absence of a proper management system. Development and implementation of National Strategy for Solid Waste Management is essential to reduce environmental, social and economic problems associated with the present disposal practice.

Recent analysis of date pertinent to solid waste reveals that the real problem associated with solid waste at present lies to a great extent wit Ii present haphazard disposal practices more than with the rate of generation. However rate of generation of solid waste is also increasing with the increase of population technological development and the changes of life styles of the people. Waste management incorporates management activities associated with generation collection transfer and transport, processing and disposal of waste iii an environmentally sound manner. It encompasses planning, organization administration, financial legal and engineering aspects involving interdisciplinary relationships.

The national waste management strategy should be involved with waste avoidance, reduction, reuse, recycling and final disposal in an environmentally sound manner.

Legal framework required for solid waste management is adequately provided under Local Government Acts, and the Local Authorities arc responsible for the collection and disposal of solid waste in the country. The section 129, 130 and 13 1 of the Municipal Council Ordinance: and sections 93 and 94 of the Pradeshiya Sabha Act have clearly and adequately provided for the management and disposal of solid waste in the respective areas.

The provisions relating to Solid Waste Management in Pradeshiya Sabbas Act, Urban Council Ordinance and Municipal Council Ordinance arc as follows:

a). All street refuse, house refuse, night—soil, or other similar matter collected by Local Authorities under the provisions of this part shall be the property of the Council, and the Council shall have lull power to sell or dispose of all such matter.

b). Every Pradeshiya Sabbha, Urban Council and Municipal Council shall, from time to time provided place convenient for the proper disposal of all street refuse, house refuse, night-soil and similar mater revived in accordance with the provisions of the Law, and for keeping all vehicles, animals, instruments, and other things required for that the purpose and shall take all such measures and precautions as may be necessary to ensure that no such refuse, night—night soil, or similar matter removed in accordance with the provisions of the law is disposed of in such a way as to cause a nuisance.

* Provisions under National Environmental Act (NEA)

Under Section 1 2 of NEA, the Central Environmental Authority may with the concurrence of the Minister from time to time, give to any local authority in writing such directions whether special or general to do or cause to be done any act or thing which the Authority dines necessary for safeguarding and protecting the environment within the local limits of such authority.

Every local authority to which a direction has been given under subsection (1) shall comply with such directions.

The regulations concerning industrial wastes have been published in Gazette Extraordinary No. 924/13 of' May 23, I 996. This came as an amendment to the National Environmental (Protection and Quality) Regulation No. I of 1990 published in Gazette Extraordinary No. 595/16 of' February 2, 1990. However, these regulations have hardly been enforced.

In the Environmental Bill, Schedule one of Part 11 lists out 19 constituents and 9 waste streams indication what should be considered hazardous waste. Procedure for obtaining license is also set out in this Bill.

Import and Export Act No. I of I 969 has introduced a Special Import License (SIL) scheme relating to Security, environment and Public morals, those who intend to import any item under SI L require to apply to the Controller for a license. The Controller would then impose various conditions as appropriate. E.g. obtaining a certificate from Registrar of pesticides before exercising his/her discretion in favour of the importer.

The schedule B of Customs Ordinance enumerates *a* table of prohibitions and restrictions for import and export. Sections 12(1), 43 and 44 of the Ordinance describe the laws with respect to import and export of goods in schedule 13 and the power to amend the schedule by the addition thereto or by the omission there from and regulate the conditions to import or export.

In the past, hazardous waste has not received much attention of the policy planners. However, Sri Lanka ratified the Basel Convention on the control of Trans-boundary Movement of Hazardous wastes and their disposal with effect from August 28, 1 992. Since *then,* significant attention has been drawn towards the movement of hazardous waste from outside sources to Sri Lanka. The Ministry of Environment and Natural Resources serves as the focal point for the convention. In the proposed National Environmental Protection Act, provisions have been made for the Ministry to give effect to the principles tinder Basal Convention.

a). Guidelines on safety measures to be adopted during generation, collection, transportation, storage, recovery, recycling and disposal of wastes
b). Guidelines for the establishment of waste disposal sites.
c). Operation regarding recycling and recovery of waste.

A program for disposal of clinical waste in SOU1C selected hospital in the Colombo Region is presently underway. The Ministry of health intends to prepare an Action Plan island—wide for the management of clinical of waste.

The Western Provincial Council has made arrangements to establish a Waste Management Authority and a draft Act is being developed for this purpose. The Ministry of’ Provincial Councils and Local government also plans to establish a Waste Management Authority at National Level.

Some fiscal incentives are being given to industries under certain conditions to use advanced technology in order to minimize and control pollution i.e. cleaner production.

4.3.5 Legislation on hazardous waste

The proposed new National Environmental Act defines hazardous waste as ‘those materials, substances and waste which have toxic, corrosive, radioactive, chemically reactive, flammable or explosive characteristics and which are listed by the Agency by Gazette notification time to time.’

The regulations concerning hazardous wastes have been published in the Gazette Extraordinary No. 924/13 of May 23, 1996. This came as an amendment to the National Environmental (Protection and Quality) Regulation No.1 of 1990, published in Gazette Extraordinary No. 595/16 of February 2, 1990. However, these regulations have hardly been enforced. According to the amended legislation, EPL regulations have been re-designated as Part I. New part two deals with hazardous waste management. This sets out requirements to obtain a license from the CEA and specifies the procedures for obtaining such licenses and conditions attached to them. Schedule one of Part II lists out 19 constituents and 9 waste streams indicating what should be considered hazardous waste.

Apart from the aforementioned regulations, there are other controls of certain hazardous waste components, from different angles and standpoints. For instance, the following Acts have certain relevant provisions for hazardous material: Import and Export Act No. I of 1969 — this act has introduced a Special Import License (SIL) scheme relating to Security, Health, Environment and Public Morals. Those who intend to import any item under SIL require applying to the Controller for a license. The Controller would then impose various conditions as appropriate (e.g. Obtaining a certificate from Registrar of Pesticides) before exercising his/her discretion in favour of the importer.

Customs Ordinance (Chapter *235)* — The Schedule B of Customs Ordinance enumerates a table of prohibitions and restrictions for import and export. Sections 12(1), 43 and 44 of the Ordinance describe the laws with respect to import and export of goods in schedule B and the power to amend the schedule by the addition thereto or by the omission there from and regulate the conditions to import or export.

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The government of Sri Lanka has made a policy decision to locate high polluting industries wherever possible within industrial estates provided with effluent disposal facilities. The up-dated National Environment Action Plan (Caring for the Environment 2003-2007) prepared by the Ministry of Environment and Natural Resources lists out relevant issues and recommendations for the Industry Sector.

Guidelines for the implementation of hazardous waste management regulation have been prepared by the CEA, under the guidance of the Ministry of Environment and Natural Resources. These include,

a) Guidelines on safety measures to be adopted during generation, collection, transportation, storage, recovery, recycling and disposal of wastes.
b) Guidelines for the establishment of waste disposal sites.
c) Operation regarding recycling and recovery of waste.

Principal Implementing Bodies with regard to Hazardous Waste Management are the Ministry of Environment and Natural Resources, Central Environmental Authority and Local Authorities. In addition to these, a large number of institutions are responsible or management of hazardous wastes under various legislation enactments.

4.3.6 Environmental Impact Assessment (EIA)

The EIA Process was first introduced to Sri Lanka by the Coastal Conservation Act of 1981, later in 1988 it was included in the National Environmental Act introducing EIA process to the entire Island.

An EIA is defined as "a written analysis of the predicted environmental consequences of a proposed project" [Section 33 of the EIA]. The same definition has been included in the Coast Conservation Act and amendment of 1993 to the Fauna and Flora Protection Ordinance. The Southern Development Authority Act of 1996 also contains the same definition.

The following contents must have been included in an EIA report

1. A description of the proposed PP;
2. Prediction of Environmental Consequences of the proposed PP;
3. Avoidable and unavoidable adverse impacts of the PP;
4. Description of irreversible and irretrievable commitment of resources for the PP;
5. Alternatives to the proposed PP
6. Reasons why these alternatives were rejected; and
7. An environmental cost / benefit analysis, if one has been prepared.

According to the definition of EIA, the process is envisaged for individual projects. Every prescribed project, whether undertaken by the Government or a private proponent must undergo the EIA process. For every prescribed project, an EIA or an IEE must be prepared. Prescribed projects were listed in the Gazette Notification No 772/22 of 24th June 1993, and will be implemented through designated Project Approving Agencies (PPA) as prescribed by the Minister under section 23 Y of the NEA. In Gazette Extra -Ordinary No 859/14 of 23rd February 1995. Under section 23 CC of the NEA, regulations have been made by the Minister stating the procedures that should be followed in order to achieve the EIA requirements of the NEA.

The Central Environmental Authority (CEA) as the agency charged with the responsibility of implementing the above provisions of the NEA, will promptly advise PPAs of any amendments to the NEA relevant to part IV C and/or the orders and regulations included in Gazette Extraordinary No 772/ 22 of 24th June 1993.

The National Environmental Act had identified two levels in the EIA process: IEE and EIA. Initial Environmental Examination (IEE) is a report where possible impacts of a prescribed project are assessed with a view to determining whether the impacts are significant or not. An IEE must address the possible impacts and the intensity of such impacts.

The EIA is a report which is a more comprehensive document whereby alternatives to the proposed project are considered and the option with the least impact on the environment identified and assessed Mitigation measures for the impacts identified as significant are part of an EIA. An environmental cost benefit analysis is also undertaken where ever possible.

The timing of the lEE/EIA is crucial if it is to become a useful tool in decision making. If the timing is late then many important decisions would have been made. Project proponents are thus advised to come within the ETA process at a very early stage in the project cycle.

There are 5 major steps in the EIA process. First step is Preliminary Information. A project proponent is required to give the PAA preliminary information on the proposed prescribed project as early as possible. The preliminary information submitted should be comprehensive and may even suffice to be considered as IEE.

Second step is Environmental Scoping is the process of identifying the important issues which must be addressed in detail in the EIA.

The next step is Public Participation. It is one of the most crucial aspects of the EIA process. The Provisions for public participation is contained in the NEA.

Decision Making is the next step. According to the regulations, the PAA shall grant approval for the project subject to specified conditions or refuse approval for the implementation of the project with reasons for doing so.

The next step is Monitoring. The success of the EIA process would be totally negated if the conditions imposed by the PAA are not effectively monitored. EIA report must be in a recommended format. Agencies should use a format for EIAs that will encourage good analysis and clear presentation of the Alternatives including the proposed action.

The text of EIA (excluding appendices) should normally be less than 50 pages. For proposals with unusual scope or complexity, it should normally be no more than 100 pages. EIA should be written in plain language and may use appropriate graphics so that decision makers and the public can readily understand them. EIA’s may be written in English, Tamil or Sinhala. But it is advisable to make available it in Sinhala or Tamil at the public inspection.

Central Environmental Authority had prepared guidelines for an Extended Benefit Cost Analysis for the use of the project proponents to make an Extended Benefit Cost Analysis for the projects. And also the project proponents should ensure the professional integrity, including scientific integrity of the discussions and analyses in EIAs.

After an EIA is prepared, the project proponent must submit it to the PAA who must check its adequacy against the terms of reference. [EIA regulation 11(i)] In the case of an IEE there is no such requirement to check the adequacy. If the PAA is not satisfied with the EIA, then it should ask the project proponent to make the necessary amendments and resubmit it [EIA regulation II (ii)] and the PAA must thereafter publish a notice in the *gazette* and in daily newspapers in all 3 languages inviting the public to inspection and make comments on the EIA/IEE within 30 days. [NEA, section 23BB(2) read with EIA regulations 8(u) and 12(u)] These costs are to be pre-estimated and collected before scoping as administrative charges from the project from the project proponent. As per EIA regulations 7 (iii)], the notice should say where and when the

EIA /IEE can he inspected. [NEA, section 23BB(2) read with EIA regulations (iii) and 12(u)]. Once the public comment period is over the PAA must decide whether the case warrants a public hearing. [NEA, section 23BB(3)]. At the conclusion t the hearing and/or comment period, the PAA must send the project proponent for review and comment.[EIA regulations 12 & 9(i) When the response is received, the PAA 30 days in the case of an EIA to make its approval decision [EIA regulations 10 & 14].

In the case of an IEE, the PAA can grant approval with conditions or refuse approval (giving reasons) or call for an EIA where significant impacts are disclosed. [EIA regulations 10]. In the case of an EIA, the PAA can grant approval with conditions or refuse approval with reasons. [EIA regulation 14]

When the PAA approves a project proposal with or without conditions, a notice of this fact must be published in the gazette and in the daily newspapers in the three languages. [NEA, Section 23BB (4) read with EIA regulation 17] The approval remains valid for 24 months [EIA regulation I 8] where approval is refused; the project proponent has a right to appeal to the secretary of the Ministry of Environment and Natural Resources [NEAS' 23 DD read with EIA regulation 15]. There is no time limit fixed for the appeal and, therefore, it may be lodged within a reasonable period of time. The appeal must be in writing and the Secretary may hear the appellant in support if his appeal. The secretary can confirm, reject or modify the PAA's decision.

The Central Environment Authority had prepared guidelines for implementation of the EIA process in three volumes.

(1) A general Guide for Project Approving Agencies (PAA)
(2) A General Guide for Conducting Environmental Scoping.
(3) Public Participation Handbook.

In addition to these, several sectoral guidelines have been prepared by the CEA.

The project - oriented focus of the ElA process could be considered as a drawback in the process. Because EIA are prepared for individual projects, the cumulative impacts of projects could be overloaded. It is desirable to prepare EIAs at the strategic level on a regional basis once development projects for a particular region have been identified. Though NEA envisages the preparation on EIA reports for individual projects, it does not rule out macro-level planning or the preparation of EIAs on a macro level. On the contrary, the NEA itself requires the preparation of a land **use** scheme for Sri Lanka.

For macro level EIA planning, the word 'effects' in the defluxion of an EIA in Article 33 of the NEA could be interpreted as including cumulative environmental effects. The guidelines prepared by the CEA for implementation of the EIA process recognize the importance of discussing the cumulative impacts of Projects where the impacts of individual projects may be insignificant, but cumulatively may give rise to significant impacts. The individual project base EIA process can overlook the overall consequences or the cumulative impacts of the activities. This seriously undermines the important role played by EIAs as a tool to achieve sustainable development.

4.4 Institutional Capacity for CDM activities in Sri Lanka

The UNFCCC, which is the main international body administering the Kyoto Protocol implementation has proposed broad institutional framework and tools to be adopted for successful implementation of the provisions of Kyoto Protocol. Under these guidelines a Designated National Authority (DNA) to act as the focal point of Kyoto Protocol coordination has been proposed (UNFCCC recommendations for the DNA Decision 17/CP.7 Annex 1).

To be included in CDM activities, the participating country requires becoming a member of the UNFCCC, which Sri Lanka had already fulfilled. In order to coordinate the related efforts, UNFCCC requires all parties involved to establish a DNA. An expert committee needs to be appointed for the purpose of evaluating and recommending the suitability of submitted Project Idea Notes (PIN) and Project Development Documents (PDDs) for CDM projects.

In order to ensure successful implementation of the CDM process, all non-annex 1 countries that are developing projects to limit greenhouse gas emissions, namely the Host Countries (HC) are required to adopt a framework for capacity building in stakeholders. According to the recommendations, the CDM related framework activities should include two main factors; the designed projects should reduce the greenhouse gas emission compared to the baseline and they should comply with sustainable development criteria of the host country. The host country, when implementing the CDM activities should consider all the existing legal requirements that are set forth by the legal system at the time. Secondly, UNFCCC guidelines also require the DNA to issue written approval of voluntary participation in CDM activities to the project developers. Once the PINs are submitted to the DNA, it is the responsibility of the DNA to issue the approval of the project in principle, to the project developer in writing. To facilitate the process it is recommended that the DNA establish a National Expert Committee (NEC) to assist and advice on PDD approval and other CDM activities. After receiving the recommendation of NEC, host country letter of approval for the PDD should also be issued by the DNA.

4.4.1 Functional areas of DNA

Accordingly the Ministry of Environment and Natural Resources the signatory to the Kyoto Protocol in Sri Lanka, has assigned these tasks of DNA to the Climate Change Secretariat (CCS), locally within the Ministry of Environment and Natural Resources. The role and functions of the DNA has been announced and include following areas.

- Approval and regulatory process
- Policy and legislative
- Promotional and consultation
- Training and creating awareness
- Monitoring and Advisory

As per the functions assigned to the DNA & the role expected from this unit, it is necessary to coordinate and liaise with public and private institutions representing different economic development Sectors. Institutional Structure and the functions of the Designated National Authority (DNA)

The Main functions and role played by some of the main agencies involved in CDM process are given below.

4.4.1.1 Ministry of Environment and Natural Resources (MENR)

Sri Lanka has decided to create the DNA within an existing ministry as a separate functional unit, for CDM activities. As a party to Kyoto protocol and its requirements to be a participant in CDM programs, Ministry Environment and Natural Resources has been chosen to represent the government of Sri Lanka and to create the Designated National Authority (DNA).

Ministry of Environment and Natural Resources is set forth to undertake the responsibility of maintaining a healthy environment in a developing economy while sustaining the nature by developing necessary policies. Mandate for the Ministry of Environment and Natural Resources is derived from the Constitution of the country and reads “state shall protect, preserve and improve the environment for the benefit of the country”. The Constitution also lays responsibility on public by stating that it is the duty of every person to protect nature and conserve its riches. In this effort the Ministry has created 11 divisions namely Natural Resources Management, Biodiversity, Pollution, Management, Policy Planning, Environmental Economics and Global Affairs, Promotion and Environmental Education, Human Resource Development, Legal, Finance, Administration and Internal Audit in order to execute its mandate. The Ministry is led by a Minister who answers to the Cabinet of Ministers which is the highest policy making body in the country which is a part of the Parliament; the legislature of the country. The Chief Executive of the Ministry is the Secretary to the Ministry, who is appointed directly by HE the President; Chief Executive of the Country with the powers to implement policies developed and sanctioned by the Parliament. The Secretary may appoint any officials or create administrative units within the ministry with the approval of the Minister in charge to help execute the mandate of the ministry.

The Ministry of Environment and Natural Resources as the Signatory to the Kyoto Protocol has taken the onus of implementing the provisions and has set out to create the institutional framework needed for implementing the CDM process. The implementation of the Kyoto Protocol has been placed under the Division of Environmental Economics and Global Affairs (EEGA), which has four major areas of focus. They are global affairs, environmental economics, air quality management and climate change. Sub sector of climate change is coordinated and made operational as the Climate Change Secretariat (CCS) unit where the Designated National Authority (DNA), the national focal point for the United Nations Framework Convention on Climate Change (UNFCCC) under Kyoto protocol, has been located.

4.4.1.2 Central Environment Authority (CEA)

Central Environment Authority (CEA) is one of the seven statutory agencies under the Ministry Environment and Natural Resources. It was created, even before a separate ministry for environment was formed to advise and implement the policies that are associated with environmental management and related issues. Under the provision of National Environmental Act (NEA) in 1980 (No. 47 of 1980 and later amended in 1988 and 2000) Central Environmental Authority (CEA) was established in August 1981 as the implementing agency attached to the Ministry Environment and Natural Resources. The mandate of CEA as given in the NEA is to protect, manage and enhance the environment and related regulations, maintain and control the quality of the environment, prevention abatement and control of pollution. The Authority comprises of four divisions. They are Environment Pollution Control (EPC), Environmental Management and Assessment (EMA), Environmental Education and Awareness (EEA) and Human resource (HR).

Under the Division of Environment Pollution Control there are three units. Pollution control unit is engaged in pollution related regulatory activities of industries. Hazardous waste management unit manages, advises and disseminates information in relation to hazardous waste. Laboratory service unit of the EPC engages activities related to monitoring and controlling of pollution.

Main role of Environmental Management and Assessment Division is to formulate and implement strategies for sustainable utilization, conservation and management of natural resource base of Sri Lanka. Three main implementing units under the division are Environmental Impact Assessment (EIA), Natural Resource Management (NRM) and Monitoring.

The role of the Environmental Education and Awareness division is to provide awareness, educate and inform and create opportunities for involvement towards progress and sustainability for a sound environment.

The Human resource, administration and finance division is mainly involved in managing the human resources of all the divisions discussed above and strengthening the institutional capacity of the CEA.

Although no specific role has been designated to CEA under the institutional arrangement created by the Ministry, the fact that all CDM projects should meet the sustainability criteria which include environmental clearances make CEA an integral part of the CDM process. In CDM activities initiated and monitored through the DNA, of CCS of the Ministry of Environment and Natural Resources, however depends on CEA for the final approval of the EIA needed for the process of project development and related document preparation activities. However the CEA has no special section or designated operational level officials that are involved with the implementation of the CDM projects. As a result the EIA division of the CEA has no special arrangements to handle or expedite the EIA s of projects with CDM potentials presented to it or the other EIA approving agencies.

4.4.1.3 Climate Change Secretariat (CCS)

Operating directly under an Additional Secretary to the Ministry of Forestry and Environment, Climate Change Secretariat (CCS) is an arm in the division of Environmental Economics and Global Affairs (EEGA). A Director who is responsible person for the activities of CCS heads environmental Economics and Global Affairs Division. Through the direction of EEGA division, CCS is dedicated to address national commitment to global environmental affairs and implementation of decisions made in international conventions, follow the protocols and adhere to treaties locally. CCS is also the national focal point for the Clean Development Mechanism (CDM) activities that's been proposed at the United Nations Framework Convention on Climate Change Conference (UNFCCC) for Kyoto protocol. Therefore the CCS encompasses the Designated National Authority (DNA) for the CDM activities. Therefore CDM related functions of CCS and DNA are complementary and interrelated.

4.4.1.4 Designated National Authority (DNA)

The chain of command for the DNA is channelled through from the Ministry of Environment and Natural Resources to the Environmental Economics and Global Affairs division and to the Climate Change Secretariat to the designated national authority. Although such a line of dominance exists in the structure, responsibility of initiating, implementing and monitoring of CDM related work is forwarded directly to the DNA. The Director Environmental Economics and Global Affairs, provides operation directions to the unit with four junior officers that have been assigned to assist the work at this unit.

When considering the process of CDM project cycle, DNA has three facilitating roles. They are Local clearances and approval of projects, international compliance approvals and certification of projects, and trading and transaction of emission reductions. In order to evaluate proposed projects for local clearance and approval DNA has appointed a 23 member expert committee. The main responsibility of the Expert Committee is to evaluate the Project Development Document (PDD).

As a requirement for international compliance and approval, the DNA is responsible for keeping track of Conference of Parties (CoP) meetings, and the subsidiary bodies, and the decisions made in those conferences. They are also responsible for making sure the decisions made at those committees are implemented at local level. The DNA is also in charge of communicating with the UNFCCC and obtains their views and stands before delegates attend the COP meetings. The DNA is in charge of identifying technological needs, and the facilitating the transfer of technology in the activities associated with the clean development mechanism.

Projects developed in Sri Lanka have not yet reached the stage of certification and trading, hence the structure needed for the process is not clearly identified; but can be still considered as emerging. Clearly the DNA needs to be organized to meet these challenges considering not only from need to approve the CDM Projects but also from keeping abreast with related developments in the CDM globally. To carry out these tasks the DNA should have very effective institutional linkages to other stakeholders. Nonetheless the need for these capacities will be arising soon since there are few projects that have been submitted to Designated Operational Entity (DOEs) for evaluation.

Figure 10: Institutional Arrangement of the DNA and it's Location in the Ministry of Environment and Natural Resources

Secretary of the
Ministry of Environment and Natural Resources

Additional Admin

Additional Secretary of Environmental Pollution

Additional Secretary of Natural Resources

Implementing agencies

- Conservator General of Forest, Forestry Department
- Director General, Department of Wild life and Conservation
- Chairman and Director General, Central Environmental Authority
- Chairman, State Timber Cooperation
  Chairman, Geological Survey and Mines Bureau
- Executive Director, Wild Life Trust of Sri Lanka
- Chairman, Marine Pollution Prevention Authority

Divisions

- Director, Natural Resources Management
- Director, Biodiversity
- Director, Pollution Management
- Director, Policy Planning
- **Director, Environmental Economics and Global Affairs**
- Director, Promotion and Environmental Education
- Director, Human Resource Development
- Legal Officer, Legal
- Chief accountant, Finance
- Senior Assistant Secretary, Administration
- Chief Internal Auditor, Internal Audit

Activities

- Global Affairs
- Environmental Economics
- **Climate Change (CCS)**
- Air Quality Management

(Environmental Management Officers, Program Assistance and Research Assistance handle activities listed, under the guidance of the Director.)

Program

Designated National Authority (DNA)

4.4.2 Linkages and institutional arrangements for CDM

4.4.2.1 Main Stakeholder

4.4.2.1.1 Ministry of Environment and Natural Resources (MENR)

The Ministry of Forestry and Environment is the main stakeholder in CDM process. MENR being the holder of DNA is involved with planning and policy, implementation, evaluation and certification, and other regulatory processes. It also actively facilitating and creating the support base for potential projects by appointing a National Expert Committee and a Steering Committee with representation from all stakeholder groups.

4.4.2.1.2 National Expert Committee (NEC)

National Expert Committee (NEC) has been appointed. The main role of the NEC is to advice the DNA in PDD approval process and other needed policy development and planning. Commencement of the committee is based on the requirement.

4.4.2.1.3 A National Steering Committee (NSE)

National Steering Committee has been formed to provide overall policy guidance required for DNA. The membership is represented by different stakeholder groups. To commence its activities a "Terms of Reference" (ToR) for the committee is been developed. The committee has gathered 3 times to discuss related issues since it was formed.

4.4.2.2 Other Stakeholders

Three main groups of stakeholders are the participating institutions of the government of Sri Lanka, private sector and the academia.

4.4.2.2.1 Public sector

The main public stakeholders are government ministries and departments that can play a major role in the CDM project development and carbon trading activities. The Public sector stakeholders can be considered as having two different functional relationships to CDM process. First is the regulatory role as the legal authority having jurisdiction over the potential projects while the second role can be identified as promoters of the potential CDM Project developers (eg: CEB as proponent of larger alternate energy projects or Forest department as an aforestation agency). The Department of Meteorology has taken steps to develop a Centre for Climate Change Studies (CCCS) and its main role is to assist stakeholders in technology transfer in relation to climate change projects.

4.4.2.2.2 Private Sector

Private sector stakeholders are mainly the project developers in Sri Lanka. A small percentage of the private stakeholder groups are involved in advising and consultation roles. They can participate in all levels of the project cycle from introducing new ideas for projects to assisting document preparation to help assisting in compliance with environmental regulations and validation and monitoring of the projects, Sri Lankan situation in CDM activities has only developed up to filing for PDDs. Private sector project developers are engaging in up to PDD level both as project developers and consultants.

4.4.2.2.3 Academia

As another group of stakeholders, academia is involved in research and development side of the activity and they mainly contribute new project ideas with new technology to reduce emissions. In order to get a better service from the academia, DNA has taken steps to establish a CDM Study Centers in the University of Peradeniya and in the University of Moratuwa. University of Peradeniya is responsible for the green sector of the studies while University of Moratuwa is responsible for the brown sector. Another two main roles of these study centers are to help the advisory committee on technical aspects of the projects and to help set up baselines for evaluation of such projects.

Present structural relations of DNA to other participating institutions have been documented as in one of the documents published by the Ministry of Forestry and Environment (Fig 12). Although this diagram shows the institutions that are participating in the CDM process, the structural relationships of the institutions to the DNA are not clearly demonstrated. The present structure of the institutional linkages can be illustrated as shown in figure 3. According to this it shows categories of participants and the linkages of each institution and the stakeholder groups and how they are linked to the DNA.

Figure 11: Institutional relations of CDM Sri Lanka as illustrated in a governmental document.

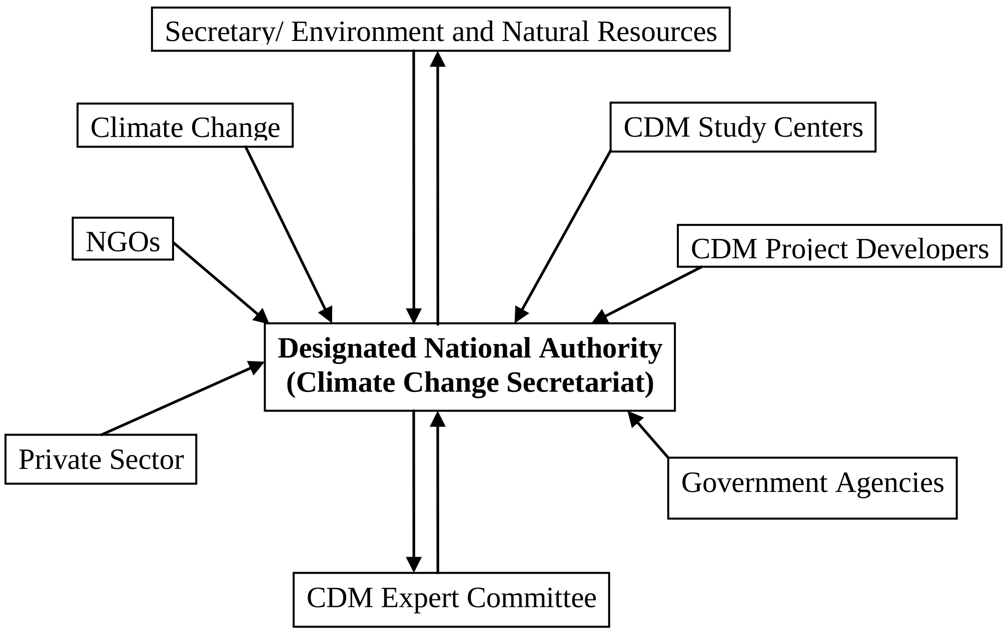
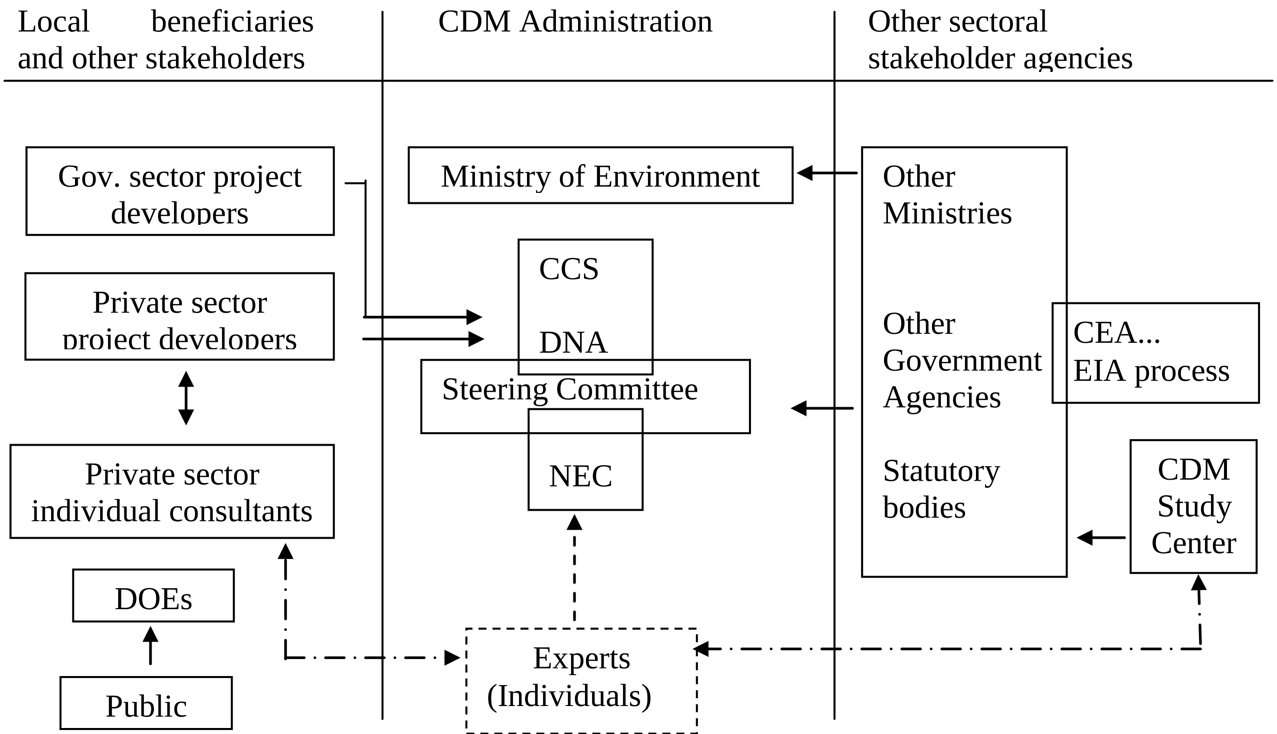


Figure 12: Illustration of the current institutional structure and linkages of CDM implementation in Sri Lanka.



4.4.3 Performances of DNA up to now according to the functional areas

The UNFCCC has recommended several mandatory roles for DNA s and suggested supportive functions in relation to CDM procedure. They can be categorized under five functional areas. They are

- Approval and regulatory process
- Policy and legislative
- Promotional and consultation
- Training and creating awareness
- Monitoring and Advisory

4.4.3.1 Approval and regulatory process

In rules and regulations of the UNFCCC, handling approval process is mandatory for DNA. At local level the DNA is evaluating and issuing letters of approval in principle after a quick perusal of the project idea notes. The evaluation process is done by environmental management officers with the supervision of the Director of the Environmental Economics and Global Affairs division of the Ministry of Environment and Natural Resources. The issuance of the letter in principle approving the project idea is signed by the Director of EEGA and this is done in order to give indicative response to the project proponent to proceed with the project until the formal approval on PIN is granted. This step has been adopted to overcome any potential delay in approving PINs, which is expected to be done by the Expert Committee. Although the Expert Committee had to be gathered for initial approval this practice has been done away lately and PIN approval has been done by the division's staff after in house evaluation. However, the NEC approves the Project Development Documents; which are more comprehensive technical documents. When the PPDs are received at the DNA, they are being directed to the NEC. They send it to an expert related to the applicable subject of the proposed project for review. With the recommendation of the expert either the host country approval letter is issued or the required changes are informed to the project developer and are helped with resubmitting for approval. The Secretary of the MENR, Additional Secretary of MENR or the Director of EEGA signs the host country letter. In granting the approval on PDD, it is expected that the DNA will ensure that the projects are in line with all the other existing regulations governing the environmental management and sustainable development in the country.

However, there are no specific checklists or terms of reference developed for guiding the technical reviewers or the officers who are approving the PDDs. It is important that uniformity is exercised in these evaluation processes where different types of project would be presented and reviewed for sustainability and environmental suitability. It would be useful if the

There are 31 PINs and four PDDs are being approved and the official letters are being issued.

4.4.3.2 Policy and legislative

The objective of the national policy on CDM is to establish institutional, financial, human resources and legislative frameworks necessary to participate in Clean Development Mechanism (CDM) activities under the Kyoto Protocol and to develop a mechanism for trading "Certified Emissions Reductions" (CER) earned through CDM activities. For successful implementation of the CDM policy of the country, institutional framework should be structured to accommodate the steps of the CDM project development process (Figure 4) and its functions. Draft policy document is now being evaluated with a subcommittee appointed to assess and make recommendations before the policy is been finalized. The mandatory requirement of the CDM policy is expected to promote sustainable development through CDM related projects and sustainable development criteria for such projects have been proposed. It is important that these criteria are finalized and published so the other agencies that are expected to play an active role could line up with the CDM policy and project approval process. Making them public is also important so the potential project developers as well as CER buyers could access them.

4.4.3.3 Promotional and Consultation

As for the promotional role of the DNA, it has advertised recently for CDM projects in the local Sunday papers for project ideas. In the consultation role, the DNA is assisting the project developers with the resources available in house or they direct the project developers to other consultants if required. Assistance is on requirement basis mainly assisting the documentation of the PIN submission to PDD submission. Though all the stakeholders are not aware, they can visit the DNA to get assistance in related project development assistance at any time of the official working hours.

However many project developers remain unaware of the whole CDM process and the role DNA is playing in promoting the CDM potentials. In this exercise the DNA has not tapped the resources available with the network of public agencies such as Board of Investment (BOI), Ministry of Industries currently involve in project approval and promotion in promoting the available CDM services.

4.4.3.4 Training and Creating Awareness

In training and creating awareness efforts, they have conducted several workshops either funded by international donors or funded by the government to educate the stakeholders. The training and raising awareness workshops are now on “invitation only” basis.

The Ministry has a Web Site devoted to the Ministry agenda, but the CDM work is not featured in this page adequately to give those who are interested an idea of the program in place or the process adopted by the DNA for approval of the projects.

4.4.3.5 Monitoring activities

DNA of Sri Lanka has not yet reached to the monitoring level of the projects that are being developed. Therefore performances of monitoring activities cannot be evaluated.

The objectives of the DNA have listed in their official document, in order to facilitate CDM activities are always not only the required functions by the UNFCCC guidelines.

4.5 Analysis of Strengths, Weaknesses and Barriers for implementing CDM

4.5.1 Analysis of Strengths and Weaknesses

As for being a new entity created to implement a new concept DNA has performed considerably efficiently in CDM related programs. But there are much more to be done to realize the full potential of the available assistance through this program. Though the program is created to reduce the greenhouse gas emission, it also helps maintain and improve sustainable development in many areas hence the development of the country. To be able to improve the process a gap analysis is needed. The process and gap of implementing CDM in relation to DNA has been evaluated and the findings are listed in table 13..

Table 13: Gaps in Implementing the CDM Process

Steps	Whom and Current Status	Remark
PIN approval	DNA/CCS/MENR done Approval granted on expert committee recommendations	Procedures in place but needs improvements. Not referred to Expert committee lately. No set guidelines even as basic approval tools.
PDD approval	DNA/CCS/MENR Approval granted on Expert committee approval	Expert committee is in place but need improvements as the expert committee also need to refer the document to an expert related to the applicable subject of the project. Here also no guidelines are formed for approval.
Registration and verifications	DOE	No local legal unit are formed to act as DoEs yet. Contacting International certification bodies can be assisted by the DNA.
Monitoring	DNA	Still to perform
Awareness raising	DNA	Need to study how much awareness currently is out there. Needs to be based on an agreed strategy on specific agenda at a time. Can conduct awareness programs to get new interested parties to participate rather than concentrating only on the already active participants.

While analyzing the process of institutional structure and the function, this study has recognized strengths and weaknesses of the involvement of DNA in CDM process. They are listed below.

4.5.1.1 Strengths

1. It is vested with the highest level of decision-making in the government in Ministry Environment and Natural Resources.
2. An ad-hoc expert committee set up already. This is in use to try to “plug in” the stakeholders in to CDM approval process
3. Defined poverty reduction (6 areas of actions)
4. Some institution linkages could ultimately have been established
5. Having an EIA process that involve possible public comments
6. Having an indicative policy on CDM with principles outlined for further development

4.5.1.2 Weaknesses

1. There is no specificity/details in the guidelines in project approvals (Subjective)
2. Not enough capacity in the Ministry of Environment and Natural Resources to asses PINs or evaluate PDDs submitted
3. Linkage of CDM to stakeholders institution remain very weak
4. Policy strategies are absent to support CDM projects for the specially where sectoral policy gaps are present

5. Expert committee needs to be provided with proper criteria of evaluation and formats to evaluate (based on TORs for Expert Committee) and make it more transparent
    1. Do they evaluate PPDs for sustainable development agenda Ex. Contribution to poverty elimination
    2. Practicing experts should be brought to the committee rather than designated officials as this is not a process for authorization but compliance
    3. Has no social/governance or finance/economics experts
    4. Not held – may be there was no demand or understanding
    5. No NGOs all GOs
6. No mechanism in place to develop the capacity among the private sector to provide necessary services.
7. Expert committee does not have a published pre-format of guidelines for approvals and records
8. No presence beyond the national ministry and no mechanism for regional/district links related to any of the CDM activities.
9. If sectoral policies such as fiscal policies are not adequately covering the concerns. The CDM process needs stronger policy framework to move forward.
10. Rigid banking/project finance practices are hindrance to the CDM projects. Banks in Sri Lanka are reluctant to recognize the CDM revenue as real income when calculating loan remittance through projects. This increases the financial burden on the project developer.

4.5.2. Barriers

4.5.2.1 Barriers for Renewable Energy

According to the "Long Term Generation Expansion Plan: 2003-2017" prepared by the Ceylon Electricity Board (CEB), Sri Lanka's electricity requirement has been growing at an average rate of 7-8% annually. This trend is expected to continue in the foreseeable future. To meet this demand about 200 MW of power plants need to be added to the national grid. Until 1996, electricity demand was met by CEB owned hydro and thermal generating plants. Since 1996, private sector has also participated in power generation. The existing generating system in the country is still predominately (76%) owned by CEB. The balance (24%) is owned by Independent Power Producers (IPP).

The country for a variety of reasons is experiencing difficulties in meeting the growing demand for electricity from conventional fossil fuel sources. The Government policy is to harness the maximum viable potential of alternative energy sources to supplement the conventional sources.

The following barriers are encountered by the renewable energy sector. A few of these barriers are relevant for specific types of renewable energy:

- **Buy-Back Tariff:** The Buy-back tariff offered by the CEB for small renewable energy is about half of the tariff offered for fossil fuel based electricity generation. The reason given for this difference is the inability of small renewable energy sources to contribute towards the capacity component of the electricity system. While this may be true for certain types of renewable energy such as wind and small hydro projects, this is not true for biomass based projects. Moreover, from a practical point of view, all small renewable energy projects do contribute towards capacity requirements of the system. As renewable energy sources have many advantages such as energy security, it is prudent to overlook any shortcoming in renewable energy and grant a tariff comparable to fossil fuel based systems. This should be included as a policy statement of the Government.

- **Lack of Project Funds:** For major fossil fuel based projects, funds are made available by donor agencies on concessionary terms. During evaluation these features make these fossil fuel based projects deliver energy at comparatively lower costs. For small renewable energy projects, funds need to be obtained from private sources or from banks at commercial rates. This makes the renewable energy projects more expensive.

- **Grid-Absorption Capacity:** The national electricity demand for energy is growing at around 8% per annum. This means that at the present level the generating capacity of the system should be increased by around 200 MW annually. To generate and distribute this additional capability, the transmission and distribution network along with substation capacities should be adequately increased. This may be carried out by connecting renewable energy generators to an existing distribution network. Currently, CEB has indicated their inability to absorb such power plants.

- **Approvals from Statutory Authorities:** Obtaining approvals from various statutory authorities for the establishment of power plants is a very tedious task.

- **Biomass Power Plants:** Biomass power plants require adequate supply of biomass fuels. Although the government has declared energy plantations as a National Plantation Crop, this has not been adequately implemented. In order for private sector institutions to invest in biomass power plants, adequate energy plantations should be in place. This task should be undertaken by the government.

- **Lack of Renewable Energy Policy:** Renewable energy has many economic benefits. Hence, the government should formulate a renewable energy policy and implement it. The CEB should be directed to incorporate such policy into their generation plan.

- **Hydropower:** Most projects are smaller than the minimum capacity for eligibility/feasibility for CDM. Bundling of projects is difficult when not owned by the same company/organization. However, organizations such as the Grid Connected Small Power Developers Association could help with forwarding the bundled CDM applications on behalf of the project developers.

- **Alternative Energy:** Solar power projects in Sri Lanka have CDM potential if bundled. Mechanisms for such applications and the required facilitation systems and expertise are not in place. These projects have a favourable community component for CDM.

- **Energy Conservation and Energy Substitution**: Projects under this category do not contradict the policies of the CEB or other state institutions, hence, would be easier to implement. However, the major barrier encountered in implementing these projects is the high interest rates prevailing for funds from commercial banks. From the CDM project incorporation point of view, bundling some of the smaller projects poses a practical problem.

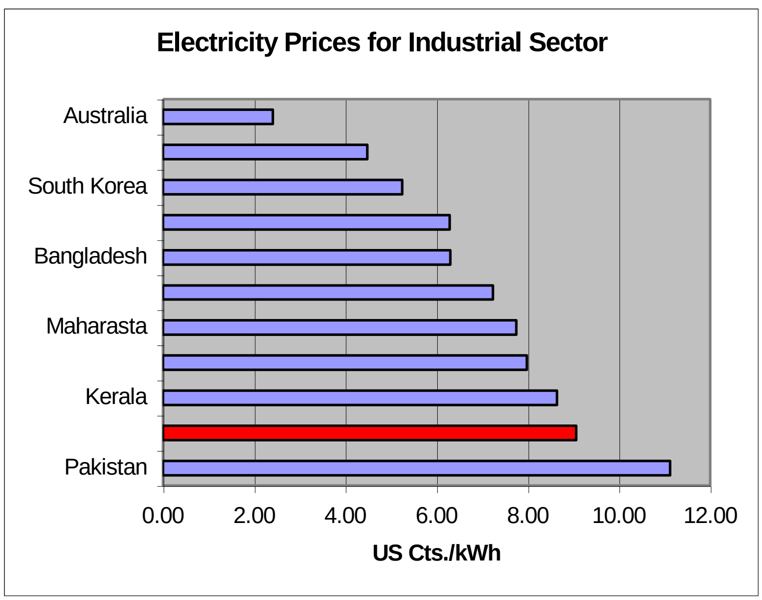
4.5.2.2 Barriers to biomass power generation

Interest in biomass energy for electricity generation has risen in the recent past. However, there are a number of constraints preventing the development of biomass based electricity generation. Some of these constraints and issues are discussed below:

(a) Lack of realistic planning

Although the electricity sector regularly carries out elaborate planning about future generation needs, these plans are not implemented as expected for a variety of reasons. Short and medium term proposals outside the long-term generation plans are regularly introduced to meet the shortfall in generation needs. These proposals are outside the "optimum" energy mix envisaged in the long-term plans. Hence, the implementation of these plans has resulted in the cost of electricity well above the anticipated and accepted values. The average sale price of electricity in Sri Lanka and the corresponding values for selected countries are illustrated in Figure 11.

Figure 13 -Industrial electricity prices in selected countries (Ref.4)



Apart from the high cost of electricity, the delays in implementing generation projects have resulted in load shedding.

(b) Failure to implement Government policies

Although successive governments have emphasized the importance of an integrated approach in the implementation of energy projects (CEB 2003) incorporating all relevant social and economic benefits such as local employment, conservation of foreign exchange, energy security etc., the share of renewable energy (apart from large hydro) has been insignificant in the energy mix of the electricity sector. The Government machinery is under pressure to deviate temporarily from laid down objectives. The electricity sector's decisions are focused on commercial viability. At times, Government's long-term policies are not given adequate weight age.

(c) "Un-level" playing field

All over the world, including the developing countries, renewable energy projects receive some form of government subsidy at least in the initial phase of development. Surprisingly, in Sri Lanka, fossil fuel based sector receives many benefits. Some of them are given below.

The price for electricity generated by Independent Power Producers (IPP) for fossil fuel based and renewable energy based Small Power Producers (SPP) sectors for the year 2002 are given in Table 14.

Table 14 - Tariff for fossil fuel and small renewable energy IPPs 2002

Name of Power Plant & Fuel	Tariff (SLR/kWh)
Hired Power – Auto Diesel	11.01
Kool Air-KKS – Furnace Oil	8.60
Asia Power – Furnace Oil	8.12
Lakdhanavi – Furnace Oil	7.41
Barge Mounted – Furnace Oil	7.06
ACE-Matara – Furnace Oil	6.72
ACE-Horana – Furnace Oil	6.13
Average (Private + Hired)	8.69
Private Small Renewable (SPP)	4.97

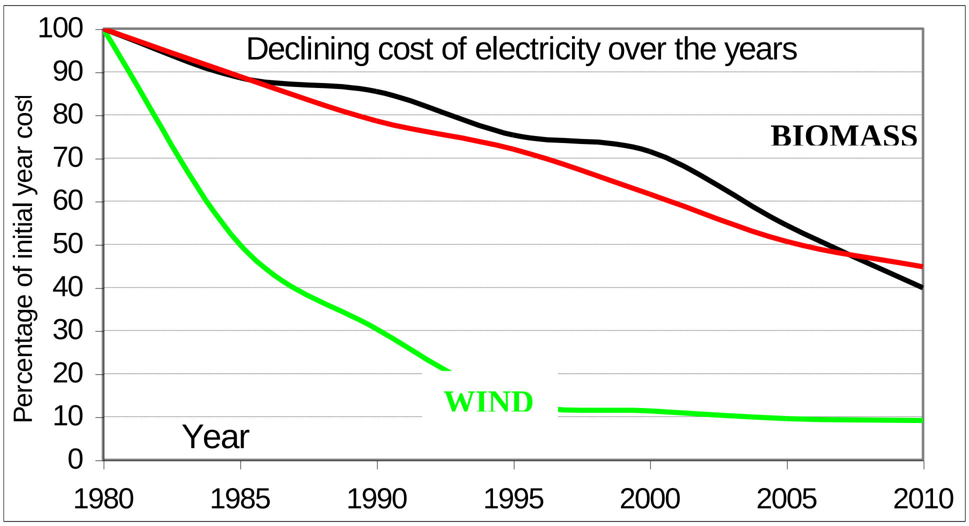
It is also important to note that the tariff for (small, renewable energy) SPP is determined by the "Avoided Cost" method, while the prices for the fossil fuel based IPP are determined on negotiated formulae.

(d) Failure to appreciate the long-term benefits of renewable energy

Energy planners in Sri Lanka do not accept the "learning curve" effect of new technologies in respect of renewable energy projects. It is a well-known fact that new renewable energy technologies such as wind, biomass, photovoltaic etc. encounter high initial costs in the early phase of development. Over the years, refinements are made to the systems and the costs gradually decrease. About a decade ago, when wind generators were introduced in Europe and in America, the cost of a unit of electricity was 38 US Cts. per kWh. Today in Europe, electricity from wind power plants is produced at less than 4 US Cts. per kWh. New offshore wind power plants are expected to produce electricity even cheaper. Figure 15 illustrates the declining trends of energy prices from renewable technologies.

In Sri Lanka, it is imagined that large coal based electricity could be generated at less than 4 US Cts. per kWh. The utility is reluctant to accept renewable energy projects with cost of generation over this price.

Figure 14 - Declining costs of renewable energy technologies (Ref: 6)



(e) Failure to appreciate the benefits of decentralized energy

The long-term generation expansion plan prepared by the utility in Sri Lanka is based on the lowest generation cost of electricity. It is taken for granted that if energy is generated cheaply, it could be sold cheaply. The costs of transmission and distribution are assumed to be constant irrespective of the location of generation and the location energy consumption. The reduction in the transmission and distribution costs by locating power plants closer to load consumers is not evaluated.

Moreover, no attempts are made to promote co-generation or absorption refrigeration from waste heat.

(f) Lack of a state institution to facilitate biomass energy development

Despite the fact that 53% of the national primary energy and 72% of the energy needs of the industrial sector are met from biomass (Ref. 7), this energy source is classified as a "Non-Commercial" energy. No state institution is assigned to facilitate the development of this source of energy. In 1997, the committee appointed to formulate the Energy Policy for Sri Lanka made a strong recommendation for the creation of a Biomass Energy Agency (Ref.8). To date this has been ignored.

A group of dedicated individuals have formed a private association (Bio Energy Association of Sri Lanka – BEASL). The Government is considering some of the requests made by this association favourably. The most important request for an equitable tariff for small power producers is yet to be addressed by the Government.

(g) Access to land for energy plantations

Many private sector institutions have come forwarded to establish energy plantations and biomass power plants with capacities ranging from 1 to 10 MW. However, they are unable to obtain information on the availability of suitable land for the establishment of energy plantations. The Land Use Policy Planning Division (LUPPD) of the Ministry of Lands has revealed to the Ministry of Science and Technology the availability of some 1.6 million hectares of degraded marginal land suitable for energy plantations. LUPPD is compiling data on all such land. This information should be made available to the public domain. Any one interested in land should be able to make use of this information and obtain such land according to stipulated procedures.

(h) Funds for bio energy

Initial capital costs and recurring operational costs including fuel costs of biomass power plants are comparable to the corresponding costs of large coal based power plants. However, the break-even price for a unit of energy from biomass power is US Cts 7 per kWh. Whereas for coal power there seems to be offers at a unit price of US Cts.4. The reason for this discrepancy is that for biomass projects developers can obtain funds locally at an interest of 9% and repayable within 7 years. For coal power, international funds are available at around 1 to 2% and payable in 25 to 30 years. This barrier must be removed.

The proposed Bio Energy Agency should make arrangements to provide this service.

(i) Skepticism on the potential of bio energy in Sri Lanka

A vast majority of decision makers do not take note of the fact that 72% of the energy for the *industrial* sector comes from bio energy (Ref.7). Perhaps, Sri Lanka is the highest in the world in this respect. Large-scale development of bio resources for modern energy needs was first mooted in Sri Lanka in 1980. It took about a decade to convince a few key people in the country of this potential. Even after more than 20 years, only a handful of officials are convinced of this potential.

(j) Requirement of diverse resources

Two distinctively divers resources are needed to establish and operate a bio energy system. The skills and resources required for plantations are different to those required for power plant. It is difficult for an entity to possess these diverse skills and resources. We need to bring two such entities together. For the plantations we need skills in labour management, and agronomy. For power plant we need engineering skills.

(k) Plantation or power plant: which should come first?

If two independent entities were to establish these two components, the question arises, “which should come first?” If plantations come up first and if there is a delay or a failure in the establishment of power plants, how could the expenditure on plantations be recovered? Similarly, if power plants are erected and the plantations are not ready, how could they operate the power plant?

In terms of cost, the plantation for a 1 MW power plant would cost Rs. 10 million (USD 100,000). The power plant itself would cost SLR 80 million (USD 800,000). Plantation to power station costs is in the ratio of 1:10. Moreover, an energy plantation has other uses. Presently the industrial sector in Sri Lanka annually consumes 264,000 ton oil equivalent of petroleum fuels valued at USD 50 million to produce process heat (Ref.7). This could be replaced with 0.8 million of wood from 27,000 hectares of energy plantations.

Therefore, it is the duty of the Government to provide necessary incentives to promote the establishment of plantations.

(l) Price stability

The Small Power Purchase (SPP) tariff provides a safety net of 90% of the initial price as a minimum price for the energy generated in succeeding years. This should be increased to 100% for the first 25 MW of biomass power for the first 7 years of operation to create investor confidence. It could be examined after this period.

As energy plantations and power plants may not be owned and managed by the same entities, the price of fuel wood applicable for the sale of fuel wood by the plantations to the power plants also should be controlled.

This situation is very similar to the sale of green tea leaves by tea small holders to “bought leave factories”. In this instance, the Tea Smallholder Authority has formulated a formula based on the sale price of made tea. This system has been functioning satisfactorily.

A more complicated situation prevails in the coconut sector. Coconut is used for many different applications such as copra manufacture, desiccated coconut, food nuts etc. The profitability in each of these applications varies. As the production of coconuts is limited and varies seasonally, coconut price also varies seasonally. Desiccated coconut is an export product. The international market decides its price. During some seasons, the cost of production of desiccated coconut exceeds far above the market price due to the very high price of coconuts. During such times, production of desiccated coconut is curtailed or halted.

Such a situation might arise for biomass power generation during rice harvesting season, due to temporary shortage of labour. Each biomass power plant should maintain adequate stocks of fuel wood to cater to such eventuality. Fortunately, fuel wood, unlike coconuts, does not perish easily.

(m) Unavailability of national grid for export of electricity

The profitability of a power plant is very sensitive to the annual plant factor. Some of the embedded generators in Sri Lanka have experienced poor annual plant factors due to breakdown in the Medium Voltage (MV) line connected to the generator. During such a down time, the generators need to be shut down as the power generated cannot be exported. Reliability of the MV lines in many parts of the country needs to be improved to acceptable level for biomass projects to be successful. In the alternative, CEB could compensate the IPPs suitably, in a manner similar to the telecommunication network.

(n) Limitations on the total embedded generation capacity

The "CEB Guide for Grid Interconnection of Embedded Generators, Sri Lanka, December 2000, Part 1: Application, Evaluation and Interconnection Procedure", has raised the following issues in respect of the total embedded generation capacity:

The requirement for some central control of embedded generation capacity will be reviewed when the total embedded generation capacity exceeds 10% of the total minimum grid load. At this time there will be some experience of the effects of embedded generation on grid stability, security and management.

It is expected that there will be a significant increase in the amount of embedded generation capacity, which will make a useful contribution to the CEB grid. It is expected that the contribution of embedded generation will exceed 15% of the minimum demand on the CEB grid by 2020.

It is anticipated that embedded generation will eventually contribute in excess of 15% of the CEB grid capacity.

The requirement for some central control of embedded generation capacity will be reviewed when the total embedded generation capacity exceeds 10% of the total minimum grid load. At this time there will be some experience of the effects of embedded generation on grid stability, security and management.

By year 2020, a reasonable estimate would be a total of 300 MW of Embedded Generators in the CEB system. The total capacity of embedded generation is expected to be less than 6% of the peak load, and about 15% of the minimum load.

In this respect, it is useful to take note of similar concerns raised on this matter in other parts of the world. In Denmark, wind based electricity generation has taken a substantial part of their total system load. At present it is around 10% and is expected to reach 20% very soon. This value is expected to exceed 50% before 2030.

Wind generators deploy induction generators. They absorb reactive power from the system. The power outputs from wind generators fluctuate very much. Due to low rotational speed wind generators also have low inertia constant, whereas biomass generators are fuel based systems. Apart from forced outages, the outputs of these systems are steady. Due to high speed of rotation of steam turbines, these systems have high inertia constants. Hence the impact of biomass generators on system stability would be minimal.

Distributed generators improve voltage stability and reactive power control to the systems. These are positive aspects of the biomass based distributed generation.

(o) Lack of target for alternative energy

Although the Government has laid a policy to "fully utilize" alternative energy sources to meet our growing needs of electrical energy, the Long Term Generation Plans drawn up year after year do not specify any targets for the share of these sources in the total energy mix. Such a target would drive the developers, planners and Government officials to this goal.

(p) Duty free diesel for IPPs and CEB

In order to keep the average cost of electricity low, the Government is granting duty free concessions to all IPPs and the CEB in respect of diesel fuel used in the generation of electricity. This has created a severe distortion in the market forces in the energy sector.

(q) Biomass based electricity is a new concept

Being a new concept of electricity generation, convincing the authorities to accept this method of electricity generation had been a difficult task. Although this concept was first introduced in 1980 (over 24 years ago), still many officials in the energy sector are skeptical of this concept.

(r) Requires multi discipline

The generation of electricity utilizing biomass obtained from a sustainable energy plantation requires expertise in the fields of agriculture and engineering. These two disciplines are very diverse in nature. Therefore the implementation of a biomass electricity generation project would require the integration of two separate institutions in the above two fields. Identifying two such institutions that are willing to collaborate on a project of this nature had been a difficult task.

(s) Competition with other crops

Paddy is the main crop in the project area. Paddy cultivation has been the main attraction for farmers in the area for many reasons such as long history, main national staple food, facilities made available by the state etc. Price of fuel wood and profitability would be the driving force for the success of *Gliricidia* cultivation. As cultivation of *Gliricidia* gives a high return on labour there is good likelihood for farmers in the area to undertake *Gliricidia* cultivation during paddy non-cultivating seasons.

(t) Awareness on SRC energy plantations

Although *Gliricidia* has been cultivated in Sri Lanka for many years in Sri Lanka, its application for sustainable SRC energy plantations is a new concept. To obtain optimum results, great care is necessary in the establishment, maintenance and harvesting activities. This could be achieved only through a proper awareness programme.

(u) Fluctuation in annual yields

An average annual yield of 30 per ha per year has been reached taking into account the yield trials obtained over many years in different locations in the dry zone.. However, the actual yield in any particular interval depends on the rainfall and its uniformity in that interval. Prolonged drought would drastically affect the yield. These features should be taken note of and adequate steps taken to cater to such eventuality.

(v) Rapport with out growers

Supply of fuel wood for the power plant is to be obtained from two sources. (i) from the nucleus plantations entirely managed by the power development company and (ii) from out grower system, partly supported by the power developer and operated and managed by the farmer families within the project area. As the nucleus plantations are expected to be used only in an emergency, it is vital to ensure continuous supply from the out grower system. All attempts should be made to encourage the farmers engaged in the out grower system to main uninterrupted supply as far as possible.

4.5.2.3 Institutional Barriers

a) Lack of awareness among government institutions and officials to make use of the benefits of Policy CDM such as energy saving policies, alternate energy policies, waste disposal policies (which incorporates methane abatement etc).

b) Lack of awareness about CDM among policy makers and project developers. Many senior government and private sector officials, who influence decision making activities in the government sector that affect the economic well being of the country, have little knowledge of Global Warming, Climate Change, the Kyoto Protocol, Clean Development Mechanism etc. This has unfortunately created the space for a few interested parties to plant wrong and biased information on CDM among a few officials.

c) Lack of attractive financing for renewable energy projects in the private sector. All large scale energy generation projects are funded by donor agencies. These projects are evaluated under the soft terms offered by such donors. However, all small projects are funded with private funds or funds from banks at commercial rates. This discrepancy gives an apparent advantage to large scale projects. If funds are made available for small renewable energy projects at the same terms as provided for major projects, some of the small projects could be more cost effective and feasible.

d) Renewable energy policy is not finalized. Although many attempts were made to formulate a renewable energy policy, such policies formulated by different committees have not been accepted by the Government.

e) Ceylon Electricity Board's (CEB) failure to include renewable energy projects in the generation plan. The Inter-Ministerial Working Committee on Dendro Thermal Power has formulated an action plan to implement biomass based electricity generation for the period 2006 to 2012. This has been approved by the cabinet of ministers. However, CEB has not included these in their generation plan.

f) Non-coherence and integration of policies in the work plans among different government institutions. For example *Gliricidia* based energy plantations have been declared as the 4th national plantation crop by the Ministry of Plantation Industries. Wood from these plantations could be used for large scale energy generation. However, CEB does not recognize this opportunity in their generation plan. Foliage from these plantations could be used as cattle fodder in the dairy industry. The Ministry of Agriculture has failed to incorporate this benefit in their dairy expansion program.

g) Banks still not fully geared to offer collateral recognizing the income generating potential through CDM. Banks are reluctant to finance CDM projects as they are not sufficiently aware of the risks involved in the process.

CHAPTER 5 - NATIONAL SECTOR BASELINES FOR CDM PROTECT ACTIVITIES

Since most of CDM projects in Sri Lanka are small scale, this chapter discusses only the sector baselines of small scale CDM projects.

5.1 Small scale baseline methodology applicable to Sri Lanka

In terms of modalities and procedures for the CDM, three types of small-scale CDM projects are possible.

Type i – Renewable energy project activities with a maximum output capacity equivalent of up to 15 megawatts or appropriate equivalent (Decision 17/CP.7 para 6 (c) (i).

Type ii – Energy efficiency improvement project activities which reduce energy consumption, on the supply and/or demand side, by up to the equivalent of 15 GWh per year (Decision 17/CP.7 para 6 (c) (ii).

Type iii – Other project activities that both reduce anthropogenic emissions by sources and directly emit less than 15 kilo(kt) of carbon dioxide equivalent annually (Decision 17/CP.7 para 6 (c) (iii)..

Each of these project types has several project categories (i.e. category 1.A, I.B, I.C,I.D. and II.A etc.) Under these three types of project the CDM executive board has approved 19 indicative simplified methodologies. Details of these methodologies can be obtained from the website http:/cdm.unfccc.int/methodologies/SSCmethodologies/approved

5.2 National Baseline for small scale CDM projects in renewable energy

5.2.1 Baseline emissions – Type I - Category I.D – Renewable power generation for a grid

Among the approved small scale methodologies Type 1- Category 1.D which is renewable power generation for a grid is mostly relevant to Sri Lanka. Most of the proposed CDM projects in Sri Lanka come under this category. Therefore most recent methodologies for estimation of baseline emissions for Type 1- Category I.D are discussed below.

The most recent approved Simplified Baseline Methodologies for Small Scale CDM Projects Activity Categories I.D, renewable power generation for grid are presented at the I.D/Version 09, Scope 1 dated 28 July 2006 [1] of the Appendix B. According to Para 9 (a) of Type I, I.D/Version 9 dated 28 July 2006, the baseline for Sri Lanka is the kWh of electrical power produced by the renewable generating unit multiplied by an emission coefficient (measured in kg CO2equ/kWh) calculated in a transparent and conservative manner as:

(a) A combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM) according to the procedures prescribed in the approved methodology ACM 0002. Any of the four procedures specified in the ACM 0002 to calculate the operating margin can be chosen, but restrictions to use the Simple OM and

Average OM calculations must be considered (Para 9 (a) of the I.D/Version 09, Scope 1 dated 28 July 2006.

OR,

(b) The weighted average emissions (in kg CO2equ/kWh) of the current generation mix. The data of the year in which project generation occurs must be used (Para 9 (a) of the I.D/Version 09, Scope 1 dated 28 July 2006.

Of these two methods, the option (a) is beneficial for Sri Lanka, since the option (b) derive very low emission factor. This is because Sri Lanka has a large share of hydro-power.
The approved methodology ACM 0002 provides formulas for calculation of combine margin (CM), build margin (BM) and operation margin (OM).

5.2.2 Operating Margin (OM)

The ACM 0002 provides four options to calculate operating margin (OM):

a) Simple operating margin
b) Simple adjusted operating margin
c) Dispatch data analysis operating margin
d) Average operating margin

Of these four options, Simple Adjusted OM method is appropriate for Sri Lanka since there are no detail data are available to use Dispatch Data Analysis OM.

The simple adjusted OM can be derived using following formula:

$$EF_{OM,y} = (1-\lambda_y) * \frac{\sum_{i,j} F_{i,j,y} COEF_{i,j}}{\sum_{j} GEN_{j,y}} \quad + \quad \lambda_y * \frac{\sum_{i,j} F_{i,k,y} COEF_{i,k}}{\sum_{k} GEN_{k,y}}$$

Where $F_{i,j,y}$ is amount of fuel i (in mass or volume unit) consumed by relevant power sources j in year(s), y. j refers to power sources delivering electricity to the grid from the sources other than low operating cost and must run power plants and k refers to power sources delivering electricity to the grid from the low operating cost and must run power plants.

$$\lambda = \frac{Number of hours per year for which low-\cos t / must run resources are in the margin}{8760 hours per year}$$

Where λ should be calculated as follows:

Step 1- Plot a load duration curve. Collect chronological load data (typically in MW) for each hour of a year, and sort data from highest to lowest MW level. Plot MW against 8760 hours in the year, in descending order

Step 2 – Organize data by generating sources. Collect data for, and calculate total annual generation (in MWh) from low-cost must-run resources (i.e. $GEN_{k,y}$)

Step 3 - Fill load duration curve. Plot horizontal line across load duration curve such that area under the curve (MW times hours) equal the total generation (in MWh) from low-cost must-run resources (i.e. $GEN_{k,y}$)

Step 4 – Determine the "Number of hours per year for which low-cost must run resources are on the margin". First locate the intersection of the horizontal line plotted in step 3 and the load duration curve plotted in step 1. The number of hours (out of total 8760 hours) to the right of the intersection is the numbers of hours for which low-cost must run resources are on the margin. If the line do not intersect, one may conclude that low-cost must run resources do not appear on the margin and λ is equal to 0. Lambda λ is the calculated number of hours divided by 8760.

$COEF_{i,j}$ is the CO_2 emission coefficient of fuel i (t/CO_2 mass or volume unit of the fuel), taking into account the carbon content of the fuels used by relevant power sources j, and the present oxidation of the fuel in year(s), y, and $GEN_{j.y}$ is the electricity (MWh) delivered to the grid by the source j.

The CO_2 coefficient $COEF_i$ was obtained as

$COEF_i = NCV_i * EF_{CO2i} * OXID_i$

Where

NCV_i is the net calorific value (energy content) of per mass or volume unit of a fuel I, and $OXID_i$ is the oxidation factor of the fuel. The EF_{CO2i} is the CO2 emission factor per unit of energy of the fuel $_i$.

Using this formula simple adjusted OM should be calculated most recent three years and get the average based on the most recent statistics available at the time of PDD submission.

5.2.3 Build Margin (BM)

The Build Margin emission factor ($EF_{BM,y}$) can be calculated as the generation-weighted average emission factor (tCO_2/MWh) of a sample of power plant m, as follows:

$$EF_{BM,y} = \frac{\sum_{i,j} F_{i,m,y} COEF_{i,m}}{\sum_{m} GEN_{m,y}}$$

Where $E_{i,m,y}$ $COEF_{i,m}$ and $GEN_{m,y}$ are analogous to variables described for the OM method above for plants m. The sample group m should consist of either the five power plants that have been built most recently or power plant capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently.

For Sri Lanka, the option 1 is most appropriate to calculate the BM which should be calculated ex-ante based on the most recent information available for plants already built for sample group m at the time of PDD submission.

The total capacity of the Sri Lankan power system is 2194.5 MW. The total annual average energy generated by the entire system is 11715 GWh; 20% of this is 2343 GWh.. The most recent five power plants have the capacity of 453 MW and average annual energy of 3176 GWh. Therefore, the five most recently commissioned power plants were used in estimating "build margin" emission coefficient for Sri Lanka.

5.2.4 Calculation of baseline emission factor

Baseline emission factor should be calculated as the weighted average of the operating margin emission factor ($EF_{OM,y}$) and build margin emission factor ($EF_{BM,y}$) as

$$EF_y = w_{OM} * EF_{BM,y} + w_{BM} * EF_{BM,y}$$

Where weights $w_{OM\ and}$ w_{BM}, by deault, are 50% (i.e $w_{OM} = w_{BM} = 0.5$) and $EF_{OM,y}$ and $EF_{BM,y}$ are calculated calculated using above formulae (ref. ACM0002)

5.2.5 Application of the combined margin (CM) to Sri Lanka

The weighted average emission baseline in $kgCO_2$/year for Sri Lanka in terms of the procedures prescribed in the approved methodology I.D/Version 09, Scope 1 dated 28 July 2006 (Para 9 (a) and ACM 0002 which was calculated based on the combine margin (CM) consisting of the combination of operating margin (OM) and build margin (BM).

5.2.5.1 Calculation of emission factors for each power plants

In order to estimate the average emissions of each power plant in the system the relative power contribution of each thermal power plant should be estimated. The contributions of each power plant to the system were estimated using following formulae (Table 14, 15, 16, 17, 18 & 19).

Following formulae was used to estimate the effective total operating hours per year:

Total effective operating hours (D) = 8760 hour/year (A) - maintenance hours per year (B) – forced outage rate in % (C)

$D = (A - B) * ((100 – C)/100)$ Where:

D = Total effective operating hours/year

A = 8760 hours/year
B = maintenance hours
C = forced outage (%)

Maximum annual energy output (kWh/year) of each power plant was calculated using following formulae:

Annual Energy Output in kWh/year (F) = Operating hours (D) * Plant capacity in MW (E) * 10^3

$F = D * E * 10^3$ Where:

D = Total effective operating hours
E = Plant capacity in MW
F = Annual energy output in kWh/year

The percentage power contribution of each power plant (% of kWh/year) was calculated using following formulae:

Percentage power of each power plant in % (G) = Annual output of each power plant (Fi)/ Sum of output of all power plants ($\Sigma\ F_1 \ldots\ldots N$)

$G = Fi / \Sigma\ F_1 \ldots\ldots N$ where

G = Contribution to total energy supply by each plant (%)
F_i = Energy output of the ith power plant

Heat rates of each power plant (MJ/MWh) were calculated using following formulae:

Plant heat rate (MJ/MWh) = (1/plant conversion efficiency) * 3.6 * 10^3

$J = [(1/ H) * 3.6 * 10^3]$ where,

J = Plant heat rate (MJ/MWh)
H = Plant conversion efficiency (%)

Source: Plant Conversion Efficiency Rates were received from CEB Generation Plans, 2003, 2004 and 2005 [8, 9 & 16]. IPCC recommended conversion factor: 1 MWh = 3.6 *10^9 J or 1 MWh = 3.6 * 10^3 MJ [12]

Adjusted carbon contents of fuel for each power plant were calculated using following equation:

Adjusted carbon content of fuel for each power plant (tC/TJ) = Carbon content of each fuel * Combustion efficiency of power plant

$M = K * L$ where:
M = Adjusted carbon content of each fuel (tC/TJ)
K = Carbon content of each fuel
L = Combustion efficiency of power plant

Note: Combustion efficiency of all plants is assumed to be 99%.

Emission factors (kgC/MWh) of each power plant were calculated using following equation.

Emission factor (kgC/MWh) = (Heat rate * adjusted carbon content of fuel * 10^3) /10^6

$N = (J * M * 10^3) / 10^6$. where,

N = Emission factor in kgC/MWh)
J = Heat rate (MJ/MWh)
M = Adjusted carbon content of fuel (tC/TJ)

The following equation was used to convert kgC/MWh into CO_2 emission per kWh:

$O = [(N * 44/12) / 10^3]$ where:

O = CO_2 emissions (kg CO_2/kWh)
N = Emission factor (kgC/MWh)

5.2.5.2 Operating margin emission calculation

According to the Appendix B, I.D/Version 9, Paragraph 9 (a), the "approximate operating margin" is the weighted average emissions (in kg CO_2equ/kWh) of all generating sources serving the system, excluding hydro, geothermal, wind, low-cost biomass, nuclear and solar generation. This was calculated using the Option 1 of paragraph 9 (c) of the approved baseline methodology, Type I – Renewable Energy Projects; Category I.D./Version 09, Scope 1, 28 July 2006. According to this the approximate operating margin is a 3 – year average, based on the most recent statistic available at the time of PDD submission [10].

Therefore approximate operating margin emissions were calculated for years 2003, 2004 and 2005 separately. Then the three year average was calculated. The weighted average emissions of approximate operating margin for each year were calculated using following formulae:

Weighted average emissions of the year i (kgCO_2/kWh) =
CO_2 emissions of i^{th} power plant * Percentage of power contribution of a power plant to the grid

$P_i = O * G$ where:

O = CO_2 emissions of each power plant
P_i = Weighted average emissions (kg CO_2/kWh)
G = Contribution of total energy supply by each power plant (%)

The approximate operating margin for the given year was estimated taking the sum of the weighted average emissions of all the power plants operating in the year using following equation:

Weighted average emissions of all plants in the year 1 (kg CO_2/kWh) = Sum of emissions factors of all thermal power plants i.e. plant i. to plant n

Q_1 = (Σ P_1……..n)

Q_1 = Weighted average emissions of all thermal plants in the year 1 (kg CO_2/kWh) = Sum of emission factors of all thermal power plants – plant i …. n

A three year average of approximate operating margin was calculated using following equation:

$$OM = \frac{[\sum Q_{1......3}] * \lambda}{3}$$

Where

OM = Operating margin emission factor (A three year average of the approximate margin emissions)

$Q_{1....3}$ = Weighted average emission factors of year 1 to 3

OM = $\lambda *$ (0.723 + 0.685 + 0.698)/3

OM = …… kg CO_2/kWh - This can be calculated once lambda is calculated

The analysis found that the approximate operating margin emission factor of Sri Lanka is 0.702 kg CO_2/kWh (to be adjusted with Lambda). This is a three year average of approximate operating margins of years 2003, 204 and 2004. The table 15 presents the weighted average approximate emission factors for year 2003, 2004 and 2005 and the average of emission factors of all these three years. Data, formula and calculation results of approximate margin for years 2003, 2004, and 2004 are presented in Tables 14, Table 15, Table 16, Table 17, and Table 18 and Table 19 respectively.

Table 15 - Weighted average approximate emission factors

Year	**Weighted average emissions factor** kg CO_2/kWh
2003	0.723
2004	0.685
2005	0.698
Approximate operating margin OM (Average emission factors of 2003, 2004 and 2005)	**0.702**

5.2.5.3 Build margin (BM) emission calculation

According to the Appendix B, I.D/Version 9, Scope 1, dated 28 July 2006 Paragraph 9 (a) and the ACM 0002 the "build margin" is the weighted average emissions (in kg CO2equ/kWh) of recent capacity additions to the system, which capacity additions are defined as the greater (in MWh) of most recent 20% of existing plants or the five most recent plants." [10]. The most recent five power plants in Sri Lanka account for more than 20% of the total MWh generated in the system. The following formulae were used to estimate the build margin weighted average emission:

Weighted average emissions of five most recent plants addition to the grid (kg CO_2/kWh) = CO_2 emissions of each of the five most recent power plants * percentage of power contribution to the grid by five most recent power plants

T_i = S * R where:

T_i = Weighted average emissions of ith power plant of the five most recent power plants additions to the grid (kgCO_2/kWh)
S = CO_2 emissions of each of the most recent five power plants
R = Percent contribution of power to the grid from these recent five power plants

BM = $\sum T_{1......5}$

BM = Build Margin emission factor (Weighted average emissions of five most recent plants addition to the grid (kg CO_2/kWh)

BM = 0.584 kg CO_2/kWh

The sum of weighted average emissions of most recent five power plants added to the grid, which is the build margin emission factor, was found to be 0.584 kg CO_2/kWh (Table 20 and Table 21).

5.2.5.4 Baseline emission factor

Combined Margin (CM) emission factor was estimated based on weighted average operating margin (OM) and build margin (BM) emission factors using following equation:

$EF_y = w_{OM} * EF_{OM,y} + w_{BM} * EF_{BM,y}$

Where

EF_y = Baseline emission factor defined as Combine Margin emission factor (kg CO_2/kWh)
$EF_{BM,y}$ = Operating margine mission factor (kg CO_2/kWh)
$EF_{BM,y}$ = Build margine mission factor for the base year (kg CO_2/kWh)
w_{OM} = 0.5

w_{BM} = 0.5

EF_y = 0.5 * 0.702 (adjusted with Lmbda) + 0.5 * 0.584 = …. kg CO_2/kWh

The Baseline Emission factor which is standardized baseline for annual emissions offset value that would result from the implementation of the Ampara EnerGeon Small Scale Biomass Power project is 0.643kg CO_2 per kWh.

Table 16 -Data and formulae used for approximate margin average emission calculations for year 2003 (Part 1)

Power plant	Date of commissioning	Fuel source	Hours /yr	Maintenance (hours/ yr)	Forced outage %	Total Operating hours	Capacity (MW)	Annual maximum energy (kWh/yr)
Variable			**A**	**B**	**C**	**D**	**E**	**F**
						(A – B) * ((100 – C)/100)		**F=D*E*1000**
CEB operated power plants								
1.Kelanitissa Gas turbines (old)	1982	Auto diesel	8760	960	20	6240	48	299520000
2. Kelanitissaa Gas turbines (new)	1997	Auto diesel	8760	1080	8	7065.6	115	812544000
3. Sapugaskanda Diesel	1984	Residual oil	8760	1200	30	5292	72	381024000
4. Sapugaskanda Diesel extension	1999	Residual oil	8760	1056	99915	6548.4	72	471484800
5. Kelanitisaa Combined Cycle (JBIC)	2002	Naphtha	8760	768	5	7592.4	165	1252746000
Independent power producers								
6. Lakdhanavi diesel	1997	Fuel oil	8760	720	8	7396.8	22.5	166428000
7. Asia power Ltd diesel	1998	Fuel oil	8760	720	8	7396.8	49	362443200
8. Colombo Power Ltd diesel	2000	Fuel oil	8760	720	8	7396.8	60	443808000
9. Ace Power Matara diesel	2002	Fuel oil	8760	720	8	7396.8	20	147936000
10. ACE Power Horana diesel	2002	Fuel oil	8760	720	8	7396.8	20	147936000
							643.5	**4485870000**

Table 17 - Data and formulae used for approximate margin average emission calculations for year 2003 (Part 2)

Variable - Power plants	**Contribution to total energy supply (% of kWh)**	**Plant conversion efficiency factor**	**Heat rate (MJ/MWh)**	**Carbon content (tC/TJ)**	**Combustion efficiency factor**	**Adjusted Carbon content (tC/TJ)**	**Emissions factor (kgC/MWh)**	**Emissions factor (kg CO2/kWh)**	**Weighted average emmisions (kgCO2/kWh)**
	G	**H**	**J**	**K**	**L**	**M**	**N**	**O**	**P**
	G=(Fi/ΣF..n)*100		**J=(1/H)*3.6*1000**			**M=K*L**	**N=J*M*$10^3/10^6$**	**O=(N*44/12)/10^3**	**P=O/100*G**
CEB operated plant									
1.Kelanitissa Gas turbines (old)	6.6770	0.2200	16363.6364	20.2	0.99	19.9980	327.2400	1.1999	0.0801
2. Kelanitissaa Gas turbines (new)	18.1134	0.3000	12000.0000	20.2	0.99	19.9980	239.9760	0.8799	0.1594
3. Sapugaskanda Diesel	8.4939	0.3850	9350.6494	21.1	0.99	20.8890	195.3257	0.7162	0.0608
4. Sapugaskanda Diesel extension	10.5104	0.4080	8823.5294	21.1	0.99	20.8890	184.3147	0.6758	0.0710
5. Kelanitisaa Combined Cycle (JBIC)	27.9265	0.4710	7643.3121	20.2	0.99	19.9980	152.8510	0.5605	0.1565
Independent power									
6. Lakdhanavi diesel	3.7100	0.4000	9000.0000	21.1	0.99	20.8890	188.0010	0.6893	0.0256
7. Asia power Ltd diesel	8.0797	0.4000	9000.0000	21.1	0.99	20.8890	188.0010	0.6893	0.0557
8. Colombo Power Ltd diesel	9.8935	0.4000	9000.0000	21.1	0.99	20.8890	188.0010	0.6893	0.0682
9. Ace Power Matara diesel	3.2978	0.4000	9000.0000	21.1	0.99	20.8890	188.0010	0.6893	0.0227
10. ACE Power Horana diesel	3.2978	0.4000	9000.0000	21.1	0.99	20.8890	188.0010	0.6893	0.0227
	100.0000								**0.7228**

Table 18 -Data and formulae used for approximate margin average emission calculations for year 2004 (Part 1)

Power plant	Date of commissioning	Fuel source	Hours /yr	Maintenance (hours/ yr)	Forced outage %	Total Operating hours	Capacity (MW)	Annual maximum energy (kWh/yr)
Variable			**A**	**B**	**C**	**D**	**E**	**F**
						(A – B) * ((100 – C)/100)		**F=D*E*1000**
CEB operated power plants								
1.Kelanitissa Gas turbines (old)	1982	Auto diesel	8760	1008	17	6434.16	51	328142160
2. Kelanitissaa Gas turbines (new)	1997	Auto diesel	8760	1440	16	6148.8	115	707112000
3. Sapugaskanda Diesel	1984	Residual oil	8760	1128	14	6563.52	72	472573440
4. Sapugaskanda Diesel extension	1999	Residual oil	8760	1320	6	6993.6	72	503539200
5. Kelanitisaa Combined Cycle (JBIC)	2002	Naphtha	8760	528	5	7820.4	165	1290366000
Independent power producers								
6. Lakdhanavi diesel	1997	Fuel oil	8760	720	8	7396.8	22.5	166428000
7. Asia power Ltd diesel	1998	Fuel oil	8760	720	8	7396.8	49	362443200
8. Colombo Power Ltd diesel	2000	Fuel oil	8760	720	8	7396.8	60	443808000
9. Ace Power Matara diesel	2002	Fuel oil	8760	720	8	7396.8	20	147936000
10. ACE Power Horana diesel	2002	Fuel oil	8760	720	8	7396.8	20	147936000
11.AES Kelanitissa (Pvt) Ltd. (ADB)	2003	Auto diesel	8760	720	8	7396.8	163	1205678400
12. Heladhanavi (Pvt) Ltd.	2004	Fuel oil	8760	720	8	7396.8	100	739680000
							909.5	**6515642400**

Table 19 - Data and formulae used for approximate margin average emission calculations for year 2004 (Part 2)

Variable – Power plants	**Contribution to total energy supply (% of kWh)**	**Plant conversion efficiency factor**	**Heat rate (MJ/MWh)**	**Carbon content (tC/TJ)**	**Combistion efficiency factor**	**Adjusted Carbon content (tC/TJ)**	**Emissions factor (kgC/MWh)**	**Emissions factor (kg CO2/kWh)**	**Weighted average emmisions (kgCO2/kWh)**
	G	**H**	**J**	**K**	**L**	**M**	**N**	**O**	**P**
	G=(Fi/ΣF..n)*100		**J=(1/H)*3.6*1000**			**M=K*L**	**N=J*M*$10^3/10^6$**	**O=(N*44/12)/10^3**	**P=O/100*G**
CEB operated power plants									
1.Kelanitissa Gas turbines (old)	5.04	0.218	16513.761	20.2	0.99	19.998	330.24220	1.2108880	0.060983001
2. Kelanitissaa Gas turbines (new)	10.85	0.33	10909.090	20.2	0.99	19.998	218.16	0.79992	0.086811552
3. Sapugaskanda Diesel	7.25	0.382	9424.0837	21.1	0.99	20.889	196.85968	0.7218188	0.052352845
4. Sapugaskanda Diesel extension	7.73	0.415	8674.6987	21.1	0.99	20.889	181.20578	0.6644212	0.051347527
5. Kelanitisaa Combined Cycle (JBIC)	19.80	0.48	7500	20.2	0.99	19.998	149.985	0.549945	0.108911798
Independent power									
6. Lakdhanavi diesel	2.55	0.4	9000	21.1	0.99	20.889	188.001	0.689337	0.017607623
7. Asia power Ltd diesel	5.56	0.4	9000	21.1	0.99	20.889	188.001	0.689337	0.038345491
8. Colombo Power Ltd diesel	6.81	0.4	9000	21.1	0.99	20.889	188.001	0.689337	0.046953663
9. Ace Power Matara diesel	2.27	0.4	9000	21.1	0.99	20.889	188.001	0.689337	0.015651221
10. ACE Power Horana diesel	2.27	0.4	9000	21.1	0.99	20.889	188.001	0.689337	0.015651221
11.AES Kelanitissa (Pvt) Ltd. (ADB)	18.50	0.42	8571.4285	20.2	0.99	19.998	171.41142	0.6285085	0.116301534
12. Heladhanavi (Pvt) Ltd.	11.35	0.42	8571.4285	21.1	0.99	20.889	179.04857	0.6565114	0.074529623
	100.00								**0.6854471**

Table 20 - Data and formulae used for approximate margin average emission calculations for year 2005 (Part 1)

Power plant	Date of commissioning	Fuel source	Hours /yr	Maintenance (hours/ yr)	Forced outage %	Total Operating hours	Capacity (MW)	Annual maximum energy (kWh/yr)
Variable			**A**	**B**	**C**	**D**	**E**	**F**
						(A – B) * ((100 – C)/100)		**F=D*E*1000**
CEB operated power plants								
1.Kelanitissa Gas turbines (old)	1982	Auto diesel	8760	864	20	6316.8	68	429542400
2. Kelanitissaa Gas turbines (new)	1997	Auto diesel	8760	240	10	7668	115	881820000
3. Sapugaskanda Diesel	1984	Residual oil	8760	1200	17	6274.8	72	451785600
4. Sapugaskanda Diesel extension	1999	Residual oil	8760	1200	12	6652.8	72	479001600
5. Kelanitisaa Combined Cycle (JBIC)	2002	Naphtha	8760	720	6	7557.6	165	1247004000
Independent power producers								
6. Lakdhanavi diesel	1997	Fuel oil	8760	720	8	7396.8	22.5	166428000
7. Asia power Ltd diesel	1998	Fuel oil	8760	720	8	7396.8	49	362443200
8. Colombo Power Ltd diesel	2000	Fuel oil	8760	720	8	7396.8	60	443808000
9. Ace Power Matara diesel	2002	Fuel oil	8760	720	8	7396.8	20	147936000
10. ACE Power Horana diesel	2002	Fuel oil	8760	720	8	7396.8	20	147936000
11.AES Kelanitissa (Pvt) Ltd. (ADB)	2003	Auto diesel	8760	720	8	7396.8	163	1205678400
12. Heladhanavi (Pvt) Ltd.	2004	Fuel oil	8760	720	8	7396.8	100	739680000
13. ACE Power Embilipitiya Ltd.	2005	Fuel oil	8760	720	8	7396.8	100	739680000
							1026.5	**7442743200**

Table 21 - Data and formulae used for approximate margin average emission calculations for year 2005 (Part 2)

Variable - Power plants	Contribution to total energy supply (% of kWh)	Plant conversion efficiency factor	Heat rate (MJ/MWh)	Carbon content (tC/TJ)	Combistion efficiency factor	Adjusted Carbon content (tC/TJ)	Emissions factor (kgC/MWh)	Emissions factor (kg CO2/kWh)	Weighted average emmisions (kgCO2/kWh)
	G	**H**	**J**	**K**	**L**	**M**	**N**	**O**	**P**
	G=(Fi/ΣF..n)*100		**J=(1/H)*3.6*1000**			**M=K*L**	**N=J*M*$10^3/10^6$**	**O=(N*44/12)/10^3**	**P=O/100*G**
CEB operated power plants									
1.Kelanitissa Gas turbines (old)	5.77	0.205	17560.961	20.2	0.99	19.998	351.18439	1.28767609	0.07431554
2. Kelanitissaa Gas turbines (new)	11.85	0.33	10909.090	20.2	0.99	19.998	218.16	0.79992	0.094774928
3. Sapugaskanda Diesel	6.07	0.382	9424.0837	21.1	0.99	20.889	196.85968	0.72181884	0.043815479
4. Sapugaskanda Diesel extension	6.44	0.415	8674.6987	21.1	0.99	20.889	181.20578	0.66442120	0.042760957
5. Kelanitisaa Combined Cycle (JBIC)	16.75	0.48	7500	20.2	0.99	19.998	149.985	0.549945	0.092141244
Independent power producers									
6. Lakdhanavi diesel	2.24	0.4	9000	21.1	0.99	20.889	188.001	0.689337	0.015414341
7. Asia power Ltd diesel	4.87	0.4	9000	21.1	0.99	20.889	188.001	0.689337	0.033569008
8. Colombo Power Ltd diesel	5.96	0.4	9000	21.1	0.99	20.889	188.001	0.689337	0.041104908
9. Ace Power Matara diesel	1.99	0.4	9000	21.1	0.99	20.889	188.001	0.689337	0.013701636
10. ACE Power Horana diesel	1.99	0.4	9000	21.1	0.99	20.889	188.001	0.689337	0.013701636
11.AES Kelanitissa (Pvt) Ltd. (ADB)	16.20	0.42	8571.4285	20.2	0.99	19.998	171.41142	0.62850857	0.101814504
12. Heladhanavi (Pvt) Ltd.	9.94	0.42	8571.4285	21.1	0.99	20.889	179.04857	0.65651142	0.065245886
13. ACE Power Embilipitiya Ltd.	9.94 **100.00**	0.42	8571.4285	21.1	0.99	20.889	179.04857	0.65651142	0.065245886 **0.697605953**

5.2.5.5 Calculation of build margin average emissions (BM)

Table 20 and Table 21 provide data and the results of the build margin emission calculations.

Table 22 - Data and formulae used for build margin average emission calculations as at year 2005 (Part 1)

Power plant	Date of commissioning	Fuel source	Hours /yr	Maintenance (hours/ yr)	Forced outage %	Total Operating hours	Capacity (MW)	Annual maximum energy (kWh/yr)
Variable			**A**	**B**	**C**	**D**	**E**	**F**
						(A - B) * ((100 – C)/100)		**F=D*E*1000**
1. Kukule hydro power	2003	Hydro					70	300000000*
2. ACE Power Horana diesel	2002	Fuel oil	8760	720	8	7396.8	20	147936000
3.AES Kelanitissa (Pvt) Ltd. (ADB)	2003	Auto diesel	8760	720	8	7396.8	163	1205678400
4. Heladhanavi (Pvt) Ltd.	2004	Fuel oil	8760	720	8	7396.8	100	739680000
5. ACE Power Embilipitiya Ltd.	2005	Fuel oil	8760	720	8	7396.8	100	739680000
							453	**3132974400**

*** CEB Generation and Expansion Plan – December 2005**

Table 23 - Data and formulae used for build margin average emission calculations as at year 2005 (Part 2)

Variable - Power plants	Contribution to total energy supply (% of kWh)	Plant conversion efficiency factor	Heat rate (MJ/MWh)	Carbon content (tC/TJ)	Combistion efficiency factor	Adjusted Carbon content (tC/TJ)	Emissions factor (kgC/MWh)	Emissions factor (kg CO2/kWh)	Weighted average emmisions (kgCO2/kWh)
	R	**H**	**J**	**K**	**L**	**M**	**N**	**S**	**T**
	G=(Fi/ΣF..n)*100		**J=(1/H)*3.6*1000**			**M=K*L**	**N=J*M*$10^3/10^6$**	**O=(N*44/12)/10^3**	**P=S/100*R**
1. Kukule hydro	9.58								
2. ACE Power Horana diesel	4.72	0.4	9000	21.1	0.99	20.889	188.001	0.689337	0.032549822
3..AES Kelanitissa (Pvt) Ltd. (ADB)	38.48	0.42	8571.4285	20.2	0.99	19.998	171.4114	0.628508571	0.241872136
4. Heladhanavi (Pvt) Ltd. – Puttalama	23.61	0.42	8571.4285	21.1	0.99	20.889	179.0485	0.656511429	0.154999151
5. ACE Power Embilipitiya Ltd.	23.61	0.42	8571.4285	21.1	0.99	20.889	179.0485	0.656511429	0.154999151
	100.00								**0.58442026**

5.2.5.6 Calculation of Combine Margin (CM) emission factor (average of approximate (OM) and build margin (BM)

Average operating margin emission factor (OM) = 0.702 kg/kWh (to be adjusted with lambda)
Average build margin emission factor (BM) = 0.584 kg/kWh

5. 3 National Baseline for small scale CDM projects in waste sector

AMS-III.D. - Methane recovery in agricultural and agro industrial activities

AMS-III.E - Avoidance of methane production from biomass decay through controlled combustion

AMS-III.F. - Avoidance of methane production from biomass decay through composting

AMS-III.G. - Landfill methane recovery

AMS-III.H. - Methane recovery in wastewater treatment

5.4 National Baseline for small scale CDM projects in transport sector

AMS-III.B. - Switching fossil fuels

AMS-III.C. - Emission reductions by low-greenhouse gas emitting vehicles

5.5 National Baseline for small scale CDM projects in industry sector

AMS-II.D - Energy efficiency and fuel switching measures for industrial facilities

III.F./Version 4
Sectoral Scope: 13
EB 31

Indicative simplified baseline and monitoring methodologies for selected small-scale CDM project activity categories

TYPE III - OTHER PROJECT ACTIVITIES

Project participants shall take into account the general guidance to the methodologies, information on additionality, abbreviations and general guidance on leakage provided at http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html.

5.5.1 III.F Avoidance of methane production from decay of biomass through composting

Technology/measure

1. This project category comprises measures to avoid the production of methane from biomass or other organic matter that would have otherwise been left to decay anaerobically in a solid waste disposal site without methane recovery. Due to the project activity, decay is prevented through aerobic treatment by composting and proper soil application of the compost. The project activity does not recover or combust methane (unlike AMS III.G), and does not undertake controlled combustion of the waste (unlike AMS III E). Measures are limited to those that result in emission reductions of less than or equal to 60 kt CO_2 equivalent annually.

2. This project category includes construction and expansion of compost production facilities as well as activities that increase capacity utilization at an existing composting production facility. For project activities that increase capacity utilization at existing composting facilities, project participant(s) shall demonstrate that special efforts are made to increase the capacity utilization, that the existing composting facility meets all applicable laws and regulations and that the existing composting facility is not included in a separate CDM project activity. The special efforts should be identified and described.

3. This category is also applicable for co-composting wastewater and solid biomass waste, where wastewater would otherwise have been treated in an anaerobic wastewater treatment system without methane recovery. The wastewater in the project scenario is used as a source of moisture and/or nutrients to the composting process e.g. composting of empty fruit bunches (EFB), a residue from palm oil production, with the addition of palm oil mill effluent (POME) which is the wastewater co produced from palm oil production.

5.5.1.1 Boundary

4. The project boundary is the physical, geographical site:

   a). where the solid waste would have been disposed and the methane emission occurs in absence of the proposed project activity,

   b). in the case of projects co-composting wastewater, where the co-composting wastewater would have been treated anaerobically in the absence of the project activity,

   c). where the treatment of biomass through composting takes place,

   d). where the soil application of the produced compost takes place, and

   e). the itineraries between them (a, b, c and d), where the transportation of waste, wastewater or compost occurs.

5.5.1.2 Project Activity Emissions

5. Project activity emissions consist of:

   f). CO_2 emissions due to incremental distances between

      i. The collection points of biomass and the composting site as compared to the baseline solid waste disposal site,

      ii. When applicable, the collection points of wastewater and composting site as compared to baseline wastewater treatment site,

      iii. Composting site and the soil application sites.

   g). CO_2 emissions on account of fossil fuel based energy used by the project activity facilities, which shall include but not limited to energy used for aeration and/or turning of compost piles/heaps and chopping of biomass for size reduction, screening and where relevant drying of the final compost product. Emission factors for grid electricity or diesel fuel use as the case may be shall be calculated as described in category AMS I.D.

$$PE_y = PE_{y,transp} + PE_{y,power}$$

Where:

PE_y	project activity emissions in the year "y" (tons of CO_2 equivalent)
$PE_{y,transp}$	emissions from incremental transportation in the year "y"
$PE_{y,power}$	emissions from electricity or diesel consumption in the year "y"

$$PE_{y,transp} = (Q_y/CT_y) * DAF_w * EF_{CO2} + (Q_{y,comp}/CT_{y,comp}) * DAF_{comp} * EF_{CO2}$$

Where:

$\mathbf{Q_y}$	quantity of waste composted and/or wastewater co-composted in the year "y" (tons)
$\mathbf{CT_y}$	average truck capacity for waste transportation (tons/truck)
$\mathbf{DAF_w}$	average incremental distance for solid waste and/or wastewater transportation (km/truck)
$\mathbf{EF_{CO2}}$	CO_2 emission factor from fuel use due to transportation (kgCO_2/km, IPCC default values or local values may be used).
$\mathbf{Q_{y,comp}}$	quantity of final compost product produced in the year "y" (tons)
$\mathbf{CT_{y,comp}}$	average truck capacity for final compost product transportation (tons/truck)
$\mathbf{DAF_{comp}}$	average distance for final compost product transportation (km/truck)

Baseline

6. The baseline scenario is the situation where, in the absence of the project activity, biomass and other organic matter are left to decay within the project boundary and methane is emitted to the atmosphere. The baseline emissions are the amount of methane emitted from the decay of the degradable organic carbon in the biomass solid waste composted in the project activity. When wastewater is co-composted, baseline emissions include emissions from wastewater co-composted in the project activity. The yearly Methane Generation Potential for the solid waste is calculated using the first order decay model as described in category AMS III.G. Baseline emissions shall exclude methane emissions that would have to be captured, fuelled or flared to comply with national or local safety requirement or legal regulations.

$$\mathbf{BE_y = BE_{CH4,SWDS,y} - MD_{y,reg} * GWP\_CH4 + MEP_{y,ww} * GWP\_CH_4}$$

Where:

$\mathbf{BE_{CH4,SWDS,y}}$	yearly methane generation potential of the solid waste composted by the project during the years "x" from the beginning of the project activity (x=1) up to the year "y" estimated as described in AMS III.G (t CO_2e)
$\mathbf{MD_{y,\,reg}}$	amount of methane that would have to be captured and combusted in the year "y" to comply with the prevailing regulations
$\mathbf{MEP_{y,ww}}$	methane emission potential in the year "y" of the wastewater. The value of this term is zero if co-composting of wastewater is not included in the project activity.
$\mathbf{CH_4\_GWP}$	GWP for CH_4 (value of 21 is used)

7. Methane emission potential of co-composted wastewater is estimated as described in category AMS III.H:

$$\mathbf{MEP_{y,ww} = Q_{y,ww} * COD_{y,ww,untreated} * B_{o,ww} * MCF_{ww,treatment} * GWP\_CH_4}$$

Where:

$Q_{y,ww}$ volume of wastewater co-composted in the year "y" (m^3)

$COD_{y,ww,untreated}$ chemical oxygen demand of the wastewater in the year "y" ($tons/m^3$)[1]

$B_{o,ww}$ methane producing capacity for the wastewater (IPCC default value for domestic wastewater of 0.21 kg CH_4/kg.COD)[1]

$MCF_{ww,\ treatment}$ methane correction factor for the wastewater treatment system in the baseline scenario (MCF higher value as per table III.H.1).

5.5.1.3 Leakage

8. If the composting technology is the equipment transferred from another activity or if the existing equipment is transferred to another activity, leakage effects are to be considered.

5.5.1.4 Monitoring

9. The emission reduction achieved by the project activity (in the case of construction of new facilities or expansion of capacity of existing facilities) will be measured as the difference between the baseline emission and the sum of the project emission and leakage.

$$\mathbf{ER_y = (BE_y - (PE_y + Leakage_y)}$$

Where:

ER_y Emission reduction in the year "y" (tCO_2e)

1 The IPCC default value of 0.25 kg CH_4/kg COD was corrected to take into account the uncertainties. For domestic waste water, a COD based value of $B_{o,ww}$ can be converted to BOD_5 based value by dividing it by 2.4, i.e. a default value of 0.504 kg CH_4/kg BOD can be used.

9. The emission reduction achieved by the project activity (in the case of increase of capacity utilization of existing facilities) will be measured as the difference between the baseline emission and the sum of the project emission and leakage.

$$\mathbf{ER_y = (BE_y - PE_y) \times (1\text{-}r)}$$

Where:

ER_y Emission reduction in the year "y" (tCO_2e)

The value for r is defined as

$$\mathbf{r = WCOM_{BAU}/TWCOM_y}$$

Where:

$TWCOM_y$ total quantity of waste composted in year of (tons) at the facility

$WCOM_{BAU}$ registered annual amount of waste composted (tons) at the facility on a BAU basis calculated as the highest amount of annual compost production in the last five years prior to the project implementation.

10. The following parameters shall be monitored and recorded annually during the crediting period:

- Quantity of waste composted ($Q_{y,comp}$) and its composition through representative sampling,
- When project activity includes co-composting of wastewater, the volume of co-composted wastewater ($Q_{y,ww}$) and its COD content through representative sampling,
- When project activity includes co-composting of wastewater, the volume of run-off water[2] from the composting site ($Q_{ww,runoff}$) and its COD content through representative sampling. The methane emission potential of the run-off water is calculated as described in paragraph 6 above and will be subtracted from baseline methane emissions from the wastewater co-composted by the project activity.
- Parameters related to project emissions (PE_y) described above such as CT_y , DAF_w, $CT_{y,comp}$, energy used for aeration, turning of compost piles, pre-processing of the biomass (e.g. size reduction, screening) and where relevant drying of the final compost product.

11. The historical records of annual amount of waste composted at the facility in the last five years prior to the project implementation and additional information to cross check the historical records (e.g. invoices of compost sales) shall be provided for project activity validation.

12. The operation of the composting facilities will be documented in a quality control program, monitoring the conditions and procedures that ensure the aerobic condition of the waste during the composting process.

[2] Consisting of the wastewater applied in excess (i.e. moisture over and above the field capacity of the biomass being composted) and rainwater in the case of unroofed sites.

13. Soil application of the compost in agriculture or related activities will be monitored. This includes documenting the sales or delivery of the compost final product. It shall also include an in situ verification of the proper soil application of the compost to ensure aerobic conditions for further decay. Such verification shall be done at representative sample of user sites.

14. The project participants shall demonstrate annually, through the assessment of common practices at proximate waste disposal sites that the amount of waste composted in the project activity facilities would have been disposed in a solid waste disposal site without methane recovery in the absence of the project activity. When project activity includes co-composting of wastewater demonstrate that wastewater would have been treated in an anaerobic system without methane recovery in the absence of the project activity.

Example

$$PE_{y,transp} = (Q_y/CT_y) * DAF_w * EF_{CO2} + (Q_{y,comp}/CT_{y,comp}) * DAF_{comp} * EF_{CO2}$$

Quantity of waste composted in the year "y" (tons), Q_y = 1000 ton
Average truck capacity for waste transportation (tons/truck), CT_y = 1 ton/truck
Average incremental distance for waste transportation (km/truck), DAF = 10 km/truck
CO2 emission factor from fuel use due to transportation (kgCO2/km), EFCO2 = 0.536 $kgCO_2$/km

Quantity of compost produced in the year "y" (tons), Qy,comp = 400 ton
Average truck capacity for compost transportation (tons/truck), CTy,comp = 0.4 ton/truck
Average distance for compost transportation (km/truck), DAFcomp = 15 km/truck

PEy,transp = (1000/1) x 10 x 0.536 + (400/0.4) x 15 x 0.536
= 13.4 ton CO2

BEy = MBy * GWP_CH4 – MDy,reg* GWP_CH4
= 0.01 (ton CH4/ton of waste) x 1000 x 21 (assume no regulatory requirement for safety) = 2160 ton CO2 eqt

ERy = BEy – (PEy + Leakage y)
= 2160 – 13.4
= 2146.6 ton CO2 eqt.

III.E./Version 12
Sectoral Scope 13
EB 31

Indicative simplified baseline and monitoring methodologies for selected small-scale CDM project activity categories

TYPE III - OTHER PROJECT ACTIVITIES

Project participants must take into account the general guidance to the methodologies, information on additionality, abbreviations and general guidance on leakage provided at http://cdm.unfccc.int/goto/SSCappmeth .

5.5.2 III.E Avoidance of methane production from decay of biomass through controlled combustion

Technology/measure

1. This project category comprises measures that avoid the production of methane from biomass or other organic matter that:

(a) Would have otherwise been left to decay under clearly anaerobic conditions throughout the crediting period[1] in a solid waste disposal site without methane recovery, or

(b) Is already deposited in a waste disposal site without methane recovery.

Due to the project activity, decay is prevented through controlled combustion of the wastes of type referred to in paragraph 1(a) and/or 1(b) above. Measures are limited to those that result in emission reductions of less than or equal to 60 kt CO_2 equivalent annually.

2. For the case of stockpile of wastes[1] where in the baseline usually there is a reduction in the amount of waste through regular open burning the use of the FOD model will have to be adjusted to take account of this burning in order to estimate correctly the baseline emission.

3. The project activity does not recover or combust methane unlike AMS III.G. Nevertheless, the location and characteristics of the disposal site in the baseline condition shall be known, in such a way as to allow the estimation of its methane emissions.

4. If the project activity involves combustion of partially decayed waste mined (i.e. removed) from a solid waste disposal site, the project participants shall:

i. Provide justifications for not using methane recovery and combustion as a technology/measure to achieve emission reductions; and
ii. If fresh wastes are generated during the crediting period, demonstrate that there is adequate capacity of the combustion facility to treat the newly generated wastes in addition to the partially decayed wastes removed from the disposal site or alternately justify the reasons for combusting the partially decayed wastes instead of the newly generated wastes.

5. If the combustion facility is used for heat and electricity generation, that component of the project activity shall use a corresponding methodology under type I project activities.

[1] Further work is undertaken to investigate to which extent and in which cases methane emissions may occur from stockpiling biomass residues. Subject to further insights on this issue the methodology may be revised.

5.5.2.1 Boundary

6. The project boundary is the physical, geographical sites:

a. where the solid waste would have been disposed or is already deposited and the avoided methane emission occurs in absence of the proposed project activity,

b. where the treatment of biomass through controlled combustion takes place,

c. where the final residues of the combustion process will be deposited, and

d. in the itineraries between them, where the transportation of wastes and combustion residues occurs.

5.5.2.2 Project Activity Emissions

7. Project activity emissions consist of:

a. CO_2 emissions related to the combustion of the non-biomass carbon content of the waste (plastics, rubber and fossil derived carbon) and auxiliary fossil fuels used in the combustion facility,

b. Incremental CO_2 emissions due to incremental distances between the collection points to the controlled combustion site and to the baseline disposal site as well as transportation of combustion residues and final waste from controlled burning site to disposal site,

c. CO_2 emissions related to the fossil fuel and/or electricity consumed by the project activity facilities, including the equipment for air pollution control required by regulations. In case the project activity consumes grid-based electricity, the grid emission factor (tCO_2e/MWh) should be used, or it should be assumed that diesel generators would have provided a similar amount of electricity, calculated as described in category I.D.

$$PE_y = PE_{y,comb} + PE_{y,transp} + PE_{y,power}$$

Where:

PE_y	project activity direct emissions in the year "y" (tCO_2e)
$PE_{y,comb}$	emissions through combustion of non-biomass carbon in the year "y"(tCO_2e)
$PE_{y,transp}$	emissions through incremental transportation in the year "y"(tCO_2e)
$PE_{y,power}$	emissions through electricity or diesel consumption in the year "y"(tCO_2e)

8. The expected annual quantity (tons) and composition of the waste combusted by the project activity during the crediting period shall be described in the project design document, including the biomass and non-biomass carbon content of the waste ($Q_{biomass}$ and $Q_{non\text{-}biomass}$).

The expected consumption of auxiliary fuel for the incineration process (Q_{fuel}) should also be reported in the project design document. CO_2 emissions from the combustion of the non-biomass (i.e., fossil) carbon content of the wastes and from the auxiliary fossil fuel consumed will be estimated assuming the complete oxidation of carbon to CO_2 in the combustion.

$$PE_{y,comb} = Q_{y,non\text{-}biomass} * 44/12 + Q_{y,fuel} * EF_{y,fuel}$$

Where:

$Q_{y,non\text{-}biomass}$	Non-biomass carbon of the waste combusted in the year "y" (tons of carbon)
$Q_{y,fuel}$	Quantity of auxiliary fossil fuel used in the year "y" (tons)
$EF_{y,fuel}$	CO_2 emission factor for the combustion of the auxiliary fossil fuel (tons CO_2 per tonne fuel, according to latest IPCC Guidelines)

9. Project activity emissions from trucks for incremental collection activities will be estimated and considered as project activity emissions.

$$PE_{y,transp} = (Q_y/CT_y) * DAF_w * EF_{CO2} + (Q_{y,ash}/CT_{y,ash}) * DAF_{ash} * EF_{CO2}$$

Where:

Q_y	quantity of waste combusted in the year "y" (tons)
CT_y	average truck capacity for waste transportation (tons/truck)
DAF_w	average incremental distance for waste transportation (km/truck)
EF_{CO2}	CO_2 emission factor from fuel use due to transportation (tCO_2/km, IPCC default values or local values)
$Q_{y,ash}$	quantity of combustion residues produced in the year "y" (tons)

$CT_{y,ash}$	average truck capacity for combustion residues transportation (tons/truck)
DAF_{ash}	average distance for combustion residues transportation (km/truck)

5.5.2.3 Baseline

10. The baseline scenario is the situation where, in the absence of the project activity, organic waste matter is left to decay within the project boundary and methane is emitted to the atmosphere. The yearly baseline emissions are the amount of methane that would have been emitted from the decay of the cumulative quantity of the waste diverted or removed from the disposal site, to date, by the project activity, calculated as the methane generation potential using the first order decay model (FOD) described in AMS III.G.

11. In the case of project activities combusting only freshly generated wastes, the baseline emissions at any year "y" during the crediting period is calculated using the amount and composition of wastes combusted since the beginning of the project activity (year "x=1") up to the year "y", using the first order decay model as referred to in AMS III.G. Baseline emissions shall exclude methane emissions that would have to be removed to comply with national or local safety requirement or legal regulations.

$$BE_y = BE_{CH4,SWDS,y} - MD_{reg,}y * GWP\_CH_4$$

Where:

BE_y	Baseline emissions at year "y" during crediting period (tCO_2e)
$BE_{CH4,SWDS,y}$	Yearly Methane Generation Potential of the wastes diverted to be disposed in the landfill from the beginning of the project (x=1) up to the year "y", calculated according to AMS III.G (tCO_2e).
$MD_{reg,y}$	methane that would be destroyed or removed in the year "y" for safety or legal regulation
GWP_CH_4	Global Warming Potential for methane (value of 21)

12. In the case of project activities that combust wastes that have partially decayed in a disposal site, the calculation of the yearly methane generation potential of the wastes combusted from the project beginning (x=1) up to the year "y" will consider the age of the wastes at the start of the project. One of the following options may be used:

> (a) Estimate the mean age of the wastes contained in the disposal site in the beginning of the project activity ("a"). It may be estimated as the weighted average age considering the yearly amount of wastes deposited in the SWDS since its beginning of operation up to the year prior to the start of the project:

$$\bar{a} = \frac{1 \cdot A_1 + 2 \cdot A_2 + 3 \cdot A_3 + \ldots + a \cdot A_a}{A_1 + A_2 + A_3 + \ldots + A_a} = \frac{\sum_{a=1}^{a\max} A_a \cdot a}{\sum_{a=1}^{a\max} A_a}$$

Where:

$\bar{a}$	weighted mean age of the wastes present in the SWDS prior to the project start,
a	years before project start, starting in the first year of waste disposal (a=1) up to the maximal age of the wastes contained in the SWDS at the project start (a=amax.)
A_a	total amount of waste deposited in the SWDS in each year "a". It shall be obtained from recorded data of waste disposals, or estimated according to the level of the activity that generated the wastes (for example, considering the amount of wood processed by a sawmill in each year "a", and estimating the amount of wastes generated and disposed in the SWDS in that year).

If the yearly amount of waste deposited in the SWDS cannot be estimated, then an arithmetic mean age may be used (a = 0.5 * amax). By using this option, the baseline emissions at any year "y" during the crediting period are calculated using the same formula as provided in the last paragraph, nevertheless, the exponential term for the First Order Decay Model "exp [-kj.(y-x)]" will be corrected for the mean age, and will be substituted by "exp[-kj.(y-x-$\bar{a}$)]".

(b) Calculate the yearly methane generation potential of the SWDS as described in AMS III.G, considering the total amount and composition of wastes deposited since its start of operation. The methane generation potential of the wastes removed to be combusted up to the year "y" in the crediting period will be estimated as proportional to the mass fraction of these wastes, relative to the initial amount:

$$BE_y = \frac{\sum_{x=1}^{y} A_x}{A} BE_{CH4,SWDS,y} - MDreg,y * GWP\_CH4$$

Where:

A_x	Amount of wastes removed to be combusted in the year "x" (tons)
A	Total amount of wastes present in the SWDS at the beginning of the project activity (tons)
$BE_{CH4,SWDS,y}$	Yearly methane generation potential of the SWDS at the year "y", considering all the wastes deposited in it since its beginning of operation, and without considering any removal of wastes by the project activity.

(c) Estimate the quantity and the age distribution of the wastes removed each year "x" during the crediting period[2], and calculate the methane generation potential of these wastes in the year "y". For example, in the year x=2 of the project activity, the amount "A_2" was removed to be combusted, and this amount can be divided into "$A_{2,n}$" parts, each part belonging to the age “n”. In the year “y” the methane generation potential of the portions removed from the SWDS may be estimated as:

$$BE_y = \sum_{n=n\,min}^{n\,max} BE_{CH4,SWDS,y,n} - MDreg,y * GWP\_CH4$$

Where:

$BE_{CH4,SWDS,y,n}$ Yearly methane generation potential of the wastes removed since the beginning of the project activity “x=1” up to the year “y” during the crediting period, segregated according to its age “n” at the time of removal (tCO_2e). It is calculated using the tool referred to in III-G, substituting the exponential term for the First Order Decay Model “exp [-kj.(y-x)]” by “exp[-kj.(y-x-n)]”.

5.5.2.4 Leakage

13. If the controlled combustion technology is equipment transferred from another activity or if the existing equipment is transferred to another activity, leakage effects at the site of the other activity are to be considered.

5.5.2.5 Monitoring

14. The emission reduction achieved by the project activity will be measured as the difference between the baseline emission and the sum of the project emission and leakage.

[2] Age distribution is the discrete partitioning of the waste by age (i.e., the number of years since it was generated and deposited at the site). The estimation of the age of the portions of waste being removed from the disposal site and combusted each year may be done by topographical modeling of the wastes present in the relevant sections of the disposal site. This approach should include segregation of the wastes into even-age layers or volumetric blocks based on historical or constructive data (design of the disposal site). This information on quantity, composition, and age may be based on (a) historical records of the yearly mass and composition of waste deposited in the section of the disposal site where waste is being removed for combustion; or (b) historical production data for cases in which the waste at the site is dominated by relatively homogeneous industrial waste materials (e.g., waste by-products from sawmills or finished wood product manufacturing). Option (b) that uses historical industrial production data should apply the following steps. Step1: Estimate the total mass of waste at the disposal site in the section where it is to be removed based on the section’s volume and the average density of the waste. Step 2: Apportion the mass of waste in this section into waste types and ages using historical records on the output of products produced in a given year from the industrial facility and factors for the average mass of waste by-products produced per unit of each product.

$$ER_y = BE_y – (PE_y + Leakage_y)$$

Where:
ER_y Emission reduction in the year "y" (tCO_2e)

15. The amount of waste combusted by the project activity in each year (Q_y) shall be measured and recorded, as well as its composition through representative sampling, to provide information for estimating the baseline emissions. The quantity of auxiliary fuel used ($Q_{,fuel}$) and the non-biomass carbon content of the waste combusted ($Q_{,non\text{-}biomass}$) shall be measured, the latter by sampling. The total quantity of combustion residues ($Q_{y,ash}$) and the average truck capacity (CT_y) shall be measured. The electricity consumption and/or generation shall be measured. The distance for transporting the waste in the baseline and the project scenario shall also be recorded.

In the case of project activities processing newly generated biomass wastes, the project participants shall demonstrate annually, through the assessment of common practices at proximate waste disposal sites, that the amount of waste combusted in the project activity facilities would have been disposed in a solid waste disposal site without methane recovery in the absence of the project activity and it would decay anaerobically in the disposal site throughout the crediting period.

III.C./Version 10
Scope 7
23 December 2006

Indicative simplified baseline and monitoring methodologies for selected small-scale CDM project activity categories

NOTE: The revised version of the methodology reflects only the revised definitions in accordance with the COP/MOP decision -/CMP.2 "Further guidance relating to the clean development mechanism", paragraph 28 and therefore there is no need to re-publish the PDD at validation stage as prescribed by EB27 para 29(a).

TYPE III - OTHER PROJECT ACTIVITIES

Project participants shall take into account the general guidance to the methodologies, information on additionality, abbreviations and general guidance on leakage provided at http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html .

5.5.3 III.C Emission reductions by low-greenhouse gas emitting vehicles

Technology/measure

1. This category comprises low-greenhouse gas emitting vehicles.

2. Measures are limited to those that result in emission reductions of less than or equal to 60 kt CO_2 equivalent annually.

5.5.3.1 Boundary

3. The project boundary is the low-greenhouse gas emitting vehicles that are part of the project activity.

5.5.3.2 Project Activity Emissions

4. For electric vehicles, the emissions from the production of electricity used will constitute the project emissions. This will be determined in accordance with the relevant sections for category I.D.

5. For hybrid vehicles that can run on fossil fuels and electricity, the emissions resulting from the fossil fuel use should also be included in the direct emissions, in addition to emissions from electricity used.

5.5.3.3 Baseline

6. The baseline is the energy use per unit of service for the vehicle that would otherwise have been used times the average annual units of service per vehicle times the number of vehicles affected times the emission coefficient for the fuel used by vehicle that would otherwise have been used. If electricity is used by the vehicles, the associated emissions shall be estimated in accordance with paragraphs of category I.D.

5.5.3.4 Leakage

7. No leakage calculation is required.

5.5.3.5 Monitoring

8. Monitoring shall track the number of low-emission vehicles operated under the small-scale CDM project activity and the annual units of service for a sample of the vehicles. Emissions from electricity generation shall be taken into account for electric vehicles.

9. The quantity of fossil fuel used should also be monitored for hybrid vehicles. The electricity consumption should also be monitored for all electric vehicles including hybrids.

Example Baseline Calculation

Energy used per unit of service	= 0.1 L of petrol / km
Average annual units of service	= 12,000 km / year / vehicle
Number of vehicles	= 1000
Emission coefficient for the fuel used	= 0.00222 (t-CO_2 / liter) (source: UNEP 2000)
Baseline Emission / year	= 0.1 (L/km) x 12,000 (km/year/vehicle) x 1000 (vehicles) x 0.00222 (t-CO_2/L) = 2664 t-CO_2/year

II.D./Version 9
Sectoral Scope: 4
EB 31

Indicative simplified baseline and monitoring methodologies for selected small-scale CDM project activity categories

TYPE II - ENERGY EFFICIENCY IMPROVEMENT PROJECTS

Project participants shall take into account the general guidance to the methodologies, information on additionality, abbreviations and general guidance on leakage provided at http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html.

5.5.4 II.D Energy efficiency and fuel switching measures for industrial facilities

Technology/measure

1. This category comprises any energy efficiency and fuel switching measure implemented at a single industrial or mining and mineral production facility. This category covers project activities aimed primarily at energy efficiency; a project activity that involves primarily fuel switching falls into category III.B.[1] Examples include energy efficiency measures (such as efficient motors), fuel switching measures (such as switching from steam or compressed air to electricity) and efficiency measures for specific industrial or mining and mineral production processes (such as steel furnaces, paper drying, tobacco curing, etc.). The measures may replace, modify or retrofit existing facilities or be installed in a new facility. The aggregate energy savings of a single project may not exceed the equivalent of 60 GWh_e per year. A total saving of 60 GWh_e per year is equivalent to a maximal saving of 180 GWh_{th} per year in fuel input.

5.5.4.1 Boundary

2. The project boundary is the physical, geographical site of the industrial or mining and mineral production facility, processes or equipment that are affected by the project activity.

5.5.4.2 Baseline

3. In the case of replacement, modification or retrofit measures, the baseline consists of the energy baseline of the existing facility or sub-system that is replaced, modified or retrofitted. In the case of a new facility the energy baseline consists of the facility that would otherwise be built.

4. In the absence of the CDM project activity, the existing facility would continue to consume energy (ECbaseline, in GWh/year) at historical average levels (EChistorical, in GWh/year), until the time at which the industrial or mining and mineral production facility would be likely to be replaced, modified or retrofitted in the absence of the CDM project activity (DATEBaselineRetrofit). From that point of time onwards, the baseline scenario is assumed to correspond to the project activity, and baseline energy consumption (ECbaseline) is assumed to equal project energy consumption (ECy, in GWh/year), and no emission reductions are assumed to occur.

ECbaseline = EChistorical until DATEBaselineRetrofit

ECbaseline = ECy on/after DATEBaselineRetrofit

[1] Thus, fuel switching measures that are part of a package of energy efficiency measures at a single location may be part of a project activity included in this project category.

In order to estimate the point in time when the existing equipment would need to be replaced in the absence of the project activity (DATEBaselineRetrofit), project participants may take the following approaches into account:

(a) The typical average technical lifetime of the equipment type may be determined and documented, taking into account common practices in the sector and country, e.g. based on industry surveys, statistics, technical literature, etc.

(b) The common practices of the responsible industry regarding replacement schedules may be evaluated and documented, e.g. based on historical replacement records for similar equipment.

The point in time when the existing equipment would need to be replaced in the absence of the project activity should be chosen in a conservative manner, i.e. if a range is identified, the earliest date should be chosen.

5. Each energy form in the emission baseline is multiplied by an emission coefficient (in kg CO_2e/kWh). For the electricity displaced, the emission coefficient is calculated in accordance with provisions under category I.D. For fossil fuels, the IPCC default values for emission coefficients may be used.

5.5.4.3 Leakage

6. If the energy efficiency technology is equipment transferred from another activity or if the existing equipment is transferred to another activity, leakage is to be considered.

5.5.4.4 Monitoring

7. In the case of replacement, modification and retrofit measures the monitoring shall consist of:

(a) Documenting the specifications of the equipment replaced;

(b) Metering the energy use of the industrial or mining and mineral production facility, processes or the equipment affected by the project activity;

(c) Calculating the energy savings using the metered energy obtained from subparagraph (b).

8. In the case of a new facility, monitoring shall consist of:

(a) Metering the energy use of the equipment installed;

(b) Calculating the energy savings due to the equipment installed.

III.G./Version 4
Sectoral Scope: 13
23 December 2006

Indicative simplified baseline and monitoring methodologies for selected small-scale CDM project activity categories

III.G. Landfill Methane Recovery (cont)

TYPE III - OTHER PROJECT ACTIVITIES

Project participants shall take into account the general guidance to the methodologies, information on additionality, abbreviations and general guidance on leakage provided at http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html .

5.5.5 III.G Landfill Methane Recovery

Technology/measure

1. This project category comprises measures to capture and combust methane from landfills (i.e., solid waste disposal sites) used for disposal of residues from human activities including municipal, industrial, and other solid wastes containing biodegradable organic matter.

2. If the recovered methane is used for heat or electricity generation the project can use a corresponding methodology under type I project activities.

3. Measures are limited to those that result in emission reductions of less than or equal to 60 kt CO_2 equivalent annually.

5.5.5.1 Boundary

4. The project boundary is the physical, geographical site of the landfill where the gas is captured and destroyed/used.

Yearly Methane Generation Potential

5. The estimation of the methane emission potential of a solid waste disposal site ($BE_{CH4,SWDS,y}$, in tCO_2e) shall be undertaken using the "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site", found on the CDM website[1]. The tool may be used with the oxidation factor (OX = 0.0), assuming no oxidation of methane in the covering layers, and the factor "f=0.0" assuming that no methane is captured and flared. The amount of waste type "j" deposited in each year "x" ($W_{j,x}$) shall be determined by sampling (as specified in the tool), in the case wastes are generated during the crediting period. Alternatively, for existing SWDS, if the pre-

existing amount and composition of the wastes in the landfill are unknown, they can be estimated by using parameters related to the attended population or industrial activity, or by comparison with other landfills with similar conditions in regional or national levels.

5.5.5.2 Project Activity Emissions

6. Project activity emissions consist of CO_2 emissions related to the power used by the project activity facilities. Emission factors for electricity shall be calculated as described in category I.D.

[1] http://cdm.unfccc.int/Reference/Guidclarif

5.5.5.3 Baseline

7. The baseline scenario is the situation where, in the absence of the project activity, biomass and other organic matter are left to decay within the project boundary and methane is emitted to the atmosphere. Baseline emissions shall exclude methane emissions that would have to be removed to comply with national or local safety requirement or legal regulations:

$$BE_y = BE_{CH4,SWDS,y} - MD_{reg,y}$$

Where:

$MD_{reg,y}$ — methane emissions that would be captured and destroyed to comply with national or local safety requirement or legal regulations in the year "y" (tCO_2e)

5.5.5.4 Leakage

8. If the methane recovery technology is equipment transferred from another activity or if the existing equipment is transferred to another activity, leakage effects are to be considered.

5.5.5.5 Monitoring

9. Emission reductions achieved by the project activity in each year will be assessed ex-post through direct measurement of the amount of methane fuelled or flared. The maximal emission reduction in any year is limited to the yearly methane generation potential calculated in the project design document for that year.

10. The amount of methane recovered and fuelled or flared shall be monitored ex-post, using continuous flow meters. The fraction of methane in the landfill gas should be measured with a continuous analyser or, alternatively, with periodical measurements at a 95% confidence level. Temperature and pressure of the landfill gas are required to determine the density of methane combusted.

11. Regular maintenance should ensure optimal operation of flares. The flare efficiency, defined as the fraction of time in which the gas is combusted in the flare, multiplied by the efficiency of the flaring process, shall be monitored. One of the two following options shall be used to determine the efficiency of the flaring process in an enclosed flare:

a. To adopt a 90% default value or

b. To perform a continuous monitoring of the efficiency.[2]

If option (a) is chosen, continuous check of compliance with the manufacturers' specification of the flare device (temperature, biogas flow rate) should be done. If in any specific hour any of the parameters is out of the range of specifications, 50% of default value should be used for this specific hour. For open flare 50% default value should be used, as it is not possible in this case to monitor the efficiency. If at any given time the temperature of the flare is below 500^0C, 0% default value should be used for this period.

12. The emission reduction achieved by the project activity can be estimated ex-ante in the PDD by:

[2] The procedures described in the Methodological Tool to determine project emissions from flaring gases containing methane shall be used.

$$ER_{y,estimated} = BE_y - PE_y - Leakage$$

The actual emission reduction achieved by the project during the crediting period will be calculated using the amount of methane recovered and destroyed by the project activity, calculated as:

$$ER_{y,calculated} = MD_y - MD_{reg,y} - PE_y - Leakage$$

Where:

MD_y methane captured and destroyed by the project activity in the year "y" (tCO_2 e), that will be measured using the conditions of the flaring process:

$$MD_y = LFG_{burnt,y} * w_{CH4,}y * D_{CH4,y} * FE * GWP_{CH4}$$

Where:

$LFG_{burnt,y}$	landfill gas[3] flared or used as fuel in the year "y" (m^3).
$w_{CH4,y}$	methane content[4] in landfill gas in the year "y" (mass fraction).
$D_{CH4,y}$	density of methane at the temperature and pressure of the landfill gas in the year "y" ($tons/m^3$).
FE	flare efficiency in the year "y" (fraction).

13. The method for integration of the terms in equation above to obtain the results for one year of measurements within the confidence level, as well as the methods and instruments used for metering, recording and processing the data obtained, shall be described in the project design document and monitored during the crediting period.

14. Flow meters, sampling devices and gas analysers shall be subject to regular maintenance, testing and calibration to ensure accuracy.

[3] Landfill gas and methane content measurements shall be on the same basis (wet or dry)

Example calculation: Baseline calculation of CH4 emission from 1 ton of waste for a period of 20 years

MB_1 = 16/12 x 0.5 x 0.77 x 1.0 x [1 x 0.1251 x 0.4 x $(1 – e^{-0.023})$ x e^0 + 1 x 0.0594 x 0.17 x $(1 – e^{-0.023})$ x e^0 + 1 x 0.5891 x 0.15 x $(1 – e^{-0.231})$ x e^0 + 1 x 0.0635 x 0.30 x $(1 – e^{-0.023})$ x e^0 + 1 x 0.1627 x 0 x $(1 – e^0)$ x e^0]

MB_1 = 0.01 CH_4 / ton of waste per year
= 0.216 ton CO_2 eqt / ton of waste per year

MB_2 = 16/12 x 0.5 x 0.77 x 1.0 x [1 x 0.1251 x 0.4 x $(1 – e^{-0.023})$ x $e^{-0.023(2-1)}$ + 1 x 0.0594 x 0.17 x $(1 – e^{-0.023})$ x $e^{-0.023(2-1)}$ + 1 x 0.5891 x 0.15 x $(1 – e^{-0.231})$ x $e^{-0.231(2-1)}$ + 1 x 0.0635 x 0.30 x $(1 – e^{-0.023})$ x $e^{-0.023(2-1)}$]

MB_2 = 0.0081 ton CH_4 / ton of waste
= 0.17 ton CO_2 eqt / ton of waste

MB_3 = 0.513 x [1.136 x 10^{-3} x $e^{-0.023 \text{ x } (3-1)}$ + 2.29 x 10^{-4} x $e^{-0.023 \text{ x}(3-1)}$ + 0.018 x $e^{-0.231 \text{ x } (3-1)}$ + 4.32 x 10^{-4} x $e^{-0.023 \text{ x } (3-1)}$]

MB_3 = 0.0067 ton CH_4 / ton of waste
= 0.14 ton CO_2 eqt / ton of waste

MB_4 = 0.513 x [1.136 x 10^{-3} x $e^{-0.023 \text{ x } 3}$ + 2.29 x 10^{-4} x $e^{-0.023 \text{ x}3}$ + 0.018 x $e^{-0.231 \text{ x } 3}$ + 4.32 x 10^{-4} x $e^{-0.023 \text{ x } 3}$]
= 0.0055 ton CH_4 / ton of waste
= 0.115 ton CO_2 eqt / ton of waste

MB_5 = 0.513 x [1.136 x 10^{-3} x $e^{-0.023 \text{ x } 4}$ + 2.29 x 10^{-4} x $e^{-0.023 \text{ x } 4}$ + 0.018 x $e^{-0.231 \text{ x } 4}$ + 4.32 x 10^{-4} x $e^{-0.023 \text{ x } 4}$]

= 0.0045 ton CH_4 / ton of waste
= 0.095 ton CO_2 eqt / ton of waste

MB_6 = 0.513 x [1.136 x 10^{-3} x $e^{-0.023 \text{ x } 5}$ + 2.29 x 10^{-4} x $e^{-0.023 \text{ x } 5}$ + 0.018 x $e^{-0.231 \text{ x } 5}$ + 4.32 x 10^{-4} x $e^{-0.023 \text{ x } 5}$]

$= 0.0037$ ton CH_4 / ton of waste
$= 0.078$ ton CO_2 eqt / ton of waste

$MB_7 = 0.513 \times [1.136 \times 10^{-3} \times e^{-0.023 \times 6} + 2.29 \times 10^{-4} \times e^{-0.023 \times 6} + 0.018 \times e^{-0.231 \times 6} + 4.32 \times 10^{-4} \times e^{-0.023 \times 6}]$

$= 0.0031$ ton CH_4 / ton of waste
$= 0.065$ ton CO_2 eqt / ton of waste

$MB_8 = 0.513 \times [1.136 \times 10^{-3} \times e^{-0.023 \times 7} + 2.29 \times 10^{-4} \times e^{-0.023 \times 7} + 0.018 \times e^{-0.231 \times 7} + 4.32 \times 10^{-4} \times e^{-0.023 \times 7}]$

$= 0.0026$ ton CH_4 / ton of waste
$= 0.055$ ton CO_2 eqt / ton of waste

$MB_9 = 0.513 \times [1.136 \times 10^{-3} \times e^{-0.023 \times 8} + 2.29 \times 10^{-4} \times e^{-0.023 \times 8} + 0.018 \times e^{-0.231 \times 8} + 4.32 \times 10^{-4} \times e^{-0.023 \times 8}]$

$= 0.0022$ ton CH_4 / ton of waste
$= 0.047$ ton CO_2 eqt / ton of waste

$MB_{10} = 0.513 \times [1.136 \times 10^{-3} \times e^{-0.023 \times 9} + 2.29 \times 10^{-4} \times e^{-0.023 \times 9} + 0.018 \times e^{-0.231 \times 9} + 4.32 \times 10^{-4} \times e^{-0.023 \times 9}]$

$= 0.040$ ton CO_2 eqt / ton of waste

$MB_{11} = 0.513 \times [1.136 \times 10^{-3} \times e^{-0.023 \times 10} + 2.29 \times 10^{-4} \times e^{-0.023 \times 10} + 0.018 \times e^{-0.231 \times 10} + 4.32 \times 10^{-4} \times e^{-0.023 \times 10}]$

$= 0.035$ ton CO_2 eqt / ton of waste

$MB_{12} = 0.513 \times [1.136 \times 10^{-3} \times e^{-0.023 \times 11} + 2.29 \times 10^{-4} \times e^{-0.023 \times 11} + 0.018 \times e^{-0.231 \times 11} + 4.32 \times 10^{-4} \times e^{-0.023 \times 11}]$

$= 0.030$ ton CO_2 eqt / ton of waste

$MB_{13} = 0.513 \times [1.136 \times 10^{-3} \times e^{-0.023 \times 12} + 2.29 \times 10^{-4} \times e^{-0.023 \times 12} + 0.018 \times e^{-0.231 \times 12} + 4.32 \times 10^{-4} \times e^{-0.023 \times 12}]$

$= 0.027$ ton CO_2 eqt / ton of waste

$MB_{14} = 0.513 \times [1.136 \times 10^{-3} \times e^{-0.023 \times 13} + 2.29 \times 10^{-4} \times e^{-0.023 \times 13} + 0.018 \times e^{-0.231 \times 13} + 4.32 \times 10^{-4} \times e^{-0.023 \times 13}]$

$= 0.024$ ton CO_2 eqt / ton of waste

MB_{15} = $0.513 \times [1.136 \times 10^{-3} \times e^{-0.023 \times 14} + 2.29 \times 10^{-4} \times e^{-0.023 \times 14} + 0.018 \times e^{-0.231 \times 14} + 4.32 \times 10^{-4} \times e^{-0.023 \times 14}]$

= 0.022 ton CO_2 eqt / ton of waste

MB_{16} = $0.513 \times [1.136 \times 10^{-3} \times e^{-0.023 \times 15} + 2.29 \times 10^{-4} \times e^{-0.023 \times 15} + 0.018 \times e^{-0.231 \times 15} + 4.32 \times 10^{-4} \times e^{-0.023 \times 15}]$

= 0.020 ton CO_2 eqt / ton of waste

MB_{17} = $0.513 \times [1.136 \times 10^{-3} \times e^{-0.023 \times 16} + 2.29 \times 10^{-4} \times e^{-0.023 \times 16} + 0.018 \times e^{-0.231 \times 16} + 4.32 \times 10^{-4} \times e^{-0.023 \times 16}]$

= 0.018 ton CO_2 eqt / ton of waste

MB_{18} = $0.513 \times [1.136 \times 10^{-3} \times e^{-0.023 \times 17} + 2.29 \times 10^{-4} \times e^{-0.023 \times 17} + 0.018 \times e^{-0.231 \times 17} + 4.32 \times 10^{-4} \times e^{-0.023 \times 17}]$

= 0.017 ton CO_2 eqt / ton of waste

MB_{19} = $0.513 \times [1.136 \times 10^{-3} \times e^{-0.023 \times 18} + 2.29 \times 10^{-4} \times e^{-0.023 \times 18} + 0.018 \times e^{-0.231 \times 18} + 4.32 \times 10^{-4} \times e^{-0.023 \times 18}]$

= 0.016 ton CO_2 eqt / ton of waste

MB_{20} = $0.513 \times [1.136 \times 10^{-3} \times e^{-0.023 \times 19} + 2.29 \times 10^{-4} \times e^{-0.023 \times 19} + 0.018 \times e^{-0.231 \times 19} + 4.32 \times 10^{-4} \times e^{-0.023 \times 19}]$

= 0.015 ton CO_2 eqt / ton of waste

Total emission for 20 years Σ MB = 1.197 ton CO_2 eqt / ton of waste

III.H./Version 5
Sectoral Scope: 13
EB 31

Indicative simplified baseline and monitoring methodologies for selected small-scale CDM project activity categories

TYPE III - OTHER PROJECT ACTIVITIES

Project participants shall take into account the general guidance to the methodologies, information on additionality, abbreviations and general guidance on leakage provided at http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html.

5.5.6 III.H Methane Recovery in Wastewater Treatment

Technology/measure

1. This project category comprises measures that recover methane from biogenic organic matter in wastewaters by means of one of the following options:

(i) Substitution of aerobic wastewater or sludge treatment systems with anaerobic systems with methane recovery and combustion.

(ii) Introduction of anaerobic sludge treatment system with methane recovery and combustion to an existing wastewater treatment plant without sludge treatment.

(iii) Introduction of methane recovery and combustion to an existing sludge treatment system.

(iv) Introduction of methane recovery and combustion to an existing anaerobic wastewater treatment system such as anaerobic reactor, lagoon, septic tank or an on site industrial plant.

(v) Introduction of anaerobic wastewater treatment with methane recovery and combustion, with or without anaerobic sludge treatment, to an untreated wastewater stream.

(vi) Introduction of a sequential stage of wastewater treatment with methane recovery and combustion, with or without sludge treatment, to an existing wastewater treatment system without methane recovery (e.g. introduction of treatment in an anaerobic reactor with methane recovery as a sequential treatment step for the wastewater that is presently being treated in an anaerobic lagoon without methane recovery).

2. If the recovered methane is used for heat and or electricity generation that component of the project activity can use a corresponding category under type I.

3. Measures are limited to those that result in emission reductions of less than or equal to 60 kt CO_2 equivalent annually.

5.5.6.1 Boundary

4. The project boundary is the physical, geographical site where the wastewater and sludge treatment takes place.

5.5.6.2 Project Activity Emissions

5. Project activity emissions consist of:

> (i) CO_2 emissions on account of power used by the project activity facilities. Emission factors for grid electricity or diesel fuel use as the case may be shall be calculated as described in category AMS I.D;
>
> (ii) Methane emissions on account of inefficiency of the wastewater treatment and presence of degradable organic carbon in treated wastewater;
>
> (iii) Methane emissions from the decay of the final sludge generated by the treatment systems;
>
> (iv) Methane fugitive emissions on account of inefficiencies in capture and flare systems;
>
> (v) Methane emissions resulting from dissolved methane in the treated wastewater effluent.

$$\mathbf{PE_y = PE_{y,\,power} + PE_{y,ww,treated} + PE_{y,s,final} + PE_{y,fugitive} + PE_{y,dissolved}}$$

Where:

$\mathbf{PE_y}$	project activity emissions in the year "y" (tCO_2e)
$\mathbf{PE_{y,power}}$	emissions from electricity or diesel consumption in the year "y"
$\mathbf{PE_{y,ww,treated}}$	emissions from degradable organic carbon in treated wastewater in year "y"
$\mathbf{PE_{y,s,final}}$	emissions from anaerobic decay of the final sludge produced in the year "y". If the sludge is controlled combusted, disposed in a landfill with methane recovery, or used for soil application, this term can be neglected, and the final disposal of the sludge shall be monitored during the crediting period.
$\mathbf{PE_{y,fugitive}}$	emissions from methane release in capture and flare systems in year "y".
$\mathbf{PE_{y,dissolved}}$	emissions from dissolved methane in treated wastewater in year "y"

$$\mathbf{PE_{y,ww,treated} = Q_{y,ww} * COD_{y,ww,treated} * B_{o,ww} * MCF_{ww,final} * GWP\_CH_4}$$

Where:

$Q_{y,ww}$ volume of wastewater treated in the year "y" (m^3)
$COD_{y,ww,treated}$ chemical oxygen demand of the treated wastewater in the year "y" ($tons/m^3$)[1]
$B_{o,ww}$ methane producing capacity of the wastewater (IPCC default value for domestic wastewater of 0.21 kg CH_4/kg.COD)[1]

[1] The IPCC default value of 0.25 kg CH_4/kg COD was corrected to take into account the uncertainties. For domestic waste water, a COD based value of $B_{o,ww}$ can be converted to BOD_5 based value by dividing it by 2.4 i.e. a default value of 0.504 kg CH_4/kg BOD can be used.

$MCF_{ww,final}$ methane correction factor based on type of treatment and discharge pathway of the wastewater (fraction) (MCF Higher Value in table III.H.1 for sea, river and lake discharge i.e. 0.2).
GWP_CH4 Global Warming Potential for methane (value of 21 is used)

Table 24 - III.H.1. IPCC default values1) for Methane Correction Factor (MCF)

Type of wastewater treatment and discharge pathway or system	MCF lower values	MCF higher values
Discharge of wastewater to sea, river or lake	0.0	0.2
Aerobic treatment, well managed	0.0	0.1
Aerobic treatment, poorly managed or overloaded	0.2	0.4
Anaerobic digester for sludge without methane recovery	0.8	1.0
Anaerobic reactor without methane recovery	0.8	1.0
Anaerobic shallow lagoon (depth less than 2 metres)	0.0	0.3
Anaerobic deep lagoon (depth more than 2 metres)	0.8	1.0
Septic system	0.5	0.5

1) Default values from chapter 6 of volume 5.Waste in *2006 IPCC Guidelines for National Greenhouse Gas Inventories*

$$\mathbf{PE_{y,s,final} = S_{y,final} * DOC_{y,s,final} * MCF_{s,final} * DOC_F * F * 16/12 * GWP\_CH_4}$$

Where:
$PE_{y,s,final}$ Methane emissions from the anaerobic decay of the final sludge generated in the wastewater system in the year "y" (tCO_2e)
$S_{y,final}$ Amount of final sludge generated by the wastewater treatment in the year y (tons)

$DOC_{y,s,final}$ Degradable organic content of the final sludge generated by the wastewater treatment in the year y (fraction). It shall be measured by sampling and analysis of the sludge produced, and estimated ex-ante using the IPCC default values of 0.05 for domestic sludge (wet basis, considering a default dry matter content of 10 percent) or 0.09 for industrial sludge (wet basis, assuming dry matter content of 35 percent).

$MCF_{s,final}$ Methane correction factor of the landfill that receives the final sludge, estimated as described in category AMS III.G.

DOC_F Fraction of DOC dissimilated to biogas (IPCC default value of 0.5)

F Fraction of CH_4 in landfill gas (IPCC default of 0.5).

$$PE_{y,fugitive} = PE_{y,fugitive,ww} + PE_{y,fugitive,s}$$

Where:

$PE_{y,fugitive,ww}$ Fugitive emissions through capture and flare inefficiencies in the anaerobic wastewater treatment in the year “y” (tCO_2e)

$PE_{y,fugitive,s}$ Fugitive emissions through capture and flare inefficiencies in the anaerobic sludge treatment in the year “y” (tCO_2e)

$$PE_{y,fugitive,ww} = (1 - CFE_{ww}) * MEP_{y,ww,treatment} * GWP\_CH_4$$

Where:

CFE_{ww} capture and flare efficiency of the methane recovery and combustion equipment in the wastewater treatment (a default value of 0.9 shall be used, given no other appropriate value)

$MEP_{y,ww,treatment}$ methane emission potential of wastewater treatment plant in the year “y” (tons)

$$MEP_{y,ww,treatment} = Q_{y,ww} * COD_{y,ww,untreated} * B_{o,ww} * MCF_{ww,treatment}$$

Where:

$COD_{y,ww,untreated}$ Chemical oxygen demand of the wastewater entering the anaerobic treatment reactor/system with methane capture in the year “y” ($tons/m^3$)

$MCF_{ww,\ treatment}$ methane correction factor for the wastewater treatment system that will be equipped with methane recovery and combustion (MCF higher values in table III.H.1).

$$PE_{y,fugitive,s} = (1 - CFE_s) * MEP_{y,s,treatment} * GWP\_CH_4$$

Where:

CFE_s capture and flare efficiency of the methane recovery and combustion equipment in the sludge treatment (a default value of 0.9 shall be used, given no other appropriate value)

$MEP_{y,s,treatment}$ methane emission potential of the sludge treatment system in the year “y” ()

$$\mathbf{MEP_{y,s,treatment} = S_{y,untreated} * DOC_{y,s,untreated} * DOC_F * F * 16/12 * MCF_{s,treatment}}$$

Where:

$\mathbf{S_{y,untreated}}$	amount of untreated sludge generated in the year "y" (tons)
$\mathbf{DOC_{y,s,untreated}}$	Degradable organic content of the untreated sludge generated in the year y (fraction). It shall be measured by sampling and analysis of the sludge produced, and estimated exante using the IPCC default values of 0.05 for domestic sludge (wet basis, considering a default dry matter content of 10 percent) or 0.09 for industrial sludge (wet basis, assuming dry matter content of 35 percent)
$\mathbf{MCF_{s,treatment}}$	methane correction factor for the sludge treatment system that will be equipped with methane recovery and combustion (MCF Higher value of 1.0 as per table III.H.1).

$$\mathbf{PE_{y,dissolved} = Q_{y,ww} * [CH_4]_{y,ww,treated} * GWP\_CH_4}$$

Where:

$\mathbf{[CH_4]_{y,ww,treated}}$	dissolved methane content in the treated wastewater (tons/m^3). In aerobic wastewater treatment default value is zero, in anaerobic treatment it can be measured, or a default value of 10e-4 tons/m^3 can be used[2].

5.5.6.3 Baseline

6. The baseline scenario will be one of the following situations:

i. The existing aerobic wastewater or sludge treatment system, in the case of substitution of one or both of these systems for anaerobic ones with methane recovery and combustion.

ii. The existing sludge disposal system, in the case of introduction of anaerobic sludge treatment system with methane recovery and combustion to an existing wastewater treatment plant.

iii. The existing sludge treatment system without methane recovery and combustion.

iv. The existing anaerobic wastewater treatment system without methane recovery and combustion.

v. The untreated wastewater being discharged into sea, river, lake, stagnant sewer or flowing sewer, in the case of introducing the anaerobic treatment to an untreated wastewater stream.

vi. The existing anaerobic wastewater treatment system without methane recovery for the case of introduction of a sequential anaerobic wastewater treatment system with methane recovery.

7. The baseline emissions are calculated as follows:

(a) For the cases 6 (i) and 6 (ii) the baseline emissions (BE_y) are calculated as:

$$\mathbf{BE_y = BE_{y,power} + BE_{y,ww,treated} + BE_{y,s,final}}$$

Where:

BE_y	Baseline emissions in the year "y" (tCO_2 e)
$\mathbf{BE_{y,power}}$	emissions on account of electricity or diesel consumed in the year "y" by the replaced aerobic wastewater or sludge treatment system

[2] Value calculated using approach given by Greenfield, P.F. and Batstone, D.J. Anaerobic digestion: impact of future GHG mitigation policies on methane generation and usage. In: Proceedings of Anaerobic Digestion Congress, Montreal, Canada, 2004

$\mathbf{BE_{y,ww,treated}}$	emissions from degradable organic carbon in treated wastewater in year "y", calculated using the same formula as that used for calculating the project emissions ($PE_{y,ww,treated}$). The value of this term is zero for the case 6 (ii).
$\mathbf{BE_{y,s,final}}$	emissions on account of anaerobic decay of the final sludge produced in the year "y", calculated using the formula as for the project emission ($PE_{y,s,final}$). If the sludge is controlled combusted, disposed in a landfill with methane recovery, or used for soil application, this term shall be neglected, and the end-use of the final sludge will be monitored during the crediting period.

(b) For the cases 6 (iii) and 6 (iv) the baseline emissions are calculated as per the formulas provided for calculating the project emissions, with the exception that MCF lower values in Table III.H.1 are used:

$$\mathbf{BE_y = MEP_{y,ww,treatment} * GWP\_CH4 + MEP_{y,s,treatment} * GWP\_CH4}$$

(c) For the case of 6 (v) since the MCF lower value for discharge of wastewater to sea, river or lake is 0.0 as per Table III.H.1, but may vary up to 0.2, the project participants shall demonstrate by measurements or by mathematical modeling of the impact of the discharge on the receiving water body, that anaerobic conditions do appear and the baseline emissions occur (a positive MCF is found). This MCF is used to determine the baseline emission scenario:

$$\mathbf{BE_y = Q_{y,ww} * COD_{y,ww,untreated} * B_{o,ww} * MCF_{ww,final} * GWP\_CH_4}$$

(d) For the case 6 (vi) the baseline emissions are calculated as:

$$\mathbf{BE_y = Q_{y,ww} * COD_{y,ww,untreated} * B_{o,ww} * MCF_{ww,treatment} * GWP\_CH_4}$$

Where,

$MCF_{ww,treatment}$ Methane correction factor for the existing wastewater treatment system to which the sequential anaerobic treatment step is being introduced (MCF lower value in TableIII.H.1.)

For the above cases (a), (b) and (c) the methane generation capacity of the treated wastewater ($B_{o,ww}$) shall be IPCC lower value of 0.21 kg CH_4/kg .COD.

5.5.6.4 Leakage

8. If the used technology is equipment transferred from another activity or if the existing equipment is transferred to another activity, leakage effects at the site of the other activity are to be considered.

5.5.6.5 Monitoring

9. For the cases listed in paragraph 1 as:

(i) Substitution of aerobic wastewater or sludge treatment system by an anaerobic treatment system with methane recovery and combustion, or

(v) Introduction of an anaerobic wastewater treatment system with methane recovery and combustion to an untreated wastewater stream

The emission reduction achieved by the project activity will be the difference between the baseline emission and the sum of the project emission and leakage.

$$\mathbf{ER_y = BE_y - (PE_y + Leakage_y)}$$

The existing records of electricity consumption, COD content of treated wastewater, and quantity of sludge produced by the replaced aerobic units will be used for the baseline calculation in case (i). The project emissions will be monitored by regular measurements and recording of:

- the flow of wastewater and/or sludge treated ($Q_{y,ww}$ and $S_{y,untreated}$);
- their initial and final content of degradable carbon ($COD_{y,ww,untreated}$, $COD_{y,ww,treated}$, $DOC_{y,s,untreated}$, $DOC_{y,s,treated}$);
- and the dissolved methane in the wastewater just leaving the anaerobic reactor (if the default value for dissolved methane is not used), for the case (i).

10. For the cases of (ii) introduction of anaerobic sludge treatment with methane recovery and combustion to untreated sludge; (iii) and (iv) introduction of methane recovery and combustion unit to an existing anaerobic wastewater or sludge treatment system, and (vi) introduction of a sequential stage of wastewater treatment with methane recovery and combustion to an existing wastewater treatment, the calculation of emission reductions shall be based on the amount of methane recovered and fuelled or flared, that is monitored ex-post. Also for these cases, the project emissions and leakage will be deducted from the emission reductions calculated from the methane recovered and combusted.

11. In all cases, the amount of methane recovered, fuelled or flared shall be monitored ex-post, using continuous flow meters. The fraction of methane in the gas should be measured with a continuous analyser or, alternatively, with periodical measurements at a 95% confidence level. Temperature and pressure of the gas are required to determine the density of methane combusted.

12. Regular maintenance should ensure optimal operation of flares. The flare efficiency, defined as the fraction of time in which the gas is combusted in the flare, multiplied by the efficiency of the flaring process, shall be monitored. One of the two following options shall be used to determine the efficiency of the flaring process in an enclosed flare:

(a) To adopt a 90% default value, or

(b) To perform a continuous monitoring of the efficiency[3].

If option (a.) is chosen continuous check of compliance with the manufacturers specification of the flare device (temperature, biogas flow rate) should be done. If in any specific hour any of the parameters is out of the range of specifications 50% of default value should be used for this specific hour. For open flare 50% default value should be used, as it is not possible in this case to monitor the efficiency. If at any given time the temperature of the flare is below 500ºC, 0% default value should be used for this period.

13. If the methane emissions from anaerobic decay of the final sludge were to be neglected because the sludge is controlled combusted, disposed in a landfill with methane recovery, or used for soil application, then the end-use of the final sludge will be monitored during the crediting period.

[3] The procedures described in the Tool to determine project emissions from flaring gases containing methane shall be used.

Example

(a) $BE_y = BE_{y,power} + BE_{y,ww,treated} + BE_{y,s,final}$

Power requirement to aerate 1 m3 of wastewater for 6 hours = 40 W
1 KWh of power emits 0.68 of CO2 eqt (assume)

1 m3 of wastewater require (40 x 6) = 240 Wh = 0.24 KWh of power per day
BEy,power = 0.24 x 0.68
= 0.163 of CO2 eqt.

BEy,ww,treated = PEy,ww,treated = Qy,ww * CODy,ww,treated * Bo,ww * MCFww * GWP_CH4
= 1 (m3) x 250 x 10-6 (ton/m3) x 0.25 (kg CH4/kg.COD) x 0.5 x 21
= 656.25 x 10-6 ton CO2 eqt

BEy,s,final = PEy,s,final = Sy,final * DOCy,s,final * DOCF * F * 16/12 * GWP_CH4
= 500 x 10-3 (ton) x 0.3 x 0.77 x 0.5 x 16/12 x 21
= 1.617 ()

BEy = 0.613 + 656.25 x 10-6 + 1.617
= 1.781 ton CO2 eqt/m3 of WW

(b) BEy = (MEy,ww,untreated + MEy,s,untreated) * GWP_CH4

MEy,ww,untreated = Qy,ww * CODy,ww,untreated * Bo,ww * MCFww,untreated
= 1 (m3) x 3000 x 10-6 (ton/m3) x 0.25 (kg CH4/kg COD) x 0.5
= 0.375 x 10-3 (CO2 eqt/m3 WW)

MEy,s,untreated = Sy,untreated * DOCy,s,untreated * DOCF * F * 16/12
= 1 (ton) x 0.3 x 0.77 x 0.5 x 16/12
= 0.154 CO2 eqt/ton of sludge

BEy = (0.375 x 10-3 + 0.154) x 21
= 3.242 ton CO2 eqt

(c) BEy = (MEy,ww,untreated) * GWP_CH4
= 0.375 x 10-3 x 21
= 7.8 (kg CO2 eqt/m3 WW)

III.B./Version 10
Scope 1
23 December 2006

Indicative simplified baseline and monitoring methodologies for selected small-scale CDM project activity categories

NOTE: The revised version of the methodology reflects only the revised definitions in accordance with the COP/MOP decision -/CMP.2 "Further guidance relating to the clean development mechanism", paragraph 28 and therefore there is no need to re-publish the PDD at validation stage as prescribed by EB27 para 29(a).

TYPE III - OTHER PROJECT ACTIVITIES

Project participants shall take into account the general guidance to the methodologies, information on additionality, abbreviations and general guidance on leakage provided at: http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html .

5.5.7 III.B Switching fossil fuels

Technology/Measure

1. This category comprises fossil fuel switching in existing[1] industrial, residential, commercial, institutional or electricity generation applications. Fuel switching may change efficiency as well. If the project activity primarily aims at reducing emissions through fuel switching, it falls into this category. If fuel switching is part of a project activity focused primarily on energy efficiency, the project activity falls in category II.D or II.E.

2. Measures are limited to those that result in emission reductions of less than or equal to 60 kt CO_2 equivalent annually.

5.5.7.1 Boundary

3. The project boundary is the physical, geographical site where the fuel combustion affected by the fuel-switching measure occurs.

5.5.7.2 Baseline

4. The emission baseline is the current emissions of the facility expressed as emissions per unit of output (e.g., kg CO_2e/kWh). Emission coefficients for the fuel used by the generating unit before and after the fuel switch are also needed. IPCC default values for emission coefficients may be used.

5.5.7.3 Project Activity Emissions

5. Project activity emissions consist of those emissions related with the use of fossil fuel after the fuel switch. IPCC default values for emission coefficients may be used.

5.5.7.4 Leakage

6. No leakage calculation is required.

[1] This does not preclude project participants from proposing, in accordance with paragraphs 7 and 8 of the simplified modalities and procedures for small-scale CDM project activities, simplified baselines for switching of fossil fuels for new applications.

5.5.7.5 Monitoring

7. The emission reduction achieved by the project activity will be calculated as the difference between the baseline emissions and the project emissions.

8. Monitoring shall involve:

(a) Monitoring of the fuel use and output for an appropriate period (e.g., a few years, but records of fuel use may be used) prior to the fuel switch being implemented - e.g. coal use and heat output by a district heating plant, liquid fuel oil use and electricity generated by a generating unit (records of fuel used and output can be used *in lieu* of actual monitoring);

(b) Monitoring fuel use and output after the fuel switch has been implemented - e.g. gas use and heat output by a district heating plant, gas use and electricity generated by a generating unit.[2]

9. In the case of coal, the emission coefficient shall be based on test results for periodic samples of the coal purchased if such tests are part of the normal practice for coal purchases.

[2] The necessary data are probably readily available, but may need to be organized into appropriate records and be supported by receipts for fuel purchases.

III.D./Version 12
Sectoral Scope 15
EB 31

Indicative simplified baseline and monitoring methodologies for selected small-scale CDM project activity categories

TYPE III - OTHER PROJECT ACTIVITIES

Project participants shall take into account the general guidance to the methodologies, information on additionality, abbreviations and general guidance on leakage provided at http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html.

5.5.8 III.D Methane recovery in agricultural and agro industrial activities

Technology/measure

1. This project category comprises methane recovery and destruction from manure and wastes from agricultural or agro-industrial activities that would be decaying anaerobically in the absence of the project activity by

(a) Installing methane recovery and combustion system to an existing source of methane emissions, or

(b) Changing the management practice of a biogenic waste or raw material in order to achieve the controlled anaerobic digestion equipped with methane recovery and combustion system.

2. The project activity shall satisfy the following conditions:

(a) The sludge must be handled aerobically. In case of soil application of the final sludge the proper conditions and procedures (not resulting in methane emissions) must be ensured.

(b) Technical measures shall be used (e.g. flared, combusted) to ensure that all biogas produced by the digester is used or flared.

3. Projects that recover methane from landfills shall use category III-G and projects for wastewater treatment shall use category III-H.

4. Measures are limited to those that result in emission reductions of less than or equal to 60 kt CO_2 equivalent annually.

5.5.8.1 Boundary

5. The project boundary is the physical, geographical site of the methane recovery facility.

5.5.8.2 Project Activity Emissions

6. Project emissions consist of CO_2 emissions from use of fossil fuels or electricity for the operation of the facility;

5.5.8.3 Baseline

7. The baseline scenario is the situation where, in the absence of the project activity, biomass and other organic matter are left to decay anaerobically within the project boundary and methane is emitted to the atmosphere. Baseline emissions ($\boldsymbol{BE_y}$) are calculated ex ante using the amount of the waste or raw material that would decay anaerobically in the absence of the project activity, with the most recent IPCC tier 2 approach (please refer to the chapter 'Emissions from Livestock and Manure Management' under the volume 'Agriculture, Forestry and other Land use' of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories).

8. If the recovered methane is used for heat or electricity generation, the corresponding category of type I project activities can be applied.

Leakage

9. No leakage calculation is required.

5.5.8.4 Monitoring

10. Emission reductions achieved by the project activity in each year will be assessed ex-post through direct measurement of the amount of methane fuelled or flared. The maximal emission reduction in any year is limited to the yearly methane generation potential calculated in the project design document for that year.

11. The amount of methane recovered and fuelled or flared shall be monitored ex-post, using flow meters. The fraction of methane in the biogas should be measured with a continuous analyzer or, alternatively, with periodical measurements at a 95% confidence level. Temperature and pressure of the biogas are required to determine the density of methane combusted.

12. Regular maintenance should ensure optimal operation of flares. The flare efficiency, defined as the fraction of time in which the gas is combusted in the flare, multiplied by the efficiency of the flaring process, shall be monitored. One of the two following options shall be used to determine the efficiency of the flaring process in an enclosed flare:

a. to adopt a 90% default value or

b. to perform a continuous monitoring of the efficiency.[1]

If option (a) is chosen, continuous check of compliance with the manufacturer's specification of the flare device (temperature, biogas flow rate) should be done. If in any specific hour any of the parameters is out of the range of specifications, 50% of default value should be used for this specific hour. For open flare 50% default value should be used, as it is not possible in this case to monitor the efficiency. If at any given time the temperature of the flare is below 500ºC, 0% default value should be used for this period.

Project activities where a portion of the biogas is destroyed through flaring and the other portion is used for energy may consider to apply the flare efficiency to the portion of the biogas used for energy, if separate measurements are not performed.

[1] The procedures described in the Methodological Tool to determine project emissions from flaring gases containing methane shall be used.

13. The emission reduction achieved by the project activity can be estimated ex-ante in the PDD by:

$$ER_{y,estimated} = BE_y - PE_y - Leakage$$

The actual emission reduction achieved by the project during the crediting period will be calculated using the amount of methane recovered and destroyed by the project activity, calculated as:

$$ER_{y,calculated} = MD_y - PE_y - Leakage$$

Where:

PE_y actual project emissions in the year y

MD_y methane captured and destroyed by the project activity in the year "y" (tCO_2 e), that will be measured using the conditions of the flaring process:

$$MD_y = BG_{burnt,y} * w_{CH4,y} * D_{CH4,y} * FE * GWP_{CH4}$$

Where:

$BG_{burnt,y}$ biogas[2] flared or used as fuel in the year "y" (m^3).

$w_{CH4,y}$ methane content[4] in biogas in the year "y" (mass fraction).

$D_{CH4,y}$ density of methane at the temperature and pressure of the biogas in the year "y" ($tons/m^3$).

FE flare efficiency in the year "y" (fraction)

GWP_{CH4} Methane global warming potential (21)

14. The method for integration of the terms in equation above to obtain the results for one year of measurements within the confidence level, as well as the methods and instruments used for metering, recording and processing the data obtained, shall be described in the project design document and monitored during the crediting period.

15. Flow meters, sampling devices and gas analysers shall be subject to regular maintenance, testing and calibration to ensure accuracy.

16. The proper soil application (not resulting in methane emissions) of the final sludge must be monitored.

17. The monitoring plan should include on site inspections for each individual farm included in the project boundary where the project activity is implemented for each verification period.

[2] Biogas and methane content measurements shall be on the same basis (wet or dry).

5.6 National Baseline for small scale CDM projects in Forestry sector

5.6.1 Accepted Baseline and monitoring methodologies for Afforestation and reforestation CDM Projects

Following accepted methodologies for large scale Afforestation and reforestation CDM projects are available.

- Afforestation and Reforestation of Land Currently Under Agricultural or Pastoral Use (Large scale; ARNM0021-rev; Valid from 14 Dec. 07 onwards)

- Afforestation and reforestation project activities implemented for industrial and/or commercial uses (Large scale; ARNM0015-rev; Valid from 22 Dec 06 onwards)

- Reforestation or afforestation of land currently under agricultural use (Large scale; ARNM0019; Valid from 14 Dec 07 onwards)

- Afforestation and reforestation of degraded land through tree planting, assisted natural regeneration and control of animal grazing (Large scale; ARNM0018; Valid from 14 Dec 07 onwards)

- Restoration of degraded lands through afforestation/reforestation (Large scale; ARNM0007-rev; Valid from 19 May 06 onwards)

- Reforestation of degraded land --- Version 2 (Large scale; ARNM0010; Valid from 19 May 06)

However, there only one accepted methodology is available for simplified small scale afforestation and reforestation on crop lands and grasslands for CDM projects. Since basic calculations expressed for baseline, carbon sequestration in the forest component, additionality and leakages etc. are more or less same, elaboration of calculation procedures are discussed.

5.6.3 Simplified baseline and monitoring methodologies for selected small-scale afforestation and reforestation project activities under the clean development mechanism

Simplified baseline and monitoring methodologies for selected small-scale afforestation and reforestation (A/R) clean development mechanism (CDM) project activities specifically covers:

(a) A simplified baseline methodology and default factors for small-scale A/R project activities implemented on grasslands or croplands

(b) A simplified monitoring methodology, based on appropriate statistical methods, to estimate, measure and monitor the actual net greenhouse gas (GHG) removals by sinks and leakage.

(baseline scenarios are considered here only for the land-use types either with grasslands or croplands prior to the implementation of the project activity, sites that have not been ploughed before the plantation is established, the displacement of households or activities due to the implementation of the A/R CDM project activity is estimated to be smaller larger than 50 per cent, eligible and having additional)

The Carbon pools to be considered by these methodologies are above-ground biomass and below-ground biomass, hereinafter referred to collectively as “living biomass pool”.

5.6.4 Baseline net greenhouse gas removals by sinks

Simplified methodologies for estimating the baseline net GHG removals by sinks are based on the baseline approach specified by paragraph 22 (a) of the modalities and procedures for afforestation and reforestation project activities under the clean development mechanism: “Existing or historical, as applicable, changes in carbon stock in the carbon pools within the project boundary.”

> “If project participants can provide relevant information that indicates that, in the absence of the small-scale afforestation or reforestation project activity under the CDM, no significant changes in the carbon stocks within the project boundary would have occurred, they shall assess the existing carbon stocks prior to the implementation of the project activity. The existing carbon stocks shall be considered as the baseline and shall be assumed to be constant throughout the crediting period.
>
> “If significant changes in the carbon stocks within the project boundary would be expected to occur in the absence of the small-scale afforestation or reforestation project activity, project participants shall” use the simplified baseline methodology contained in this document.

In order to assess if significant changes in the baseline carbon stocks within the project boundary would have occurred in absence of the project activity, project participants shall assess whether changes in carbon stocks in the baseline land-use type (grasslands or croplands), in particular the living biomass pool of woody perennials[2] and the below-ground biomass of grasslands, are expected to be significant. They shall provide documentation to prove this, for example, by including expert judgment, and proceed as follows:

(a) If significant changes in the carbon stocks, in particular the living biomass pool of woody perennials and the below-ground biomass of grasslands, are not expected to occur in the absence of the project activity, the changes in carbon stocks shall be assumed to be zero;

(b) If the carbon stock in the living biomass pool of woody perennials or in below-ground biomass of grasslands is expected to decrease in the absence of the project activity, the baseline net GHG removals by sinks shall be assumed to be zero. In the above case, the baseline carbon stocks in the carbons pools is constant at the level of the existing carbon stock measured at the start of the project activity;

(c) Otherwise, baseline net GHG removals by sinks shall be equal to the changes in carbon stocks from the living biomass pool of woody perennials or from below-ground biomass of grasslands that are expected to occur in the absence of the project activity and shall be estimated using the methodology in section III.A below.

2 Woody perennials refers to the non-tree vegetation (for example coffee, tea, rubber or oil palm) and shrubs that are present in croplands and grasslands below the thresholds (of canopy cover, minimum area and tree height) used to define forests.

5.6.5 Estimating baseline net greenhouse gas removals by sinks

Baseline net GHG removals by sinks will be determined by using the following equation:

$$B_{(t)} = \sum_{i}^{I} (B_{A(t)\,i} + B_{B(t)\,i}) * A_i \qquad (1)$$

where:

$B_{(t)}$ = carbon stocks in the living biomass pools within the project boundary at time t in the absence of the project activity (t C)

$B_{A(t)\,i}$ = carbon stocks in above-ground biomass at time t of stratum i in the absence of the project activity (t C/ha)

$B_{B(t)\,i}$ = carbon stocks in below-ground biomass at time t of stratum i in the absence of the project activity (t C/ha)

A_i = project activity area of stratum i (ha)

i = stratum i (I = total number of strata)

Stratification of the project activity for the purposes of estimating the baseline net GHG removals by sinks shall proceed in accordance with section 4.3.3.2 of the *Good Practice Guidance for Land Use, Land-Use Change and Forestry* of the Intergovernmental Panel on Climate Change (IPCC) (hereinafter referred to as the IPCC good practice guidance for LULUCF). For each stratum, the following calculations shall be performed as shown below.

5.6.5.1 Above-ground biomass

$B_{A(t)}$ is calculated per stratum *i* as follows:

$$B_{A(t)} = M_{(t)} * 0.5 \qquad (2)$$

where:

$B_{A(t)}$ = carbon stocks in above-ground biomass at time *t* in the absence of the project activity (t C/ha)

$M_{(t)}$ = above-ground biomass at time *t* that would have occurred in the absence of the project activity (t dry matter(d.m.)/ha)

0.5 = carbon fraction of dry matter (t C/t d.m.)

$M_{(t)}$ shall also be estimated using average biomass stock and growth rates specific to the region. In the absence of such values, national default values should be used. If national values are also not available, the values should be obtained from table 3.3.2 of the IPCC good practice guidance for LULUCF)

If living biomass carbon pools are expected to be constant, the average above-ground biomass stock is estimated as the above-ground biomass stock in grass and woody perennials; biomass in crops is ignored since it is considered transient:

$$M_{(t=0)} = M_{(t)} = M_{grass} + M_{woody\ (t=0)} \qquad (3)$$

where:

$M_{(t)}$ = above-ground biomass at time *t* that would have occurred in the absence of the project activity (t dm/ha)

M_{grass} = above-ground biomass in grass on grassland at time *t* that would have occurred in the absence of the project activity (t dm/ha)

$M_{woody\ (t)}$= above-ground woody biomass of woody perennials at time *t* that would have occurred in the absence of the project activity (t dm/ha)

If living biomass carbon pools are expected to increase according to paragraph 10.c, the average biomass stock is estimated as the above-ground biomass stock in grass plus the age-dependent above-ground biomass stock in woody vegetation:

$$M_{(t=0)} = M_{grass} + M_{woody\ (t=0)} \qquad (4)$$

if: $M_{woody\ (t=n-1)} + g * \Delta t < M_{woody\_max}$ then

$$M_{(t=n)} = M_{grass} + M_{woody\ (t=n-1)} + g * \Delta t \qquad (5)$$

if: $M_{woody\ (t=n-1)} + g * \Delta t \geq M_{woody\_max}$ then

$$M_{(t=n)} = M_{grass} + M_{woody\_max} \qquad (6)$$

where:

$M_{(t)}$ = above-ground biomass at time t that would have occurred in the absence of the project activity (t dm/ha)

M_{grass} = above-ground biomass in grass on grassland at time t that would have occurred in the absence of the project activity (t dm/ha)

$M_{woody\ (t)}$ = above-ground woody biomass of woody perennials at time t that would have occurred in the absence of the project activity (t dm/ha)

M_{woody_max} = maximal above-ground woody perennials at time t that would have occurred in the absence of the project activity (t dm/ha)

g = annual biomass growth rate of woody perennials (t dm/ha/year)

Δt = time increment = 1 (year)

n = running variable that increases by $\Delta t = 1$ for each iterative step, representing the number of years elapsed since the project start (years)

Documented local values for g should be used. In the absence of such values, national default values should be used. If national values are also not available, the values should be obtained from the IPCC good practice guidance for LULUCF: from table 3.3.2 for g and for M_{woody_max}.

5.6.5.2 Below-ground biomass

For below-ground biomass $B_{B(t)}$ is calculated per stratum i as follows:

If living biomass carbon pools are expected to be constant (carbon stocks in the living biomass of woody perennials and the below-ground biomass of grasslands are expected not to exceed 10% of ex-ante actual net GHG removals by sinks or net GHG removals by sinks shall be equal to the changes in carbon), the average below-ground carbon stock is estimated as the below-ground carbon stock in grass and in biomass of woody perennials (biomass in crops is ignored since it is considered transient);

$$B_{B(t=0)} = B_{B(t)} = 0.5 * (M_{grass} * R_{grass} + M_{woody\ (t=0)} * R_{woody}) \qquad (7)$$

where:
$B_{B(t)}$ = carbon stocks in below-ground biomass at time t that would have occurred in the absence of the project activity (t dm/ha)
M_{grass} = above-ground biomass in grass on grassland at time t that would have occurred in the absence of the project activity (t dm/ha)
$M_{woody\ (t)}$ = above-ground woody biomass at time t that would have occurred in the absence of the project activity (t dm/ha)
R_{woody} = root to shoot ratio of woody perennials (t dm/t dm)
R_{grass} = root to shoot ratio for grassland (t dm/t dm)

If living biomass carbon pools are expected to increase (baseline net GHG removals by sinks shall be equal to the changes in carbon stocks in the living biomass pool of woody perennials and in below-ground biomass of grasslands that are expected to occur in the absence of the project activity), the average below-ground carbon stock is estimated as the above-ground carbon stock in grass plus the age-dependent above-ground carbon stock in woody vegetation:

$$B_{B(t=0)} = 0.5 * (M_{grass} * R_{grass} + M_{woody\ (t=0)} * R_{woody}) \qquad (8)$$

if: $M_{woody\ (t=n-1)} + g * \Delta t < M_{woody\_max}$ then

$$B_{B\ (t=n)} = 0.5 * [M_{grass} * R_{grass} + (M_{woody\ (t=n-1)} + g * \Delta t) * R_{woody}\ ] \qquad (9)$$

if: $M_{woody\ (t=n-1)} + g * \Delta t \geq M_{woody\_max}$ then

$$B_{B\ (t=n)} = 0.5 * (M_{grass} * R_{grass} + M_{woody\_max} * R_{woody}) \qquad (10)$$

where:
$B_{B(t)}$ = carbon stocks in below-ground biomass at time t that would have occurred in the absence of the project activity (t dm/ha)
M_{grass} = above-ground biomass in grass on grassland at time t that would have occurred in the absence of the project activity (t dm/ha)
$M_{woody\ (t)}$ = above-ground woody biomass of woody perennials at time t that would have occurred in the absence of the project activity (t dm/ha)
R_{woody} = root to shoot ratio for woody perennial j (t dm/t dm)
R_{grass} = root to shoot ratio for grassland (t dm/t dm)
g = annual biomass growth rate of woody perennials (t dm/ha/year)
Δt = time increment = 1 (year)
n = running variable that increases by Δt = 1 year for each iterative step, representing the number of years elapsed since the project start (years)
0.5 = carbon fraction of dry matter (t C/t dm)

Documented local values for R_{grass} and R_{woody} should be used. In the absence of such values, national default values should be used. If national values are also not available, the values should be obtained from table 3.4.3 of the IPCC good practice guidance for LULUCF.

5.6.5.3 Actual net greenhouse gas removals by sinks

Actual net GHG removals by sinks consider only the changes in carbon pools for the project scenario. The stocks of carbon for the project scenario at the starting date of the project activity[4] (t=0) shall be the same as the baseline stocks of carbon at the starting date of the project (t=0). Therefore:

4 The starting date of the project activity should be the time when the land is prepared for the initiation of the afforestation or reforestation project activity under the CDM. In accordance with the modalities and procedures for afforestation and reforestation project activities under the CDM (paragraph 23), the crediting period shall begin at the start of the afforestation and reforestation project activity under the CDM (see UNFCCC web site at <http://unfccc.int/resource/docs/cop9/06a02.pdf#page=21>).

$$N_{(t=0)} = B_{(t=0)} \qquad (11)$$

For all other years, the carbon stocks within the project boundary at time t ($N_{(t)}$) shall be calculated as follows:

$$N_{(t)} = \sum_{i}^{I} (N_{A(t)\,i} + N_{B(t)\,i}) * A_i \qquad (12)$$

where:
$N_{(t)}$ = total carbon stocks in biomass at time t under the project scenario (t C/ha)
$N_{A(t)\,i}$ = carbon stocks in above-ground biomass at time t of stratum i under the project scenario (t C/ha)
$N_{B(t)\,i}$ = carbon stocks in below-ground biomass at time t of stratum i under the project scenario (t C/ha)
A_i = project activity area of stratum i (ha)
i = stratum i (I = total number of strata)

Stratification for the project scenario shall be undertaken in accordance with section 4.3.3.2 of the IPCC good practice guidance for LULUCF. The calculations shown below shall be performed for each stratum.

For above-ground biomass

$N_{A(t)}$ is calculated per stratum i as follows:

$$N_{A(t)} = T_{(t)} * 0.5 \qquad (13)$$

where:

$N_{A(t)}$ = carbon stocks in above-ground biomass at time *t* under the project scenario (t C/ha)
$T_{(t)}$ = above-ground biomass at time *t* under the project scenario (t dm/ha)
0.5 = carbon fraction of dry matter (t C/t dm)

$$T_{(t)} = SV_{(t)} * BEF * WD \qquad (14)$$

where:
$T_{(t)}$ = above-ground biomass at time *t* under the project scenario (t dm/ha)
$SV_{(t)}$ = stem volume at time *t* for the project scenario (m^3/ha)
BEF = biomass expansion factor (over bark) from stem volume to total volume (dimensionless)
WD = basic wood density (t dm/m^3)

Values for $SV_{(t)}$ shall be obtained from national sources (such as standard yield tables). Documented local values for *BEFand Wd* should be used. In the absence of such values, national default values should be used. If national values are also not available, the values should be obtained from table 3A.1.10 and 3A.1.9, respectively, of the IPCC good practice guidance for LULUCF.

For below-ground biomass

$N_{B(t)}$ is calculated per stratum *i* as follows:

$$N_{B(t)} = T_{(t)} * R * 0.5 \qquad ` (15)$$

where:
$N_{B(t)}$ = carbon stocks in below-ground biomass at time *t* under the project scenario (t C/ha)
$T_{(t)}$ = above-ground biomass at time *t* under the project scenario (t dm/ha)
R = root to shoot ratio (dimensionless)
0.5 = carbon fraction of dry matter (t C/t dm)

Documented national values for *R* should be used. If national values are not available, appropriate values should be obtained from table 3A.1.8 of the IPCC good practice guidance for LULUCF.

5.6.5.4 Leakage

If project participants demonstrate that the small-scale afforestation or reforestation project activity under the CDM does not result in the displacement of activities or people, or does not trigger activities outside the project boundary, that would be attributable to the small-scale afforestation or reforestation project activity under the CDM, such that an increase in greenhouse gas emissions by sources occurs, a leakage estimation is not required. In all other cases leakage estimation is required" (decision 14/CP.10, annex, appendix B, paragraph 9).

In regions where the lands surrounding the project activity contain no significant biomass (i.e. degraded land with no or only a few trees or shrubs per hectare) and if evidence can be provided that these lands are likely to receive the shifted activities without causing further activity shifting, leakage can be considered insignificant. Such evidence can be provided e.g. by demonstrating based on experts' judgment or scientific literature that these lands have the biophysical potential to receive the shifting pre-project activities and that the legal status of these lands or local tradition allows their use for shifting pre-project activities.

In all other cases, project participants should assess the possibility of leakage from the displacement of activities or people by considering the following indicators:

(a) Percentage of families/households of the community involved in or affected by the project activity displaced due to the project activity;

(b) Percentage of total production of the main agricultural produce (for example corn) within the project boundary displaced due to the project activity;

(c) The time-average number of grazing animals per hectare within the project boundary displaced due to the project activity divided by the average grazing capacity of land for the area, expressed as percentage. The default values of average grazing capacity of the land under tropical conditions will be given in Appendix D to the annex 4A.2 of the IPCC good practice guidance for LULUCF;

Dry climates: 0.5 head of cattle or 2.3 head of sheep per hectare

Wet climates: 1.0 head of cattle or 4.9 head of sheep per hectare

The project proponents may use locally derived values for average grazing capacity providing adequate documentation.

If the value of each of these indicators is lower than 10 per cent, then

$$L_{(t)} = 0 \qquad (16)$$

where:
$L_{(t)}$ = leakage attributable to the project activity within the project boundary at time t (t C)

If the value of one of these indicators is higher than 10 per cent and less than or equal to 50 per cent, then the entire leakage shall be equal to 15 per cent of the ex-ante actual net GHG removals by sinks achieved during the first crediting period, that is the average annual leakage is equal to:

$L_{(t)} = N_t * 0.15$ (17)

where:
$L_{(t)}$ = leakage attributable to the project activity within the project boundary at time *t* (t C)
$N_{(t)}$ = ex-ante actual net greenhouse gas removals by sinks in year t (t CO2-e / year)

As indicated above, if the value of any of these indicators is larger than 50 per cent, net anthropogenic removals by sinks cannot be estimated.

If project participants consider that the use of fertilizers would be significant leakage of N_2O (>10 per cent of the net anthropogenic GHG removals by sinks) emissions should be estimated in accordance with the IPCC *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*

D. Ex ante estimation of net anthropogenic greenhouse gas removals by sinks

. Net anthropogenic greenhouse gas removals by sinks is the actual net GHG removals by sinks minus the baseline net GHG removals by sinks minus leakage.

The net anthropogenic GHG removals by sinks for each year during the first crediting period are calculated as,

$ER_{AR\ CDM,\ t} = \Delta\ _{CPROJ,\ t} - \Delta\ C_{BSL,\ t} - GHG_{PROJ,\ t} - L_t$ *(21)*

$ER_{AR\ CDM,\ t}$ = *net anthropogenic GHG removals by sinks (t CO2-e / year)*
$\Delta\ _{CPROJ,\ t}$ = *project GHG removals by sinks at time t (t CO2-e / year)*
$\Delta\ C_{BSL,\ t}$ = *baseline net GHG removals by sinks (t CO2-e / year)*
$GHG_{PROJ,\ t}$ = *project emissions (t CO2-e / year)*
L_t = *leakage attributable to the project activity at time t (t CO2-e / year)*

For subsequent crediting periods $L_t = 0$.

The resulting temporary certified emission reductions (tCERs) at the year of assumed verification
tv are calculated as follows:

$$tCER_{(tv)} = \sum_{t=0}^{l} ER_{AR\text{-}CDM,t} * \Delta\ .t$$

Where:

tCER(t) = temporary certified emission reductions (tCERs) at the year of assumed verification tv
$ER_{AR\ CDM,\ t}$ = net anthropogenic GHG removals by sinks (t CO2-e / year)
tv = assumed year of verification (year)
t = time increment = 1 (year)

The resulting long-term certified emission reductions (*l*CERs) at the year of assumed verification *tv* are calculated as follows:

$$lCER_{(tv)} = \sum_{t=0}^{l} ER_{AR\text{-}CDM\ ,t} * \Delta\ .t - lCER_{(t-k)}$$

Where:

lCER(tv) = long-term certified emission reductions (lCERs) at the year of verification tv

$ER_{AR\ CDM,\ t}$ = net anthropogenic GHG removals by sinks; (t CO2-e / year)

k = time span between two verifications (year)

tv = year of assumed verification (year)

I. Simplified monitoring methodology for small-scale afforestation and reforestation projects under the clean development mechanism

5.5.6.5 Ex post estimation of the baseline net greenhouse gas removals by sinks

In accordance with decision 6/CMP.1, appendix B, paragraph 6, no monitoring of the baseline is requested. Baseline net GHG removals by sinks for the monitoring methodology will be the same as using the simplified baseline methodology mentioned previously.

5.5.6.6 Ex post estimation of the actual net greenhouse gas removals by sinks

Before performing the sampling to determine any changes in carbon stocks, project participants need to measure and monitor the area that has been planted. This can be performed through, for example, on-site visits, analysis of cadastral information, aerial photographs or satellite imagery of adequate resolution.

Once project participants have selected the method to monitor the area that has been planted, this method should be used to monitor the performance of the planted areas throughout the project activity. If significant underperformance is detected, changes in carbon stocks from such areas shall be assessed as a separate stratum.
Carbon stocks shall be estimated by carrying out stratified sampling procedure to improve the accuracy and precision of biomass estimates.

For ex post estimation of project GHG removals by sinks, strata shall be defined by:

(i) relevant guidance on stratification for A/R project activities under the clean development
mechanism as approved by the Executive Board (if available); or
(ii) stratification approach that can be shown in the PDD to estimate biomass stocks according to
good forest inventory practice in the host country in accordance with DNA indications; or
(iii) other stratification approach that can be shown in the PDD to estimate the project biomass
stocks to targeted precision level of ±10% of the mean at a 95% confidence level.

Carbon stocks (expressed in t CO2-e) shall be estimated through the following equations:

$$P_{(t)} = \sum_{i}^{I} (P_{A(t)\,i} + P_{B(t)\,i}) * A_i * (44/12) \quad (23)$$

where:
$P_{(t)}$ = carbon stocks within the project boundary at time *t* achieved by the project activity (t CO2 -e)
$P_{A(t)\ i}$ = carbon stocks in above-ground biomass at time *t* of stratum *i* achieved by the project activity during the monitoring interval (t C/ha)
$P_{B(t)\ i}$ = carbon stocks in below-ground biomass at time *t* of stratum *i* achieved by the project activity during the monitoring interval (t C/ha)
A_i = project activity area of stratum *i* (ha)
i = stratum *i* (*I* = total number of strata)

Stratification for sampling shall be the same as the stratification for the ex ante estimation of the actual net GHG removals by sinks as mentioned above. The calculations shown below will be performed for each stratum.

For above-ground biomass

$P_{A(t)}$ is calculated per stratum *i* as follows:

$$P_{A(t)} = E_{(t)} * 0.5 \qquad (24)$$

where:
$P_{A(t)}$ = carbon stocks in above-ground biomass at time *t* achieved by the project activity during the monitoring interval (t C/ha)
$E_{(t)}$ = estimate of above-ground biomass at time *t* achieved by the project activity (t dm/ha)
0.5 = carbon fraction of dry matter (t C/t dm)

$E_{(t)}$ shall be estimated through the following steps:

(a) **Step 1:** Design a statistically sound sampling procedure. Such procedures should be designed according to the standard methods described in section 4.3.3.4. of the IPCC good practice guidance LULUCF. Additional strata should be considered subsequently for areas affected by fires and pests. This procedure includes the specification of the number, type and size of permanent plots and should be described in the CDM-SSC-AR-PDD. The allowed precision target for monitoring shall be not larger than ± 10 per cent, at a 95 per cent confidence level for the mean;

(b) **Step 2:** Establish permanent plots and document their location in the first monitoring report;

(c) **Step 3:** Measure the diameter at breast height (*DBH*) or *DBH* and tree height, as appropriate; this measure and document it in the monitoring reports;

(d) **Step 4:** Estimate the above-ground biomass (AGB) using allometric equations developed locally or nationally. If these allometric equations are not available:

(i) Option 1: Use allometric equations included in **appendix C** to this report or in annex 4A.2 of the IPCC good practice guidance for LULUCF;

(ii) Option 2: Use biomass expansion factors and stem volume as follows:

$$E_{(t)\,i} = SV_{(t)\,i} * BEF * WD \qquad (25)$$

where:

$E_{(t)\,i}$ = estimate of above-ground biomass of stratum I at time t achieved by the project activity (t dm/ha)
$SV_{(t)\,i}$ = stem volume (m^3/ha)
WD = basic wood density (t dm/m^3)
BEF = biomass expansion factor (over bark) from stem volume to total volume (dimensionless)

Project participants shall use the default *BEF* proposed by the IPCC good practice guidance for LULUCF, specifically for tropical broad-leaved species, in order to obtain a conservative estimate of total biomass.

$SV_{(t)\,i}$ shall be estimated from on-site measurements using the appropriate parameters (such as *DBH* or *DBH* and height). Consistent application of *BEF* should be secured on the definition of stem volume (e.g. total stem volume or thick wood stem volume requires different *BEF*s).

Documented local values for *WD* should be used. In the absence of such values, national default values should be used. If national values are also not available, the values should be obtained from table 3A.1.9 of the IPCC good practice guidance for LULUCF.

The same values for BEF and WD should be used in the ex-post and in the ex-ante calculations.

???

For below-ground biomass

Carbon stocks in below-ground biomass at time t achieved by the project activity during the

monitoring interval $P_{B(t)}$ shall be estimated for each stratum *i* as follows:

$$P_{B(t)\,i} = E_{(t)\,i} * R * 0.5 \qquad (26)$$

where:
$P_{B(t)\,i}$ = carbon stocks in below-ground biomass at time *t* achieved by the project activity during the monitoring interval (t C/ha)
$E_{(t)\,i}$ = estimate of above-ground biomass of stratum i at time t achieved by the project activity (
t d.m./ha)
R = root to shoot ratio (dimensionless)
0.5 = carbon fraction of dry matter (t C/t dm)

Documented national values for *R* should be used. If national values are not available, the values should be obtained from table 3A.1.8 of the IPCC good practice guidance for LULUCF.

If root to shoot ratios for the species concerned are not available, project proponents shall use the allometric equation developed by Cairns et al. (1997) or a more representative equation taken from the IPCC good practice guidance for LULUCF, Table 4.A.4:[5]

$$P_{B(t)\,i} = \exp(-1.085 + 0.9256 * \ln E_{(t)\,i}) * 0.5 \qquad (27)$$

where:
$P_{B(t)\,i}$ = carbon stocks in below-ground biomass at time *t* achieved by the project activity during the monitoring interval (t C/ha)
$E_{(t)\,i}$ = estimate of above-ground biomass at time *t* achieved by the project activity (t dm/ha)
0.5 = carbon fraction of dry matter (t C/t dm)

If project participants consider that the use of fertilizers would result in significant emissions of N2O (>10 per cent of the actual net greenhouse gas removals by sinks) project emissions (GHGPROJ, (t) -t CO2e / year) should be estimated in accordance with the IPCC Good Practice Guidance and Uncertainty Management in National

Greenhouse Gas Inventories.

C. Ex post estimation of leakage lettering and numbering sequences will need to be re-checked. There is no A and B preceding this section C

In order to estimate leakage, project participants shall monitor each of the following indicators during the first crediting period:

(a) Area under cropland9 within the project boundary displaced due to the project activity;

(b) Percentage of total production of the main produce (for example meat or corn) within the project boundary displaced due to the project activity.

(c) Number of domesticated grazing animals within the project boundary displaced due to the project activity;

(d) For domesticated roaming animals, the time-average number of domesticated grazing animals per hectare within the project boundary displaced due to the project activity.

If the values of these indicators for the specific monitoring period are not greater than 10 per cent,
then

$L_{tv} = 0$

Where:
L_{tv} = total GHG emission due to leakage at the time of verification (t CO2-e)

(Cropland also includes lands which are currently under a fallow state as part of the agricultural cycle (eg. slash and burn)).

If the value of any of these indicators is higher than 10 per cent and less than or equal to 50 percent during the first crediting period, then leakage shall be determined at the time of verification using the following equations

$$Ltv = 0.15*(P_{(tv)} - B_{(t=0)} - \sum_{t=0}^{tv} GHG_{PROJ,(t)})$$

for subsequent verification periods:

$$L_{tv} = 0.15*(P_{(tv)} - P_{(tv=k0)} - \sum_{tv=k}^{tv} GHG_{PROJ,(t)})$$

where:

L_{tv} = GHG emission due to leakage at the time of verification (t CO2-e)
$P_{(t)}$ = carbon stocks within the project boundary achieved by the project activity at time t (t CO2-e)
$GHG_{PROJ,(t)}$ = project emissions from use of fertilizers (t CO2-e / year)

$B_{(t=0)}$ = carbon stocks in biomass at time 0 that would have occurred in the absence of the project activity (t C/ha)
tv = year of verification (year)
k = time span between two verifications (year)

As indicated in chapter I, paragraph 3, if the value of one of these indicators is larger than 50 per cent net anthropogenic GHG removals by sinks cannot be estimated.

(If project participants consider that the use of fertilizers would be significant, leakage of N_2O emissions (>10 per cent of the net anthropogenic removals by sinks) should be estimated in accordance with the IPCC good practice guidance.

At the end of the first crediting period the total leakage equals to:

$$L_{cp1} = 0.15*(P_{(tc)} - B_{(t=0)} - \sum_{t=o}^{tc} GHG_{PROJ,(t)})$$

Where:
L_{cp1} = GHG emission due to leakage at the end of the first crediting period (t CO2-e)

$GHG_{PROJ,(t)}$ = project emissions from use of fertilizers (t CO2-e / year)

$B_{(t=0)}$ = carbon stocks in biomass at time 0 that would have occurred in the absence of the project activity (t C/ha)
tc = duration of the crediting period

D. Ex post estimation of the net anthropogenic GHG removals by sinks

Net anthropogenic greenhouse gas removals by sinks is the actual net greenhouse gas removals by sinks minus the baseline net greenhouse gas removals by sinks minus leakage as appropriate.

The resulting tCERs at the year of verification *tv* are calculated as follows:

for the first crediting period:

$$tCER_{(tv)} = P_{(t)} - \sum_{t=0}^{tc} (GHG_{PROJ,(t)} - \Delta C_{BSL,t}) - L_{(tv)}$$

for subsequent creaditing period

$$tCER_{(tv)} = P_{(t)} - \sum_{t=0}^{tc} (GHG_{PROJ,(t)} - \Delta C_{BSL,t}) - L_{CP1}$$

Where:
$P_{(t)}$ = carbon stocks within the project boundary achieved by the project activity at time t (t CO2-e)

$GHG_{PROJ,(t)}$ = project emissions from use of fertilizers (t CO2-e/ year)
$C_{BSL,t}$ = baseline net GHG removals by sinks (t CO2-e/ year)

L_{tv} = total GHG emission due to leakage at the time of verification (t CO2-e)

L_{CP1} = total GHG emission due to leakage at the end of the first crediting period (t CO2-e)
tv = year of verification

The resulting *lCERs* at the year of verification *tv* are calculated as follows:

For the first crediting period

$$lCER_{(tv)} = P_{(t)} - \sum_{t=0}^{tc} (GHG_{PROJ,(t)} - \Delta C_{BSL,t}) - L_{(tv)} - lCER_{(tv-k)}$$

for subsequent crediting period

$$lCER_{(tv)} = P_{(t)} - \sum_{t=0}^{tc} (GHG_{PROJ,(t)} - \Delta C_{BSL,t}) - L_{CP1} - lCER_{(tv-k)}$$

where:
$P_{(t)}$ = carbon stocks within the project boundary achieved by the project activity at time t (t CO2-e)
$GHG_{PROJ,(t)}$ = project emissions from use of fertilizers (t CO2-e/ year)
$C_{BSL,t}$ = baseline net GHG removals by sinks (t CO2-e/ year)

L_{tv} = total GHG emission due to leakage at the time of verification (t CO2-e)

L_{CP1} = total GHG emission due to leakage at the end of the first crediting period (t CO2-e)
tv = year of verification
k = time span between two verifications (years)
$lCER_{(tv-k)}$ = units of *lCERs* issued following the previous verification

E. Monitoring frequency

A five-year monitoring frequency of the permanent sample plots established within the project boundary is needed for an appropriate monitoring of above-ground and below-ground biomass. Monitoring frequency for each variable is defined in Table 1 and 2.

Data collection shall be organized taking into account the carbon pools measured, the sample frame used and the number of permanent plots to be monitored in accordance with the section on quality assurance/quality control (QA/QC) below. Tables 1 and 2 outline the data to be collected to monitor the actual net GHG removals by sinks and leakage.

F. Quality control and quality assurance

As stated in the IPCC good practice guidance LULUCF (page 4.111), monitoring requires provisions for quality assurance (QA) and quality control (QC) to be implemented via a QA/QC plan. The plan shall become part of project documentation and cover procedures as described below for:

(a) Collecting reliable field measurements;

(b) Verifying methods used to collect field data;

(c) Verifying data entry and analysis techniques;

(d) Data maintenance and archiving. This point is especially important, also for small-scale A/R CDM project activities, as timescales of project activities are much longer than those of technological improvements of electronic data archiving. Each point of importance for small-scale A/R CDM project activities is treated in the following section.

60. Collecting reliable data from field measurements is an important step in the quality assurance plan. Those responsible for the measurement work should be trained in all aspects of the field data collection and analysis. It is good practice to develop standard operating procedures (SOPs) for each step of the field measurements, which should be adhered to at all times. These SOPs describe in detail all steps of the field measurements and contain provisions for documentation for verification purposes so that future field personnel can check past results and repeat the measurements in a consistent fashion. To ensure the collection and maintenance of reliable field data, it is good practice to ensure that:

(a) Field-team members are fully aware of all procedures and the importance of collecting data as accurately as possible;

(b) Field teams install test plots if needed in the field and measure all pertinent components using the SOPs to estimate measurement errors;

(c) The document will list all names of the field team and the project leader will certify that the team is trained;

(d) New staff is adequately trained.

61. To verify that plots have been installed and the measurements taken correctly, it is good practice to remeasure independently every 10 plots and to compare the measurements. The following quality targets should be achieved for the remeasurements, compared to the original measurements:

(a) Missed or extra trees: no error within the plot

(b) Tree species or groups: no error

(c) DBH: $< \pm 0.5$ cm or 3 % whichever is greater

(d) Height:$<$ + 10/ and - 20%

62. At the end of the field work 10–20 per cent of the plots shall be checked independently. Field data collected at this stage will be compared with the original data. Any errors found should be corrected and recorded. Any errors discovered should be expressed as a percentage of all plots that have been rechecked to provide an estimate of the measurement error.

63. In order to obtain reliable estimates data must be entered into the data analysis spreadsheets correctly. Errors in this process can be minimized if the entry of field data and laboratory data are cross-checked and, where necessary, internal tests are incorporated into the spreadsheets to ensure that the data are realistic. All personnel involved in measuring and analysing data should communicate to resolve any apparent anomalies before the final analysis of the monitoring data is completed. If there are any problems with the monitoring plot data that cannot be resolved, the plot should not be used in the analysis.

64. Due to the long-term nature of A/R project activities under the CDM, data archiving (maintenance and storage) is an important component of the work. Data archiving should take several forms and copies of all data should be provided to each project participant.

65. The following shall be stored in a dedicated and safe place, preferably offsite:

(a) Copies (electronic and/or paper) of all field data, data analyses, and models; estimates of the changes in carbon stocks and corresponding calculations and models used;

(b) Any geographical information system (GIS) products;

(c) Copies of the measuring and monitoring reports.

66. Given the time frame over which the project activity will take place and the pace of updating of software and hardware for storing data, it is recommended that the electronic copies of the data and the report be updated periodically or converted to a format that could be accessed by any future software application.

G. Procedures to ensure reliable field measurements

H. Procedures to verify field data collection

I. Procedures to verify data entry and analysis

J. Data maintenance and storage

Data to be collected or used in order to monitor the verifiable changes in carbon stock in the carbon pools within the project boundary from the proposed afforestation and reforestation project activity under the clean development mechanism, and how these data will be archived.

Table 25 - Data for monitoring carbon stock

Data variable	**Source**	**Data unit**	**Measured, calculated or estimated**	**Frequency (years)**	**Proportion**	**Archiving**	**Comment**
Location of the areas where the project activity has been implemented	Field survey or cadastral information or aerial photographs or satellite imagery	latitude and longitude	Measured	5	100 per cent	Electronic, paper, photos	GPS can be used for field survey
A_i - Size of the areas where the project activity has been implemented for each type of strata	Field survey or cadastral information or aerial photographs or satellite imagery or GPS	ha	Measured	5	100 per cent	Electronic, paper, photos	GPS can be used for field survey
Location of the permanent sample plots	Project maps and project design	latitude and longitude	Defined	5	100 per cent	Electronic, paper	Plot location is registered with a GPS and marked on the map
Diameter of tree at breast height (1.30 m)	Permanent plot	cm	Measured	5	Each tree in the sample plot	Electronic, paper	Measure diameter at breast height (*DBH*) for each tree that falls within the sample plot and applies to size limits
Height of tree	Permanent plot	m	Measured	5	Each tree in the sample plot	Electronic, paper	Measure height (*H*) for each tree that falls within the sample plot and applies to size limits

Basic wood density	Permanent plots, literature	tons of dry matter per m^3 fresh volume	Estimated	Once	3 samples per tree from base, middle and top of the stem of three individuals	Electronic, paper	
Total CO_2	Project activity	Mg	Calculated	5	All project data	Electronic	Based on data collected from all plots and carbon pools

Table 26 - Data to be collected or used in order to monitor leakage and how these data will be archived

Data variable	Source	Data unit	Measured, calculated or estimated	Frequency (years)	Proportion	Archiving	Comment
Percentage of families/ households of the community involved in or affected by the project activity displaced due to the implementation of the project activity	Participatory survey	Number of families or households	Estimated	5	per cent	Electronic	
Percentage of total production of the main produce (e.g. meat, corn) within the project boundary displaced due to the CDM A/R project activity.	Survey	Quantity (volume or mass)	Estimated	5	per cent	Electronic	

Table 27 - Abbreviations and parameters (in order of appearance).

Parameter or abbreviation	Refers to	Units
$B_{(t)}$	Carbon stocks within the project boundary at time *t*hat would have occurred in the absence of the project activity	t C
$B_{A(t)\ i}$	Carbon stocks in above-ground biomass at time *t* of stratum *i* that would have occurred in the absence of the project activity	t C/ha
$B_{\ (t)\ i}$	Carbon stocks in below-ground biomass at time *t* of stratum *i* that would have occurred in the absence of the project activity	t C/ha
A_i	Project area of stratum *i*	ha
$M_{(t)}$	Above-ground biomass at time *t*hat would have occurred in the absence of the project activity	t dm/ha
M_{grass}	Above-ground biomass in grass on grassland at time *t*hat would have occurred in the absence of the project activity	t dm/ha
$M_{woody\ (t)}m$	Above-ground woody biomass at time *t*hat would have occurred in the absence of the project activity	t dm/ha Time
R_{woody}	Root to shoot ratio of woody perennials	t dm/t dm
R_{grass} *R*	Root to shoot ratio for grassland	t dm/t dm
g	Annual biomass growth rate of woody perennials	t dm/ha/year
i	Stratum *i* (*I* = total number of strata)	
n	Running variable that increases by Δt = 1 year for each iterative step, representing the number of years elapsed since the project start	years
$N_{(t)}$	Carbon stocks within the project boundary at time *t* under project scenario	t C
$N_{A(t)\ i}$	Carbon stocks in above-ground biomass at time *t* of stratum *i* from project scenario	t C/ha
$N_{B(t)\ i}$	Carbon stocks in below-ground biomass at time *t* of stratum *i* from project scenario	t C/ha
$T_{(t)}$	Above-ground biomass at time *t* for the project scenario	t dm/ha
$SV_{(t)}$	Stem volume at time *t* for the project scenario	m^3/ha
WD	Basic wood density	t of dm/m^3 (fresh volume)
BEF	Biomass expansion factor (over bark) from stem volume to total volume	Dimensionless
L_t	Leakage for the project scenario at time *t*	t C
$P_{(t)}$	Carbon stocks within the project boundary at time *t* achieved by the project activity	t C
$P_{A(t)\ i}$	Carbon stock in above-ground biomass at time *t* of stratum *i* achieved by the project activity	t C/ha
$P_{B(t)\ i}$	Carbon stocks in below-ground biomass at time *t* of stratum *i* achieved by the project activity during the monitoring interval	t C/ha
$E_{(t)}$	Above-ground biomass at time *t* achieved by the project activity	t of dm/ha
DBH	Diameter at breast height (130 cm or 1.30 m)	cm or m
$L_{\ p(t)}$	Leakage resulting from the project activity at time *t*	t C
$tCER_{(tv)}$	tCERs emitted at year of verification *tv* (t CO_2)	t CO_2
$lCER_{(tv)}$	lCERs emitted at year of verification *tv* (t CO_2)	t CO_2

T_0	Year of the project start	
tv	Year of verification	
κ	Time span between two verifications (years)	years
Δt	Time increment = 1 (year)	year

Appendix A

II. Demonstration of land eligibility

1. Eligibility of the A/R CDM project activities under Article 12 of the Kyoto Protocol shall be demonstrated based on definitions provided in paragraph 1 of the annex to the Decision 16/CMP.1 (“Land use, land-use change and forestry”), as requested by Decision 5/CMP.1 (“Modalities and procedures for afforestation and reforestation project activities under the clean development mechanism in the first commitment period of the Kyoto Protocol”), until new procedures to demonstrate the eligibility of lands for afforestation and reforestation project activities under the clean development mechanism are recommended by the EB.

Appendix B

III. Assessment of additionality

1. Project participants shall provide an explanation to show that the project activity would not have occurred anyway due to at least one of the following barriers:

2. **Investment barriers, other than economic/financial barriers**, inter alia:

(a) Debt funding not available for this type of project activity;

(b) No access to international capital markets due to real or perceived risks associated with domestic or foreign direct investment in the country where the project activity is to be implemented;

(c) Lack of access to credit.

3. **Institutional barriers**, inter alia:

(a) Risk relating to changes in government policies or laws;

(b) Lack of enforcement of legislation relating to forest or land-use.

4. **Technological barriers**, inter alia:

(a) Lack of access to planting materials;

(b) Lack of infrastructure for implementation of the technology.

5. **Barriers relating to local tradition**, inter alia:

   (a) Traditional knowledge or lack thereof, of laws and customs, market conditions, practices;

   (b) Traditional equipment and technology;

6. **Barriers due to prevailing practice**, inter alia:

   (a) The project activity is the "first of its kind". No project activity of this type is currently operational in the host country or region.

7. **Barriers due to local ecological conditions**, inter alia:

   (a) Degraded soil (e.g. water/wind erosion, salination);

   (b) Catastrophic natural and/or human-induced events (e.g. land slides, fire);

   (c) Unfavourable meteorological conditions (e.g. early/late frost, drought);

   (d) Pervasive opportunistic species preventing regeneration of trees (e.g. grasses, weeds);

   (e) Unfavourable course of ecological succession;

   (f) Biotic pressure in terms of grazing, fodder collection, etc.

8. **Barriers due to social conditions**, inter alia:

   (a) Demographic pressure on the land (e.g. increased demand on land due to population growth);

   (b) Social conflict among interest groups in the region where the project activity takes place;

   (c) Widespread illegal practices (e.g. illegal grazing, non-timber product extraction and tree felling);

   (d) Lack of skilled and/or properly trained labour force;

   (e) Lack of organization of local communities.

Appendix C

Table 28 - Default allometric equations for estimating above-ground biomass

Annual rainfall	DBH limits	Equation	R^2	Author
Broad-leaved species, tropical dry regions				
<900 mm	3–30 cm	$AGB = 10^{\{-0.535 + \log_{10}(\pi * DBH^2/4)\}}$	0.94	Martinez-Yrizar et al. (1992)
900–1500 mm	5–40 cm	$AGB = \exp\{-1.996 + 2.32 * \ln(DBH)\}$	0.89	Brown (1997)
Broad-leaved species, tropical humid regions				
< 1500 mm	5–40 cm	$AGB = 34.4703 – 8.0671*DBH + 0.6589*(DBH^2)$	0.67	Brown et al. (1989)
1500–4000 mm	< 60 cm	$AGB = \exp\{-2.134 + 2.530 * \ln(DBH)\}$	0.97	Brown (1997)
1500–4000 mm	60–148 cm	$AGB = 42.69 – 12.800*(DBH) + 1.242*(DBH)^2$	0.84	Brown et al. (1989)
1500–4000 mm	5–130 cm	$AGB = \exp\{-3.1141 + 0.9719*\ln(DBH^2*H)\}$	0.97	Brown et al. (1989)
1500–4000 mm	5–130 cm	$AGB = \exp\{-2.4090 + 0.9522*\ln(DBH^2*H*WD)\}$	0.99	Brown et al. (1989)
Broad-leaved species, tropical wet regions				
> 4000 mm	4–112 cm	$AGB = 21.297 – 6.953*(DBH) + 0.740*(DBH^2)$	0.92	Brown (1997)
> 4000 mm	4–112 cm	$AGB = \exp\{-3.3012 + 0.9439*\ln(DBH^2*H)\}$	0.90	Brown et al. (1989)
Coniferous trees				
n.d.	2–52 cm	$AGB = \exp\{-1.170 + 2.119*\ln(DBH)\}$	0.98	Brown (1997)
Palms				
n.d.	> 7.5 cm	$AGB = 10.0 + 6.4 * H$	0.96	Brown (1997)
n.d.	> 7.5 cm	$AGB = 4.5 + 7.7 * WDH$	0.90	Brown (1997)

Note: *AGB* = above-ground biomass; *DBH* = diameter at breast height; *H* = height; *WD* = basic wood density

Appendix D

IV. Calculating average grazing capacity

A. Concept

1. Sustainable grazing capacity is calculated by assuming that the grazing animals should not consume more biomass than is annually produced by the site

B. Methodology

2. The sustainable grazing capacity is calculated using the following equation:

$$GC = \frac{ANPP * 1000}{365 * DMI} \quad (A.5)$$

where:
GC = grazing capacity (head/ha)
$ANPP$ = above-ground net primary productivity in tons dry biomass (t d.m.)/ha/yr)
DMI = daily dry matter intake per grazing animal (kg d.m./head/day)

3. Annual net primary production $ANPP$ can be calculated from local measurements or default values from Table 3.4.2 of IPCC good practice guidance LULUCF can be used. This table is reproduced below as Table 1.

4. The daily biomass consumption can be calculate from local measurements or estimated based on the calculated daily gross energy intake and the estimated dietary net energy concentration of diet:

$$DMI = \frac{GE}{NE_{ma}} \quad (A.6)$$

where:
DMI = dry matter intake (kg d.m./head/day)
GE = daily gross energy intake (MJ/head/day)
NE_{ma} = dietary net energy concentration of diet (MJ/kg d.m.)

5. Daily gross energy intake for cattle and sheep can be calculated using equations 10.3 through 10.16 in 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4: Agriculture, Forestry and Other Land Use (AFOLU)[1]. Sample calculations for typical herds in various regions of the world are provided in Table 2; input data stems from Table 10A.2 of the same 2006 IPCC Guidelines. Dietary net energy concentrations as listed in Table 3 can be calculated using the formula listed in a footnote to Table 10.8 of the same 2006 IPCC Guidelines.

Table 29 - DEFAULT ESTIMATES FOR STANDING BIOMASS GRASLAND (AS DRY MATTER) AND ABOVEGROUND NET PRIMARY PRODUCTION, CLASSIFIED BY IPCC CLIMATE ZONES.

IPCC Climate Zone	Peak above- ground live biomass Tons d.m. ha^{-1}			Above-ground net primary production (ANPP) Tons d.m. ha^{-1}		
	Average	No. of studies	Error[#]	Average	No. of studies	Error[1]
Boreal-Dry & Wet[2]	1.7	3	±75%	1.8	5	±75%
Cold Temperate-Dry	1.7	10	±75%	2.2	18	±75%
Cold Temperate-Wet	2.4	6	±75%	5.6	17	±75%
Warm Temperate-Dry	1.6	8	±75%	2.4	21	±75%
Warm Temperate-Wet	2.7	5	±75%	5.8	13	±75%
Tropical-Dry	2.3	3	±75%	3.8	13	±75%
Tropical-Moist & Wet	6.2	4	±75%	8.2	10	±75%

Data for standing live biomass are compiled from multi-year avaerages reported at grassland sites registered in the ORNL DAAC NPP database [http://www.daac.ornl.gov/NPP/html_docs/npp_site.html]. Estimates for above-ground primary production are from: Olson, R. J.J.M.O. Scurlock, S.D. Prince, D.L. Zheng, and K.R. Johnson (eds.). 2001. NPP Multi-Biome: NPP and Driver Data for Ecosystem Model-Data Intercomparison. Sources available on-line at [http://www.daac.ornl.gov/NPP/html_docs/EMDI_des.html].

[1] Represents a nominal estimate of error, equivalent to two times standard deviation, as a percentage of the mean.

2Due to limited data, dry and moist zones for the boreal temperate regime and moist and wet zones for the tropical temperature regime were combined.

Table 30 - Data for typical cattle herds for the calculation of daily gross energy requirement Cattle – Africa

	Weight (kg)	Weight Gain (kg/day)	Milk (kg/day)	Work (hrs/day)	Pregnant	DE	Coefficient for NE_m equation	Mix (of grazing)
Mature Females	200	0.00	0.30	0	33%	55%	0.365	8%
Mature Males	275	0.00	0.00	0	0%	55%	0.370	33%
Young	75	0.10	0.00	0	0%	60%	0.361	59%
Weighted Average	**152**	**0.06**	**0.02**	**0**	**3%**	**58%**	**0.364**	**100%**

Cattle - Asia

	Weight (kg)	Weight Gain (kg/day)	Milk (kg/day)	Work (hrs/day)	Pregnant	DE	Coefficient for NE_m equation	Mix (of grazing)
Mature Females	300	0.00	1.10	0	50%	60%	0.354	18%
Mature Males	400	0.00	0.00	0	0%	60%	0.370	16%
Young	200	0.20	0.00	0	0%	60%	0.345	65%
Weighted Average	**251**	**0.13**	**0.20**	**0**	**9%**	**60%**	**0.350**	**100%**

Cattle - India

	Weight (kg)	Weight Gain (kg/day)	Milk (kg/day)	Work (hrs/day)	Pregnant	DE	Coefficient for NE_m equation	Mix (of grazing)
Mature Females	125	0.00	0.60	0.0	33%	50%	0.365	40%
Mature Males	200	0.00	0.00	2.7	0%	50%	0.370	10%
Young	80	0.10	0.00	0.0	0%	50%	0.332	50%
Weighted Average	**110**	**0.05**	**0.24**	**0.3**	**13%**	**50%**	**0.349**	**100%**

Cattle - Latin America

	Weight (kg)	Weight Gain (kg/day)	Milk (kg/day)	Work (hrs/day)	Pregnant	DE	Coefficient for NE_m equation	Mix (of grazing)
Mature Females	400	0.00	1.10	0	67%	60%	0.343	37%
Mature Males	450	0.00	0.00	0	0%	60%	0.370	6%
Young	230	0.30	0.00	0	0%	60%	0.329	57%
Weighted Average	**306**	**0.17**	**0.41**	**0**	**25%**	**60%**	**0.337**	**100%**

Sheep

	Weight (kg)	Weight Gain (kg/day)	Milk (kg/day)	Wool (kg/year)	Pregnant	DE	Coefficient for NE_m equation	Mix (of grazing)
Mature Females	45	0.00	0.70	4	50%	60%	0.217	40%
Mature Males	45	0.00	0.00	4	0%	60%	0.217	10%
Young	5	0.11	0.00	2	0%	60%	0.236	50%
Weighted Average	**25**	**0.05**	**0.28**	**3**	**20%**	**60%**	**0.227**	**100%**

Table 31 - Daily gross energy requirement of Cattle

Region	**Average Characteristics**								**Energy (MJ/head/day)**								**Consumption**		
	Weight	Weight gain	Milk	Work	Preg-nant	DE	CF	Mainte-nance	Activity	Growth	Lactation	Power	Wool	Preg-nancy	REM	REG	**Gross**	NE_{ma}	**DMI**
		(kg)	(kg/day)		(kg/day)		(hrs/day)							(note 1)	(note 2)		(MJ/kg - note 5)		(kg/head/day)
Africa	152	0.06	0.02	0.0	3%	58%	0.364	15.7	5.7	1.2	0.0	0.0	0	0.0	0.49	0.26	**84.0**	5.2	**16.2**
Asia	251	0.13	0.20	0.0	9%	60%	0.350	22.1	8.0	2.8	0.3	0.0	0	0.2	0.49	0.28	**119.8**	5.5	**21.9**
India	110	0.05	0.24	0.3	13%	50%	0.349	11.8	4.3	1.0	0.4	0.3	0	0.2	0.44	0.19	**87.6**	4.0	**21.6**
Latin America	306	0.17	0.41	0.0	25%	60%	0.337	24.6	8.9	3.8	0.6	0.0	0	0.6	0.49	0.28	**139.5**	5.5	**25.5**

Sheep

Region	**Average Characteristics**								**Energy (MJ/head/day)**								**Consumption**		
	Weight	Weight gain	Milk	Work	Preg-nant	DE	CF	Mainte-nance	Activity	Growth	Lactation	Power	Wool	Preg-nancy	REM	REG	**Gross**	NE_{ma}	**DMI**
			(kg)		(kg/day)		(kg/day)			(hrs/day)		(note 3)		(note 4)		(MJ/kg - note 5)		(kg/head/day)	
All regions	25	0.05	0.28	3.0	20%	60%	0.227	2.5	0.6	1.5	1.29	0	0.2	0.0	0.49	0.28	**25.0**	5.5	**4.6**

Notes
1. Assumes grazing
2. Assumes 4% milk fat
3. Assumes grazing on hilly terrain
4. Assumes 7% milk fat
5. Calculated using equation listed in Table 10.8

CHAPTER 6 – Institutional assessment and recommendation

6.1 National CDM strategy

The Kyoto Protocol has created a big international market for emission reductions, which is around 5.0 to 5.5 billion of CO2e. The regulatory framework for this carbon market has been established considerably with the entry into force of the Kyoto Protocol on February 16, 2005. The estimated market potential of the CDM is 250 MtC02e (range 50 to 500 MtC02e) at a price of $11.00 tCO2e (range ± 50%). This represents a total demand of 1250 MtC02e by 2012. Of the 15.5 M/tCO2 marketed so far (September 2007) Sri Lanka has sold only 134,000 tCO2. This is insignificant with compared to the amount of CDM credits sold by many other developing countries.

In order for Sri Lanka to capture a considerable share of the global CDM market during the first commitment period ending in 2012 in the short run and any possible future similar market beyond 2012, the country should act fast and adopt a proactive strategy, which should include the following:

- **Early submission of low-hanging projects**

In the short-term, Sri Lanka should encourage project developers for the submission of all projects that are pending completion at various stages particularly the projects that are at the financial closure. The government should facilitate the speedy implementation of these projects and undertake a comprehensive assessment of these on their contribution to sustainable development. Local sustainable development benefits should be the main consideration for promoting CDM project in Sri Lanka.

- **Development of Legal and Institutional structure**

The government should facilitate efficient and transparent institutional framework for providing speedy host country approval, as the first commitment period will end in 2012. Therefore, the development of an institutional infrastructure for smooth functioning of CDM in the country is necessary. Since there could be conflicting interests among the large number of agencies involved in the CDM i.e Ministry of Finance, Power and Energy, Transport, Industries and Municipalities, the legal mandate of each partner should be clearly defined and regulated.

Sri Lanka National CDM office (DNA) should be equipped with skilled human resources, infrastructure facilities, technical, legal and marketing units in order to provide all kind of services such as providing information and data, promotion of CDM concept, interaction with international agencies and efficient processing of project approval requests.

Sri Lanka National CDM office (DNA) should operate on a targeted action plan which should be developed in synergy with sectoral agencies, Central Environmental Authority (CEA), Energy Conservation Fund (ECF), Ceylon Electricity Board (CEB), the private sector, industry associations, municipalities, consulting companies and NGOs that are engaged in CDM activities.

Effective coordination and cooperation across government and between government and private sector is important. This inter-agency coordination should be used to speed up government support mechanisms for CDM approval process such as EIAs approval.

- **Development of an effective information dissemination system**

One of the barriers that hinder the CDM project development is lack of accessibility to data and information. The data available with state agencies and private sector are sometimes not accessible to project developers. Project developers are often not aware of the data sources. The government should collect and compile the relevant data and make them available to the public through a dedicated website for the benefit of the project developers. The government should streamline the data availability for CDM project development rather than limiting the services to a regulatory role.
It is essential to develop a comprehensive website with the proper link to other relevant sites, with baseline information, available technology that can be adapted to Sri Lanka and potential buyers and current market rates of CERs.

- **Awareness and outreach programs**

The government should also play a facilitative role in terms of building capacity of the private sector. This should be done through regular awareness and outreach programs at all levels. Regular awareness programs for school children, policy makers and political leaders should be conducted in the immediate future.

- **Establishment of baselines**

One of the major difficulties faced by project developers and CDM consultants is the development of baselines for the relevant project. This is due to two reasons. One is the approved baseline methodologies are being frequently changed so that developers are nor aware of which is the appropriate methodology to be used in their project. The other is that developers do not have access to data necessary to determine the baseline from both private and state agencies. The government should intervene and develop baselines where necessary or gather information on relevant baseline estimates that have been approved by CDM executive board and make them available for developers. Where possible, the DNA should provide updated baselines and approved methodologies (especially grid connected energy projects).

- **Facilitating financing**

Financial institutions in Sri Lanka are not yet convinced on the potential benefits of CDM and as a result, they are not proactive in providing accelerated funding for CDM projects. The government should intervene and facilitate the establishment of a financial inter-mediatory network to promote investments for CDM projects. The government may also develop a mechanism to share some of the perceived risks of CDM by the financial institutions.

The government can encourage financial institutions to create special funding arrangements to provide finances for CDM projects which otherwise may not be able to compete with other projects.

- **Establishment of a Carbon Fund and Conservation Bank**

The government should consider establishment of a National Carbon Bank to provide overall support for the country to enter into the global CDM market through the provision of financial and technical assistance. The Carbon Bank should be given authority to undertake carbon asset management activities including providing equity finances, invest on CDM projects, purchasing carbon credits, CDM consultancy service, document preparation, bundling of small CDM projects including creation of bundling organizations to encourage bundling of small CDM projects and preparing CDM sales agreements. This fund may also deal with other development banks to organize capital funding for CDM projects. This Fund will also be able to attract local and foreign investments for the marginal sectors which are not attractive to normal commercial banks. The fund may be established as a partnership program with the private sector. The fund should be managed as a profitable venture.

The projects that provide clear sustainable development benefits including poverty alleviation providing rural employment etc. may not be viable only with CDM revenues. Therefore, the establishment of a Carbon Fund can promote these small CDM projects with high co-benefits in terms of sustainable development.

- **Setting up of a Carbon Trading Exchange**

Marketing of CERs is an urgent issue that needs special attention in order to develop Sri Lanka CDM market. This is particularly relevant for small-scale project developers. At present, the cost is unbearable for a small CDM project developer to access an international buyer. Only a few international buyers operate in Sri Lanka. They are also not willing to consider small projects which deliver CERs below a certain amount. In order to assist such small project developers, a state sponsored Carbon Trading Exchange (CTX) that buys and sells CERs should be established. The CTX should be equipped with experts of CDM marketing experience. The proposed Carbon Fund and the Carbon Bank can operate with the CTX on profit base and the income can be reverted back to support CDM activities. Project proponents shall be given the choice of trading independent of the CTX.

- **Encouraging Unilateral CDM development**

Most CDM projects in the country have experienced difficulty in finding buyers. Sri Lanka should develop a strategy to promote and implement unilateral CDM for which buyers can be contracted at any project development stage. Building capacity for the development of unilateral CDM should be a priority.

- **Avoiding introduction of perverse incentives**

It is important to make sure that country's existing and proposed policies and regulations do not hinder the CDM development in the country. Introducing new policies and regulations may penalize some CDM projects on "additionality" ground. As a result, the trade off between new regulations and CDM additionality needs should be reviewed prior to introducing new regulations. Improving coordination between sectoral policy development and CDM rules and regulation can avoid creating perverse incentives and unnecessary hurdles for CDM project development.

- **Capacity building**

The CDM project development process is entirely dependent upon local or foreign consultants. Currently, the level of capacity of CDM stakeholders, particularly among the project developers is inadequate. The CDM project development cost in Sri Lanka is very high because of the heavy dependency upon the international consultants. The government should take initiatives to build the capacity of local experts and agencies as a cost reduction measure.

Most CDM project developers are not fully aware of the potential benefits and risks involved in the CDM project development. The government should coordinate with other bilateral and multilateral agencies to provide specific training on financial, legal and other CDM rules applicable, to the stakeholders of eligible CDM sectors. The government should also introduce a coordinated approach to interact with bilateral and multilateral programs available for CDM capacity building in order to maximize the benefits of outreach and maintain continuity of capacity building programs whilst avoiding duplication. CDM centers with collaboration of Universities and other post graduate and research institutes can help build capacity and awareness by short courses etc

- **Bundling small scale CDM projects**

In Sri Lanka many CDM projects are small scale, which are not attractive to CERs buyers due to high transaction cost. CDM rules allow the bundling of these small-scale projects in order to reduce the transaction cost. However, experience suggests that the bundling of projects that belongs to different project developers is complicated and requires specific administrative, institutional, legal and technical skills. It is recommended that those local entities that have necessary technical, administrative, and legal skills should be identified and their capacity should be built for bundling of CDM projects. The government may coordinate with bilateral and multilateral agencies to build the capacity of such bundling organizations to facilitate the PDD preparation, validation, registration, verification and marketing of CERs of bundled CDM projects.

- **Service Charge on CERs**

The government should consider charging a percentage base fee to cover the administrative expenses of the CDM project approval process. Charges should be made by the government for services rendered and approvals granted. These charges should be based on the tones of CO2 and not on revenues. Lower capacity projects can be exempted with a cut off level. Charges to be made on slab basis. Generated revenue from this should only be used for development of CDM activities.

- **Defining the ownership of CERs**

The ownership of CERs should be clearly defined since project developers may have concerns of the possibility of the government claiming sole ownership of the CERs when a government controlled fund or trading unit is involved in the process. This is particularly important when sharing CERs among the project developers of bundled CDM projects. The right of the project developers to trade in CERs that they have obtained should be clearly established without any intervention by the government.

- **Establishment of arbitration mechanism**

It is the responsibility of the government to provide a low cost dispute resolution mechanism to settle any dispute arisen with regard to a CDM project. Most of the CDM projects in Sri Lanka will be small hence, be bundled projects for trading convenience. For these small CDM partners whose financial capability is lower than that of a large CDM project proponent, inexpensive dispute resolving scheme such as arbitration is a viable mechanism to make available.

- **Undertaking strategic research studies through CDM study centre**

An independent CDM study and reference centre should be established in partnership with government departments and research institutes, universities, the private sector and NGOs to function as repository of CDM information and provide technical support for all stakeholders and to undertake strategic research on CDM. Relevant Government departments, research institutes and other Universities should incorporate activities to help CDM in their corporate plan

- **Promotion of Policy and programmatic CDM**

The concept of "programmatic and policy CDM" is being widely discussed. With programmatic and policy CDM a large volume of emission reductions is possible. The transaction cost of programmatic CDM projects is lower than that of project based CDM. Sri Lanka should create policies and develop institutional framework including technical, economic, methodological capacity for the development and implementation of programmatic and policy CDM targeting the second commitment period.

- **Facilitate Local Designated Operational Entity (DOE)**

The government should facilitate the accreditation of a local Designated Operation Entity (DOE) in order to reduce the cost of validation and verification, which accounts for a significant percentage of CDM transaction cost. This needs to be expedited with high priority.

- **State sector CDM**

State sector has a large CDM potential which has never been studied or explored. These projects can be developed as a long term measure. Encourage state sector entities such as NWSDB and CEB to participate in CDM projects that significantly contribute to sustainable development through providing electricity to rural areas and introducing energy efficient improvements.

- **Making methane flaring mandatory for waste processing projects**

As a measure to encourage CDM projects in the waste sector regulations should be made to make methane collection and flaring mandatory for all engineered waste processing projects and encourage energy recovery through technical and fiscal incentives.

- **CDM projects in the land use land use changes and forest (LULUCF) sector**

Develop a program to encourage CDM projects in the land use land use changes and forest (LULUCF) with assistance from international organizations.

- **Encourage the development of all potential CDM sectors**

All potential sectors for CDM projects should be encouraged and developed through creating awareness and providing necessary assistance. Concepts such as food mileage to the tourism industry can be introduced to reduce the emission from transportation. Some of the strategic targets are given in the table 32.

Table 32 - National CDM Potential by Sectors for strategic development

Sector	Annual Energy Reduction/Substitution potential/ year	Annual CO_2 Reduction Potential t/CO_2/year	Potential income at US$ 7 per t/CO2 Rs. Mn./year
Hydro Power	250 MW	613,200	472
Wind	480 MW	672,768	518
Solar PV	To be estimated		
Biomass (Grid Power)	300 MW	1,680,000	1293
Biomass (Industrial Heat)	162 toe	512,000	394
Biomass (Absorption Refrigeration)	100 MW	400,000	308
Energy Conservation: Electricity (Industry)	20,400 toe?	64,700	49
Energy Conservation: Petroleum (Industry)	36,000 toe?	113,800	87
Tourism	To be estimated		
Transport	206,000 toe	600,000	462
Agro Residue-Rice Husk	20 MW	112,000	86
Agro Residue-Sawdust	20 MW	112,000	86
Municipal Solid Waste	500000 tones	500000	385
Forestry	100000 ha	1,352,000	1041
Total		6,732,468	5184

toe: of equivalence

6.2. Proposed Institutional arrangement for DNA in implementation of CDM in Sri Lanka

The DNA should continue to be at the Ministry Environment and Natural Resources. It will have following major functional responsibilities under its purview

1. Creation of enabling policy environment and formulation of strategies to facilitate implementation of CDM projects in Sri Lanka.
2. Coordinate all CDM related activities locally and internationally on behalf of GoSL as committed by Sri Lanka when acceded to the Kyoto Protocol.
3. Provide necessary guidance to submit projects to the international CDM market and facilitate such submissions
4. Provide necessary support to the other government and non governmental agencies interested in participating in the CDM process.
5. Monitor and Regulate the CDM market by formulating necessary regulations to ensure Sri Lanka remains a credible CER supplier to the international market
6. Initiate organize and facilitate necessary studies to provide required information for preparation of projects for CDM market.
7. Invite, encourage and promote participation of Sri Lankan agencies in the private and public sector in the CDM market
8. Define necessary guidelines to formulate various methodologies and other implementation instruments for preparation of CDM projects
9. Monitor and publish the progress made in CDM implementation in Sri Lanka by collection and dissemination of relevant information to the public.
10. Set up the necessary institutional structure for successful implementation of the CDM projects in Sri Lanka.

The DNA needs to be structured to provide these primary functions efficiently. However it is also essential to carry out these tasks in collaborative manner with the other stakeholders and it may even be necessary to consider outsourcing of some functions for better and efficient execution of these functions. It is with this functional objective that the following institutional arrangement is proposed for the DNA in Sri Lanka for implementation of CDM programs

The Ministry Environment and Natural Resources shall appoint the Additional Secretary to the Ministry to head the DNA that will have necessary staff to carry out the functions identified under the CDM program of Kyoto Protocol.

DNA shall have following Staff Positions

The Director DNA:
The Director should be reporting directly to the Additional Secretary of the Ministry who will represent Secretary of the Ministry in all CDM related activities. The director should be a senior public official with experience in coordination of governmental policy formulation, monitoring and evaluation of project progress. It is essential that the person is provided with necessary exposure to international CDM related activities.

The incumbent of this position is a senior government official with long years of experience in the environmental management sector. He/She needs to be given further exposure in regional DNAs on mechanisms adopted by such institutes in facilitating the CDM process. The main functional tasks of the director will include giving the leadership to all the activities planned and executed at the DNA to achieve its objectives.

The director should oversee the following three units that should established at the DNA to carry out tasks assigned to each unit.

1. Regulatory and Monitoring unit
2. Planning, Research and Development unit:
3. Promotional and Trade facilitating unit

<u>Regulatory and Monitoring Unit:</u>

This unit will be responsible for granting approvals and monitoring of CDM projects. The unit will be assigned with following tasks to perform

- Entertain all PIN applications (develop suitable application forms to obtain all needed information for approvals by SL) and granting approvals after checking the primary data provided as to whether the project is eligible under the CDM.
- Clear the PDD approvals when requested by the international bodies
- Provide necessary information that may be sought by the international buyers that may either have bought or interested in participating in Sri Lanka CDM program.
- Liaise with the Validating agencies that may need to check on various CDM conditions and criteria provided in the documents submitted to them.
- Prepare a monitoring report that will be published annually giving the progress of CDM activities in Sri Lanka.
- Mediate in the case of disputes that may arise between the local sellers and buyers as the DNA has a clear obligation to looks after the credibility of the local program and also the interests of local investors who may be in the receiving end of foreign buyers who may default on the deal for some unexpected reasons.

In order to carry out these tasks the division will need following staff in place

One Assistant Director and Mediation officers.

This Unit within the DNA will be the one that will have constant interactions with the local investors and their buyers. Therefore the division should have sufficient officers who are trained in respective tasks allocated to them. It is recommended that criteria for approval of PIN and PDD be published in the web so that people interested can refer to them without visiting the division physically. As the DNA will be the authority in executing and safeguarding the interests of local investors who are committed to carrying out certain tasks under the CDM commitments, it will need to collect regular information on the on-going projects (at least annually). This may be requested on a format developed by the DNA where the required information can be provided by the local producers/sellers so that the information can be stored and available for decision making in the event of disputes.

It is proposed that monitoring of those projects that enter into CDM agreements with international buyers for their compliance with the expected manner be done by a certified group of agencies who will be licensed by the DNA to carry out these tasks. Such licensing may be necessary since this exercise will involve checking and verification of the data maintained by the client that could be considered by them as confidential. Therefore it is expected that the unit will oversee the monitoring process using these certified agencies that will be performing a role similar to the audit companies with respect to accounts maintained by corporate clients.

Due to the nature of the work involved the unit will require services of persons trained in monitoring and evaluation of projects.

Planning, Research and Development Unit:

This unit will be responsible for following tasks

- Regularly collect analyze and disseminate all information on CDM activities to enable formulation of policies and plans.
- Prepare a regular CDM news letter to help dissemination of important information among the stakeholders. This will provide the clients with the information on baseline data, methodologies and other technical information needed for CDM proposals
- Commission studies necessary for implementation of CDM activities in Sri Lanka.
- Set up an advisory committee consisting of academics (from the Study centers), scientists, NGOs representatives, private sector persons and government decision makers selected for their expertise to advise and guide the CDM process in Sri Lanka. It is recommended that this committee be convened once in a quarter to review the progress of CDM program in Sri Lanka and advise the DNA on suitable actions to resolve problems and ways to address issues. Convening and keeping the minutes of this advisory committee and preparing an agenda for the discussion should be tasked to the Assistant director who shall carry out this task in consultation with the Director and the Additional Secretary to the Ministry Environment and Natural Resources.

It is not expected for this unit to deal directly with the public but to provide necessary information clients may sought to the promotional division either on routine or on request basis.

The unit should have two graduate CDM planning officers to assist the Director in the execution of the above functions. If one of the persons has sufficient experience (more than 5 years) that person may be appointed as the Assistant Director CDM planning. It is useful to have or train the planning persons on policy analysis and data analysis techniques as the expected functions will demand in depth knowledge on such techniques.

Promotion and trade facilitating Unit:

This unit within the DNA will be the marketing arm that will interact with the clients and potential clients who may seek various types of information at various stages of project development. The unit will carry out promotional activities in the CDM implementation and hence conduct various training and awareness programs for the benefit of potential participants of the program. As the unit will be expected to work closely with the private sector it is proposed that this unit be structured as a public private partnership to provide the expected services by inviting the interested qualified corporate entities to submit proposal of doing various tasks identified by them. Therefore it is recommended that DNA calls expression of interests from interested private sector agencies to provide the following and additional services that may be deemed necessary by the DNA:

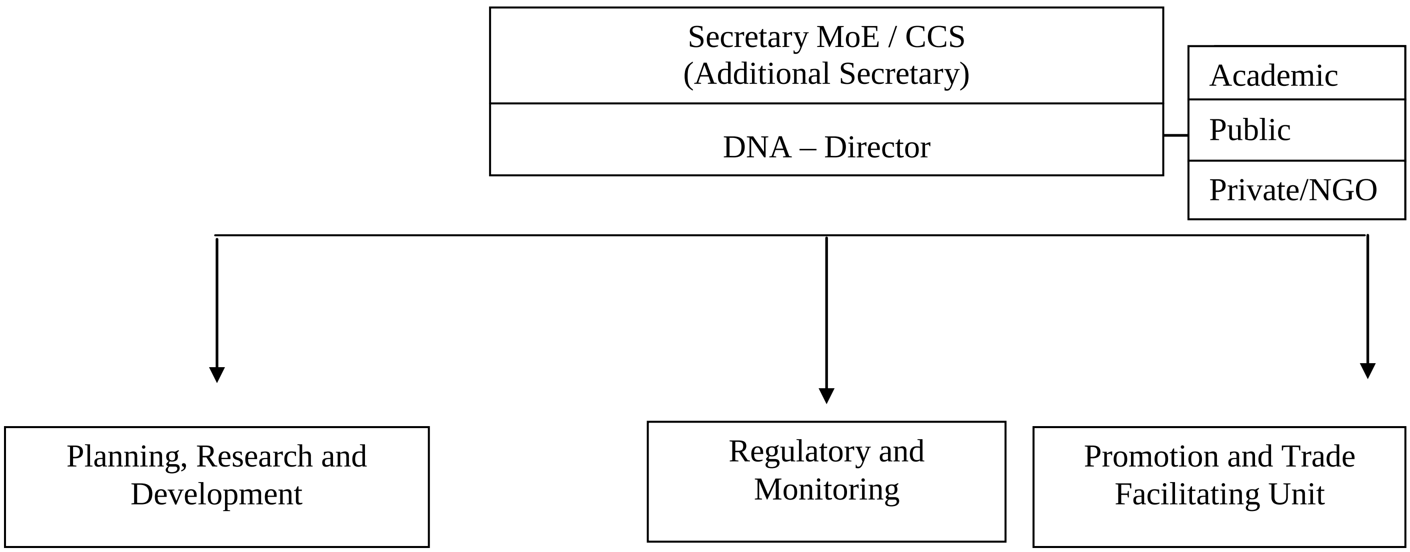
- To provide a service desk facility by way of online and on call facility for those who need to find out various aspects of CDM programs.
- To carry out a promotional campaign that will enlighten the general public and business community about the advantages and ways of participating in the CDM projects.
- Conduct training and other capacity building exercises to improve the effectiveness of agencies and individuals participating in the CDM program activities.
- Assist in creating enabling environment by raising awareness among the institutions for example; liaise with the financial sector agencies to accommodate the CDM project income as a viable source of income in considering the project finances.
- Start a web based system to help advertise CERs and CDM projects available locally for international buyers.
- Together with the other units to take lead role in publication of the CDM online newsletter at regular intervals.

In order to carry out these tasks it is recommended that the DNA appoint following staff:

An Assistant Director and a Promotional officer

These two officers can coordinate the above activities and oversee implementation of the program.

It is recommended that the DNA commences with the existing staff that are currently at the Officers grade assigning them to the above functional areas. As the work load increases with the increase in number of CDM projects it may be necessary to either appoint new or promote the staff to next level (Assistant Director Level) as appropriate.



- Baseline Research
- Research grant Administration
- International Co-ordination of Policy & Commitments with introduced grants Planning publication & Awareness
- Information & Data
- Maintaining and monitoring annual progress report on CDM activities

- Regulatory
- Approval processes Co-ordination
- (PIN & PDD)
- Legal & Dispute Settlement Co - ordination
- Appointing ombudsman for disputes settleme

- Information dissemination (Service Desk)
- Fund Management
- Co- ordinate with industrial Buyers
- Co- ordinate
- Private Sector Co-ordination
- Promotional campaigns
- Training and other capacity building

Each unit – to be headed by an Assistant Director / Planning Officer

6.3 Institutional arrangement to facilitate small size potential CDM projects:

As explained elsewhere in this report one of the main challenges the progress of CDM project development in Sri Lanka will face is the typically small size of the projects in the country. As the cost of preparation of projects for CDM consideration could be prohibitive for any project that may not produce 100,000 CERs annually, it is essential that DNA as the facilitating/regulating authority for CDM projects makes special arrangements to address this issue. This section will identify the possible arrangements for handling such tasks and the role the DNA can play in such process.

1. **The bundling of CDM projects via formation of join venture companies**: The DNA could encourage those companies to talk to each other and form consortium of companies or join Venture Company that may propose one CDM project with sufficient CER to offset or share the cost of preparation. The benefits accrued from such project CDMs need to be distributed as per their own agreement.

   Under this arrangement, the DNA will not have a major role to play except making available the information on potential projects that seek partners to bundle their projects and this may be done easily through a properly constituted web site. It may however be necessary to develop suitable instructions for the benefit of those who are keen to join such program in voluntarily.

   However, it is unlikely that this process can be very successful given the difficulties that may be faced by the companies that will come together to form such joint ventures, especially when raising necessary finances from local institutions.

2. **The piggy backing of selected projects on larger state projects**. The DNA can investigate the possibility of setting up or facilitating public private joint venture arrangements to obtain sufficient CERs and to share the benefits according to the shareholdings. As most of the larger scale projects that may qualify for CDM will in all possibility come from State agencies, they may be encouraged to advertise themselves as potential partners for several smaller private sector projects that may have some relations to their project (either by sharing of resources, or by generation process etc) to apply to join their CDM program. This process can also be guided and assisted by the DNA to enable formation of viable CDM projects.

One of the advantages of such arrangement is the flexibility that will be brought to the partnership in marketing, seeking buyers for CERS in the world market in a more beneficial manner. Such arrangement will help the financing institutions to recognize smaller private sector investors as the majority of the shares of the project will come from the state agency with some sort of state guarantee on the credibility and sustainability of the project.

The role of the DNA in this instance will be facilitation of the process by proving guidance and monitoring of the overall project of their commitments. The DNA will have least costs in this situation and may earn a success fee from such arrangements going thru to the final stages of CDM.

3. **Formation of C financing fund to facilitate the small CDM projects**: This will be the arrangement that could be initiated by the DNA to form a Sri Lanka C facility that may set aside some funds to facilitate the CDM proposal development by the private sector. The fund could not only assist by providing the finances necessary to raise a successful CDM project but can act as the first buyer of such CERS that can be bundled up together for the future sales at a better more lucrative fee. However this arrangement will need the government setting aside funds for such initial costs that may be recovered later on by way of CDM income and certainly will be taking a financial risk. Details and conditions of such operation may need to work out fairly early in detail if the country is to benefit from the potential global CDM market.

In addition to the above institutional possibilities there are several other steps that can be introduced by the DNA to facilitate the small CDM developers. In order to do so it may be useful for the DNA to hold a workshop that may allow the different institutional mechanisms to be developed in collaboration with the other development and financing agencies operating in the country. In such a workshop it is possible to discuss different regimes of risks that may be involved, institutional barriers (regulatory and policy issues) and the available mechanism that may be in practice internationally in doing similar tasks in details.

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