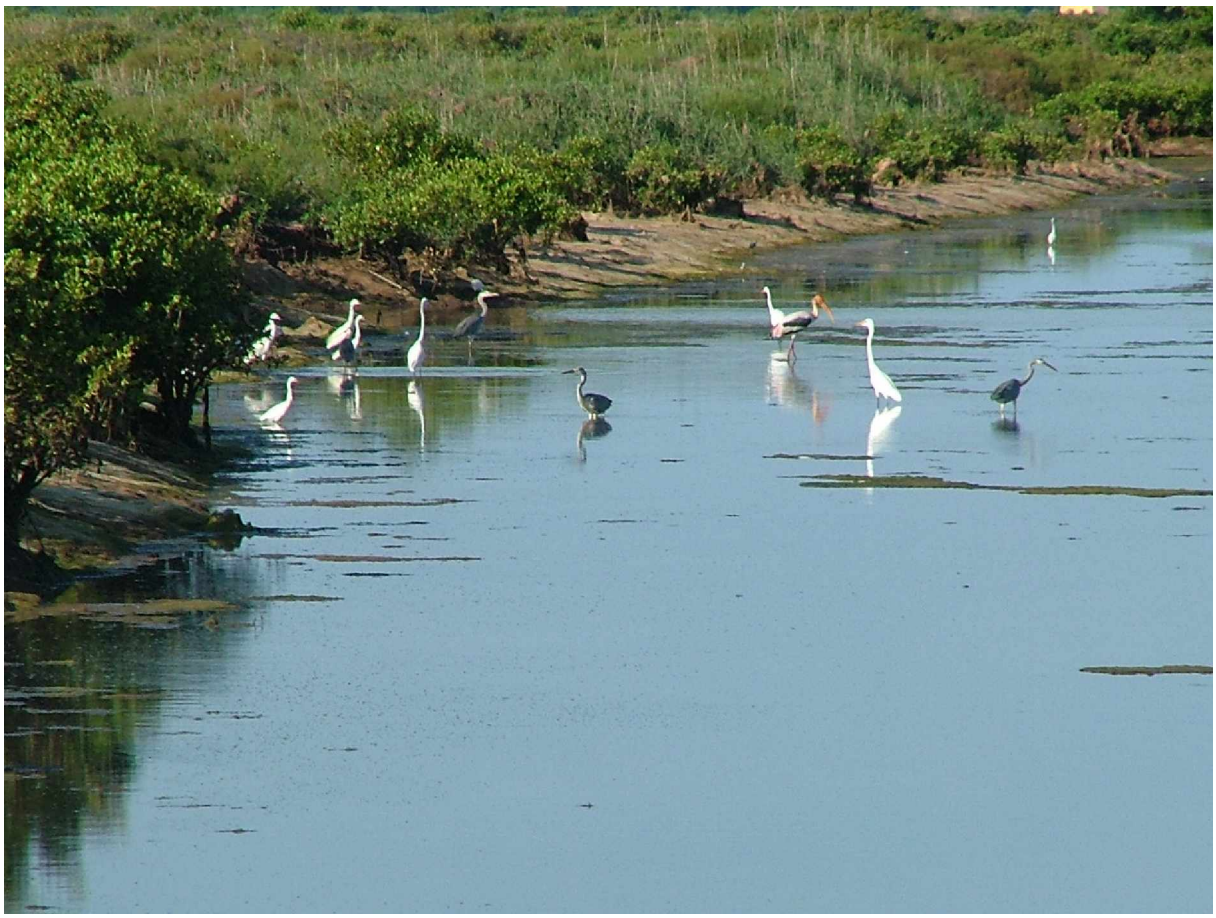
Draft 1

Ministry of natural resources and environment of viet nam

Unep/gef project "Viet Nam: Expedited financing for measures for capacity building in priority areas (Phase II)"

Technical report on the identification and assessment of technology needs for GHG emission reduction and climate change adaptation in Viet Nam



Ha Noi, November 2005.

FOREWORD

This work is the continuation and constituent part of the Initial National Communication on the Climate Change of Viet Nam submitted to the United Nations Framework Convention on Climate Change (UNFCCC) Secretariat in November 2003 at COP 9, Milan, Italy.

The Technology Needs Assessment (TNA) report provides an assessment of national needs for both types of technologies - greenhouse gas abatement technologies and adaptation technologies. It has been designed into two parts structured as follows:

Part 1: TNA for Abatement of GHG Emissions - this part gives an assessment for country needs on less GHG emission technologies, for each sector that contributes to the greenhouse gas emission.

Part 2: TNA for Adaptation Technology - this part gives an assessment for country needs on adaptation technologies focused on the Viet Nam's coastal zone.

The TNA report starts with an introduction, including the Convention context, explanation on what are the TNA and the structure of the report

The present document focuses mainly on the identification, assessment and application of effective technologies needs with a view of improving the policies, measures related to Climate Change issues in specified economic sectors including the determination of principal barriers in the technologies transfer and project implementation in Viet Nam.

This work is sponsored and financed by UNEP/GEF under the project "Viet Nam: Expedited financing for measures for capacity building in priority areas (Phase II)" and prepared by the International Cooperation Department of Ministry of Natural Resources and Environment of Viet Nam in cooperation with experts, scientists from different Ministries, Agencies, Organizations of Viet Nam.

The results of this work are a good and important basis for the stocktaking exercise and especially preparation of the Second National Communication on Climate Change of Viet Nam to the UNFCCC Secretariat in pursuance of Articles 4.1 and 12.1 of the Convention. They also contribute to achieve sustained environmentally sound socio-economic development goals in the country.

On the occasion of the publication of the present document, I would like to take this opportunity to express my sincere thanks to all authors for their effective contribution to this report.

Finally, I wish to extend my deep gratitude to the UNEP, GEF for their unceasing support and fruitful cooperation during the implementation of the above-mentioned project in Viet Nam

Nguyen Khac Hieu
Deputy Director General
International Cooperation Department
Ministry of Natural Resources and Environment of Viet Nam

CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

Climate change is one of the critical environmental problems, which the world and Viet Nam is facing today. Effects of climate change in various sectors affect many countries including Viet Nam. The consequences may be profound on agriculture and terrestrial systems, hydrology and water resources, human health, forests and wild life, coastal zones, finance, insurance, energy, commerce, industry and urban and rural settlements.

Presently, initiatives are underway to identify and develop technologies and practices for mitigating climate change and adapting to it. The development and application of the technologies is fully consistent with the general goals of sustainable development.

Article 4.5 of the UNFCCC calls for country parties to undertake technology transfer and needs assessment with the aim of adapting to and mitigating the effects of climate change. In undertaking the task, the Viet Nam Government reviewed its national circumstances and identified priority climate change issues that need intervention through technology transfer and needs assessment.

Viet Nam signed the United Nations Framework Convention on Climate Change (UNFCCC) at the Rio de Janeiro Earth Summit in June 1992, after the Convention was adopted on 9 May 1992. The Climate Convention entered into force globally on 21 March 1994 and specifically for Viet Nam ratification on 16 November 1994 and Kyoto Protocol (KP) on 25 September 2002.

The Ministry of Natural Resources and Environment of Viet Nam was assigned by the Government of Viet Nam as a National Focal Authority for taking part in and implementing UNFCCC and KP. The International Cooperation Department of MONRE has responsibilities to assist the Minister of MONRE in coordinating and managing all activities related to the UNFCCC, KP and Clean Development Mechanism in Viet Nam.

The Project "Viet Nam: Preparation of the Initial National Communication on Climate Change to the UNFCCC - GF/2200-97-54" financially and technically supported by UNEP/GEF was successfully completed in 2002. This INC of Viet Nam was submitted to the UNFCCC Secretariat in November 2003. Within the framework of this INC, the GHGs inventory for 1994 and GHGs emission projection to 2020 were carried out; different GHG abatement options in energy, agriculture and forestry sectors were developed; the potential impacts of climate change on some major economic activities and adaptation measures were evaluated; the GHGs mitigation strategies through socio-economic development plan were also presented.

The Project "Viet Nam: Expedited financing for measures for capacity building in priority areas (Phase II) - GF/2724-03-4701" funded and assisted by UNEP/GEF is managed by ICD, MONRE. The main objectives of this project are:

- To help meet the added requirement of enhancing capacity in order to identify and analyse technological needs;
- To access information on technology transfer and sensitise the public awareness on climate change;

- To build capacity to prepare climate change programmes promoting technology transfer;
- To build the capacity to improve the quality of climate change enabling activities.

This project is a follow-up to the INC. It helped Viet Nam reinforce capacities, identify and assess technological needs in the area of climate change.

Structure of the report

The TNA report provides an assessment of national needs for both types of technologies - greenhouse gas abatement technologies and adaptation technologies. The TNA report starts with an Introduction, including the UNFCCC context, explanation on what are the TNA and the structure of the report. It has been designed into two parts structured as follows:

- Foreword
- Introduction
- Chapter 1: National circumstances
- Chapter 2: The Needs assessment process

Part I: Technology needs assessment for abatement of GHG emissions

- Chapter 3: The Technology needs assessment for Energy supply
- Chapter 4: The Technology needs assessment in Service and Household sector
- Chapter 5: The Technology needs assessment for Industry sector
- Chapter 6: The Technology needs assessment for Transport sector
- Chapter 7: The Technology needs assessment for Forestry sector
- Chapter 8: The Technology needs assessment for Agricultural sector

Part II: Technology needs assessment for adaptation technology

- Chapter 9: Identification and assessment of adaptation technology needs on agriculture, water resources, coastal zone management
- Chapter 10: Participation in Systematic observation network
- Conclusions

A. What is the Technology needs assessment

The UNFCCC identifies TNA as one of the five key elements of a framework to enhance technology transfer 1. The elements of the technology transfer are as following:

- Technology needs and needs assessment
- Technology information
- Enabling environments
- Capacity building
- Mechanisms for technology transfer

This framework to facilitate and enhance technology transfer activities under the UNFCCC is based in large part on examination of the experience gained through existing technology transfer initiatives between developing countries and donor organizations. According to the Intergovernmental Panel on Climate Change (IPCC), "*technology transfer*" means a set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change amongst different stakeholders such as governments, private sector entities, financial institutions, NGOs and research /education institutions.

TNA as a component of the technology transfer process is a mean by which assessment of development and climate response needs and opportunities are brought together and integrated. TNA is a complex process, it is not a stand alone activity; rather it is a continuation of the work most countries have already carried out or identified/recommended in their National Communications and through other activities to enhance technology transfer.

TNA entails the identification and evaluation of technical means for achieving specified ends. From a climate change and developmental perspective, TNA would identify technologies, practices and reforms that might be implemented in different sectors of a country to reduce GHG emissions and vulnerability to climate change and to contribute to development goals.

Technology needs assessment is therefore a component of an integrated set of activities that are designed to enhance technology transfer, and which is critical to the avoidance of adopting mal-suited technologies that could run counter to sustainable development objectives

B. Approaches and Principles of Technology needs assessment

Technology needs assessments (TNAs) are frameworks designed to help identify the technology needs and priorities of Viet Nam in order to ensure technology transfer can occur successfully. Because successful technology transfer depends crucially on the existence of local abilities to assess and acquire technology ('acquisition capability'), the TNA frameworks developed in this report focus on needs, strengths and weaknesses from a country capability point of view.

There are two major dimensions of technological capability. First, is the capability to develop strategies and manage technological acquisition, use and further development

(sometimes called 'techno-managerial' capabilities). Second, is the detailed engineering (or scientific) capacity needed to acquire and develop specific technologies.

Technology needs assessment entails the identification and evaluation of technical means for achieving specified ends. From a climate change and developmental perspective, TNA prioritises technologies, practices, and policy reforms that can be implemented in different sectors of a country to reduce greenhouse gas emissions and/or to adapt to the impacts of climate change by enhancing resilience and/or contributing to sustainable development goals in Viet Nam.

Think of TNA as an approach by which sustainable development, climate change technologies, and opportunities are integrated. Many of the applicable technologies for mitigating GHG emissions and adapting to climate change may also be well-suited to sustainable development priorities in a broad sense. Indeed, those concerned with adaptation – such as those that protect or improve natural resources, or that maintain and improve agricultural output – are also necessary for sustainable development. Similarly, many of the technologies being developed in response to the needs of GHG mitigation, especially those related to renewable energy and energy efficiency, will also help to produce and consume energy in a sustainable way. TNA is not a stand-alone activity. Rather, it is a continuation of the work countries have carried out or identified in their National Communications and through other activities to enhance technology transfer. in particular developing countries, in the process of technology transfer.

Conducting technology needs assessment for climate change requires a focus on two major areas, GHG mitigation and adaptation to the impacts of climate change. It needs to be recognised at the outset that the particular processes used to assess technology needs in these two areas, though fundamentally consistent in key areas, may be operationally distinct in others.

Assessing technologies for mitigating GHG emissions is fairly "straightforward". Such technologies have a simple and clear objective – i.e., the reduction or avoidance of GHG emissions – and tend to target specific, well-known, emitting sectors such as power generation and transportation.

There is a large case study literature of mitigation technology applications that yields lessons that can be learned and taken into account when assessing such technologies in a local context.

Assessing technologies for adapting to climate change poses a more complex challenge on two levels.

- **First**, there's inherently more uncertainty regarding vulnerability, as impacts tend to be highly site-specific and not easily general sable across spatial and temporal scales. This uncertainty carries over to identification of appropriate adaptation measures, options, and technologies – as well as the stakeholders that are affected. Therefore, hard technologies may not be appropriate.
- **Secondly**, adaptation concerns have only recently moved onto centre stage of the climate change negotiations. Unlike the mitigation area, which can claim a formal

protocol as a framework for North-South cooperation on reducing GHGs (i.e., the Kyoto Protocol), there is no comparable approach as yet in the adaptation area.

Technology Needs Assessment is country-driven and must be done through a consultative process that engages all relevant stakeholders. To achieve that, the National Climate Change Co-coordinator brought all stakeholders to a common level of understanding of the TNA process by developing introductory materials for them. This material referred to as the ‘ Scoping Document’ defined in general the TNA process and outlined the purpose and the generic approach to TNA. In addition, the scoping document gave a brief background to the United Nations Framework Convention on Climate Change, indicating in particular the status of technology transfer negotiating process.

As was mentioned by IPCC, the technologies serving for climate change impacts mitigation and adaptation to climate change must be an Environmentally Sound Technology (EST) and support the sustainable development. While identifying the technology needs of Viet Nam not only the assessment of specific technology types is necessary, but it is also significant to consider the entire systems, which include such aspects as know-how, production procedures, goods and services, organization and management. Thus the concept “technology” covers not only the physical appearance but also all of the procedures concerning production and usage of a technology in its’ physical terms.

Manufacturing and introduction of new technologies must base upon the national economic development priorities. Achievement of social and economic growth is the basic objective of economic policies pursued by Viet Nam with transition economies. However methods of how to achieve and support economic growth must conform to environmental standards and priorities.

Methodology of study

Method of study included the preparation of a scoping document that gave a background to the UNFCCC and the TNA process. This was discussed by a Technical Committee on Technology Needs Assessment composed of all relevant stakeholders under grand by MONRE. Terms of reference for work to be carried out under the various sectors identified under the initial national communication chapter on mitigation options were developed and experts from the relevant institutions identified. They carried out literature searches, reviewed national reports and documents to come up with reports on information on GHG emissions and technologies/practices in their areas of expertise.

These reports were reviewed and in-depth analysis carried out in workshops organized by the Technical Committee. After the finalization of the work, the compiled report was circulated to all stakeholders and a final workshop called to adopt the report.

C. Objective of TNA in context of National development goals

The objective of report is valuable to anyone wishing to understand how to undertake an assessment of climate change adaptation technologies, regard less of their level of familiarity with the particular technologies associated with GHG mitigation and adaptation, and may be tasked with organising policy or project formulation related to Environmentally Sound Technology transfer

The role of technology needs assessment has been defined and justified under the Climate Change Convention. From a climate change and developmental perspective, technology needs assessment entails the identification and evaluation of technologies, practices and reforms that can be implemented in different development sectors to reduce green house gas emissions and climate change vulnerability and also to contribute towards national development goals.

Technology needs assessment is capable of yielding a variety of outputs, depending on how it is applied. While specific outputs depend on the particular needs and goals of the exercise, in general, a completed TNA process leads to a clarification of technology barriers, strategies, policies, and options that a country could implement to reduce GHG emissions and/or enhance the ability to adapt to climate change. These can be aimed at different levels of society, as well as at different sectoral and temporal scales

Many of the technologies and practices for adaptation to and mitigating adverse effects of climate change are well suited to the needs of the country's socio-economic development. Also, many of such technologies have become economically important sources of supplying and utilizing energy efficiently.

The Viet Nam Government has established institutional structures and arrangements to engage various stakeholders and development partners in technology transfer and needs assessment. Priority technologies have been identified and appraised based on special criteria that encompass development benefits, market potential and adaptation to climate change. Presently, the priority sectors selected for climate change adaptation include energy, transport, agriculture, irrigation, water, meteorology, industry, health and education.

This report purpose will be to identify and exploit the country and international opportunities for technology transfer. Several major outcomes are envisioned:

- **National policy development:** TNA can be used to explore governmental decisions aimed at integrating sustainable development planning with the impacts of climate change. For adaptation, this policy focus may be directed at important sectors of the national economy such as agriculture, forestry, water resources, coastal zones, etc. For mitigation, the transportation or power generation sectors could be targeted.
- **Adaptation and mitigation assessments:** Technology used to address mitigation issues may also have implications for addressing adaptation issues. TNA can be used to explore these potential linkages in conjunction with other initiatives aimed at analysing options and/or national plans for mitigation and adaptation.

D. Methodologies for TNA

The concept of a *methodology* for technology needs assessment is simply a clear, comprehensive and consistent description of a set of activities that can help to ensure that TNA is undertaken in an effective and efficient manner. It is simply an outline or overview of a step-by-step approach to a particular problem. This does not mean that TNA can be reduced to a simplistic or linear approach (where one step must be followed by another); there are linkages and feedbacks between all of the steps and activities described here.

It is possible to identify a wide range of issues for Viet Nam seeking to improve the development and transfer of technologies – assessment of technology needs is only one of aspect. The report is concerned with this aspect alone, but this is not to suggest that TNA is any more or less important than any of the other activities that can improve the flow of technologies and know-how between and within Viet Nam and others countries; indeed needs assessments only make sense when viewed within this wider context.

It is also the case that a variety of approaches to technology needs assessment are available; several studies have considered, either explicitly or implicitly, the TNA process. These studies entail varying degrees of complexity, in part as a result of the extent to which they focus solely on TNA, or also deal with wider issues. It is not the purpose of the report to provide a discussion of different approaches and their merits; rather it is to set out a viable and consistent approach that Viet Nam may apply directly

Finally, it is important to be clear that in describing an approach, or methodology, for TNA the report does not set out to prescribe a single, inflexible means by which TNA may be delivered. This diversity of circumstance is often captured in the expression ‘one size does not fit all’. However, there are many steps and considerations that *are* common to all and the approach set out here is designed, as far as is practicable, to be modified and adapted to suit circumstances.

CHAPTER 1

NATIONAL CIRCUMSTANCES

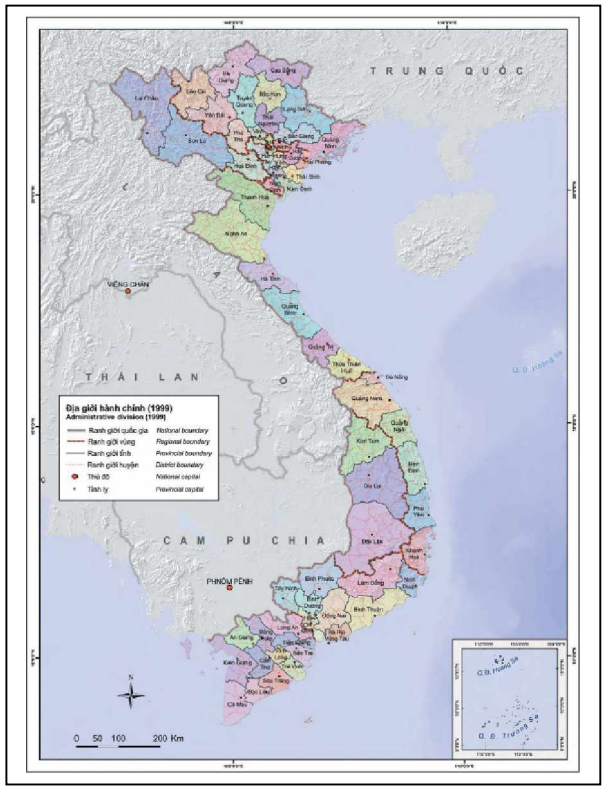
Introduction

There is a growing awareness that the increase in the amount of greenhouse gases being released into the atmosphere will have adverse effects on the global weather systems. This will likely affect the natural resources. The key natural resource sectors that might be susceptible to changes in climate include agricultural crops, livestock, forests, water resources, coastal resources, fisheries, and wildlife.

Viet Nam is more vulnerable than industrialized countries to the effects of climatic change for two reasons. First, the current economic and ecological crises have weakened the capacity of many countries to adjust to drastic economic and ecological changes. Second, most of the people depend on agriculture for their subsistence, and agriculture depends a great deal on climatic patterns.

Viet Nam is one of the countries that have ratified the United Nations Framework Convention on Climate Change. Under this Convention, Parties to the Convention must communicate to the Conference of the Parties (COP) their national inventories of anthropogenic emissions of all greenhouse gases by sources and sinks using comparative methodologies. Viet Nam undertook their greenhouse gas inventory based on the years 1990 and 1994. Additionally, Viet Nam has started to assess the vulnerability of important sectors (Energy, Transport, Agriculture, Forest and others) to climate change impacts and recommend adaptation and mitigation measures.

The aim of this chapter is to give the context in which Viet Nam exists, especially in relation to climate change and capacity of the country to respond to climate change impacts. The subsequent sections give a summary of Viet Nam's geography and climate, natural resources, land use, history and climate, population, energy, industry and tourism, socio-economic and development profile, forestry and agriculture of Viet Nam.



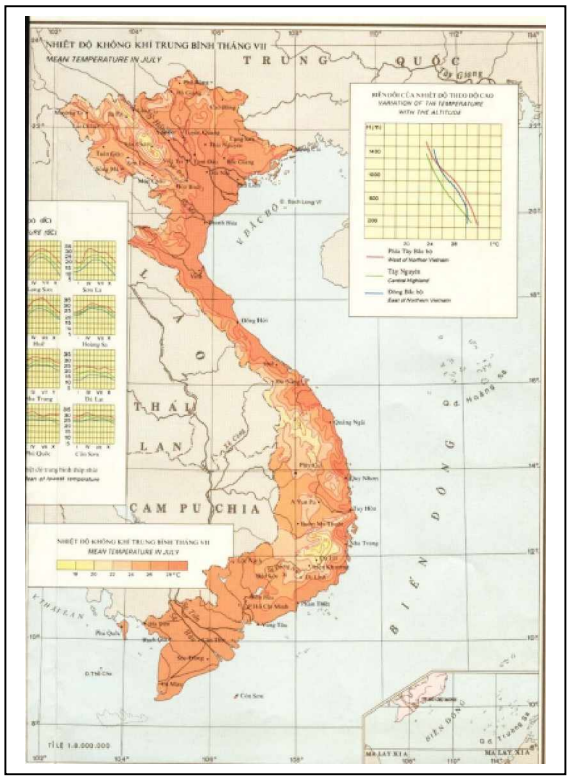
1.1. Geography

Viet Nam country is located in the South East Asia, stretching from $8^0$27 to $23^0$23 N and from $102^0$08 to $109^0$30 E, Viet Nam has a total land area of 329,314 km^2, of which the area of plains is only 7 million ha and the remainder is mountains, hills and plateau. Viet Nam has also a sea water territory under sovereignty and jurisdiction

of approximately 1 million km^2 and 3000 big, medium and small islands with total area of more than 1600 km^2. The entire length of the coastline is 3260 km.

Viet Nam is a strip of land shaped like the letter "S". It borders China to the North, Laos and Cambodia to the West, the East Sea to the East and the Pacific Ocean to the East and South. The inland border is 4500 km. The country total length from North to South is 1650 km. Its width, stretching from East to West, is 600 km at the widest point in the North, 400 km in the South and 50 km at the narrowest part, in the Centre, in Quang Binh province. Viet Nam is also a transport junction from the Indian Ocean to the Pacific Ocean.

1.2. Climate



Viet Nam climate generally is subtropical and tropical, hot and wet monsoon climate. Its climate is characterized by strong monsoons, a considerable number of sunny days, high levels of rainfall and high humidity.

Although, the entire country lies in the tropics and subtropics, it presents a very diverse climate according to its different altitudes and latitudes. Based on climate conditions, Viet Nam can be divided into two regions, separated by the Hai Van mountain pass, with is located between Hue and Da Nang cities. In the areas North from Hai Van Mountain pass, it is cold in the winter and hot and wet in the summer, with average annual temperature of 22 - 24^0C. The average temperature of the coldest month is 15 - 19^0C, and average temperature of the hottest month is 32 - 34.4^0C. In the areas from South of the Hai Van mountain pass, it is hot all the year round, with average annual temperature of 25 - 27^0C (except Tay Nguyen plateau with average annual temperature of 20 - 22^0C), and average temperature in the coldest month of 21 - 26^0C and average temperature in the hottest month of 32 - 34.5^0C.

Viet Nam is often threatened by typhoons, storms, floods and salinity intrusion. On average, Viet Nam is hit annually by 4 - 5 typhoons.

The rainfall in Viet Nam is irregularly distributed during the year and over different regions of the country. Therefore, floods and inundation occur during rainy season but in dry season, drought is often recorded in several regions. The average annual rainfall of Viet Nam is from 1500 to 2500 mm and the average annual humidity is 80 - 85%. The total amount of annual solar radiation is 95 - 175Kcal/cm^2.

1.3. Natural resources

Viet Nam is richly endowed with natural resources, and the country's economy is heavily dependent on this base. Agriculture, forestry and fisheries account for 25.7% of total GDP and 70% of total employment.

These sub-sectors underpin almost all rural economic activity. But trends indicate that use and management patterns in the natural resource sector are a threat to Viet Nam's continued economic viability. Environmental degradation from unsustainable use is increasingly undermining this sector's capacity to support current, let alone forecast increases in, economic demand. This is because use patterns in all sub sectors are causing environmental degradation. While there are issues common to the entire natural resource sector, each sub-sector has its own unique set of use and management characteristics that are causing this degradation.

Viet Nam's coal reserves are located mainly in the northeastern province of Quang Ninh. Reserves are estimated at 3.88 billion tons, of which 660 million tons are approved and 410 million tons are accessible through underground operations. Most of the reserves are anthracite or semi-anthracite varieties. Lignite coal in the Red River Delta has the forecast reserves of 250 billion tons. Peat coal is concentrated in the Mekong River Delta with the reserves of about 10 billion tons. Fat coal is distributed in many areas with small reserves. The annual production is approximately 200,000 - 300,000 tons per year.

In Viet Nam, there are six operating fields (all offshore) producing between 245,000 to 290,000 barrels per day. Recoverable reserves of gas have been estimated to be as high as 60 - 80 trillion cubic feet.

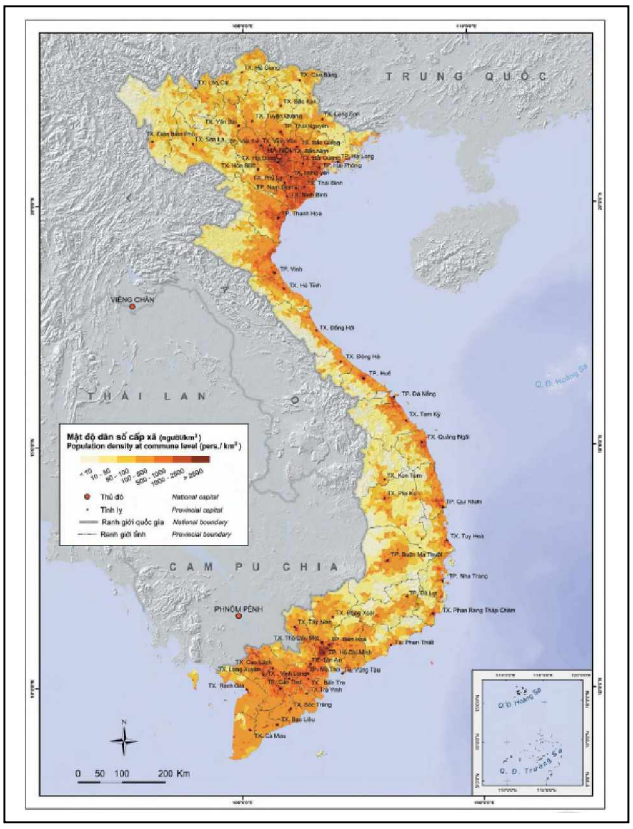
Viet Nam has a high rainfall and a dense rivers-streams system. Over 400 small hydro stations are now in place with a total installed capacity of 30 MW. On a smaller scale, it is believed that over 100,000 micro and family hydropower generators are now in use.

In Viet Nam, solar energy potential is rather rich. Average total annual insulation ranges from 4 - 5 kWh per square meter per day. There are currently five large-scale solar photovoltaic power systems in Viet Nam. A considerable number of hybrid systems of solar PV and micro-hydropower generation and hybrid systems of PV and diesel are being built. The government of Viet Nam has financed the construction of 100 solar home systems and 200 solar community systems for inhabitants of islands off the northeast coast.

The wind energy potential is not high, mainly in islands and coastal areas. The Research Center for Thermal Equipment and Renewable Energy (RECTARE), Ho Chi Minh Technical University is organization developing and promoting wind energy technologies, and has installed over 800 wind generators in over 40 provinces and towns throughout Viet Nam. The largest numbers of these units have been installed near Nha Trang city in Khanh Hoa province on the South-Central coasts, where 135 units are in use. The potentials of biogas and biomass in Viet Nam are rather big and mainly used for fuel in rural areas.

1.4. Population

Viet Nam has 54 different ethnic groups, living on an equal ground and in a close-knit manner, creating a large family of brother-like people, which act for the cause of national development. Viet Nam has 64 cities/provinces, and Ha Noi is the capital city with the population of about 3.2 million people.



Viet Nam is one of the world's most populated countries. In 2004, its population reached 82.03 million people, of which women account for 50.85%. The population growth rate is 1.4%. The population's part of the working age includes about 43.6 million people, i.e. 53% of the total population. The average life expectancy is 71 years old. The population density is 249 persons per km^2. By the end of 2004, the urban population accounting for about 26.3%. Approximately 73.7% of the population in Viet Nam is still living on agriculture.

Table 1.1. Population and population density in Viet Nam in 2004 by region

No.	Region	Average population (1000 persons)	Area (km^2)	Population density (person/km^2)
1.	Red River Delta	17,836.0	14,812.5	1,204
2.	North East	9,244.8	63,629.8	145
3.	North West	2,524.9	37,336.9	68
4.	North Central Coast	10,504.5	51,510.8	204
5.	South Central Coast	6,981.7	33,069.0	211
6.	Central Highlands	4,674.2	54,473.7	86
7.	South East	13,190.1	34,743.1	380
8.	Mekong River Delta	17,076.1	39,738.7	430
	Whole Country	82,032.3	329,314.5	249

Sources: Viet Nam Statistical Yearbook 2004

Table 1.2. Average population in Viet Nam by sex and by residence

No.	Year	Total (1000 persons)	By sex		By residence	
			Male (1000 persons)	Female (1000 persons)	Urban (1000 persons)	Rural (1000 persons)
1.	1995	71,995.5	35,237.4	36,758.1	14,938.1	57,057.4
2.	1996	73,156.7	35,857.3	37,299.4	15,419.9	57,736.8
3.	1997	74,306.9	36,473.1	37,833.8	16,835.4	57,471.5
4.	1998	75,456.3	37,089.7	38,366.6	17,464.6	57,991.7
5.	1999	76,596.7	37,662.1	38,934.6	18,081.6	58,515.1
6.	2000	77,635.4	38,166.4	39,469.0	18,771.9	58,863.5
7.	2001	78,685.8	38,684.2	40,001.6	19,469.3	59,216.5
8.	2002	79,727.4	39,197.4	40,530.0	20,022.1	59,705.3
9.	2003	80,902.4	39,755.4	41,147.0	20,869.5	60,032.9
10.	2004	82,032.3	40,317.9	41,714.4	21,591.2	60,441.1

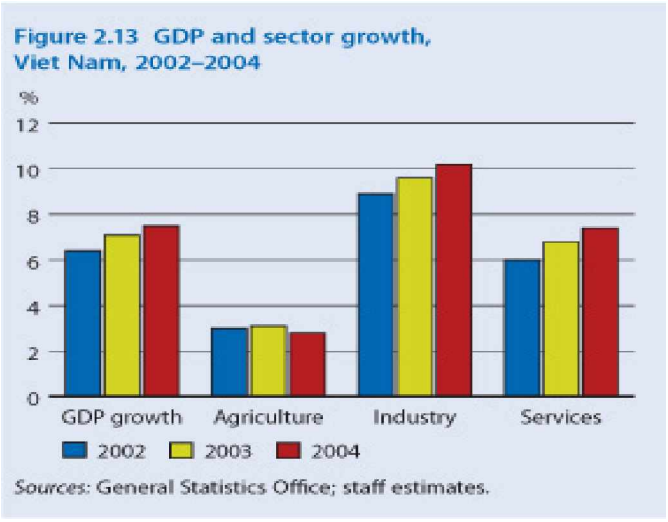
Sources: Statistical Yearbook 2004

1.5. National Socio-economic profile and development

In the last 15 years, 1990 - 2005, Viet Nam's gross domestic product (GDP) was nearly triple. Remarkable achievements in social performance were observed. The international economic relations, especially in international trade and FDI, are continuously expanded. The physical and spiritual living conditions of the population are improved, and the political and social status is stable.

Continuing the cause of renewal, Viet Nam has achieved encouraging successes in socio-economic development and environmental protection. The economic growth rate has been continuously increasing; in 15 years from 1990 to 2004, the GDP has been increased by 7.5% per year on the average (it was 7.3% for 2001 - 2004 period). The average GDP per capita in 2004 is about 560 USD. The 2004 GDP at current prices by economic sectors are agriculture, forestry and fishing: 21.76%; industry and construction: 40.09% and services: 38.15%. Industry grew at 11% per year (it was 10.3% for the last 5 years). The value of services has been grown up by about 7% per year on the average. Agriculture has maintained its annual growth rate of 4.06% (3.6% for the last 5 years) in spite of many difficulties in terms of natural disasters.

In the five-year-plan 2001-2005: Viet Nam has set as the primary objectives of this period the restoration of a rapid and sustainable economic growth and improvement of the quality of development in order to stabilize and improve the living standards of the people to accelerate the process of restructuring the economy towards industrialization and modernization.



Viet Nam will focus all efforts on achieving following targets: GDP in 2005 double that in 1995; average annual GDP growth rate of 7.5% during the period 2001-2005. Agricultural, forestry and fishery output increases by 4.8% per year. Industrial output increases 13% per year. Service revenue increases 7.5% per year.

Planned structure of sectors in GDP by 2005: Agriculture sector accounts for 20-21%. Industry sector accounts for 38-39%. Service sector accounts for 41-42%. Reduce the population growth rate to 1.16% by 2005.

Export has been increased quickly, with the export value increased by 16% per year and the export market maintained and expanded. The export value per capita is approximately 324 USD in 2004.

The fiscal deficit, estimated at 3.8% of GDP, is below the Government's target of 5.0%. GDP growth is projected at around 7.6% for 2005, 7.6% in 2006, and 7.5% in 2007, supported by strong domestic demand and export growth. The fiscal position is expected to remain expansionary but manageable to cover the cost of reforms and infrastructure. Inflation (average for the period) will likely moderate to 6% in 2005 and 5.2% in 2006 and 2007.

Table 2.13 Major economic indicators, Viet Nam, 2004–2007, %

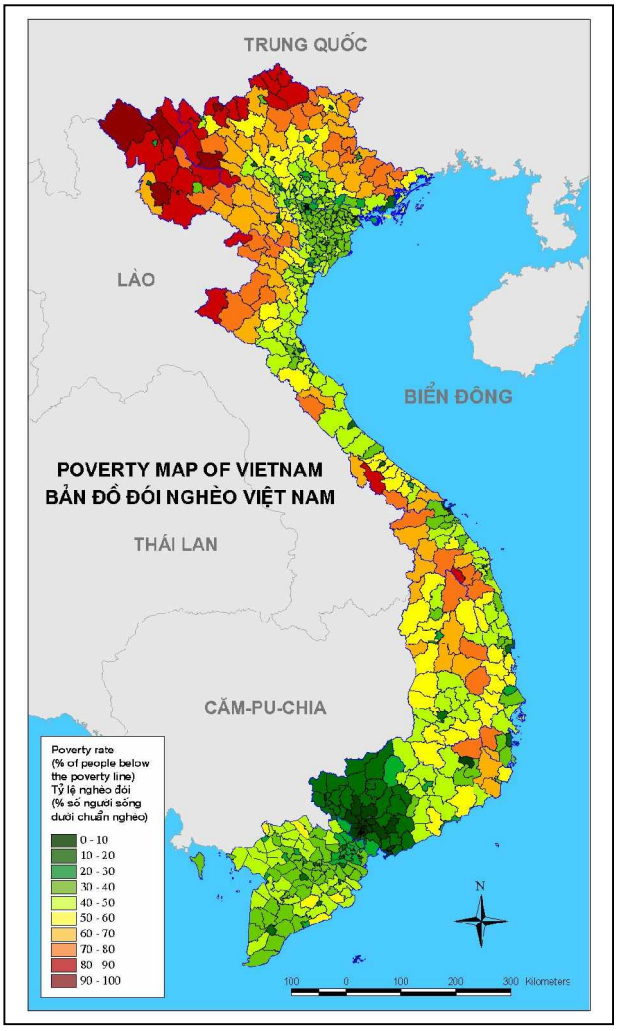
Item	2004	2005	2006	2007
GDP growth	7.5	7.6	7.6	7.5
GDI/GDP	35.5	36.1	37.1	37.7
Inflation (CPI)	7.7	5.7	5.2	5.2
Money supply (M2) growth	28.0	28.0	27.0	25.0
Fiscal balance/GDP	-3.8	-4.9	-5.0	-4.8
Merchandise export growth	30.3	11.4	8.9	8.6
Merchandise import growth	26.0	12.0	10.0	10.0
Current account/GDP	-5.7	-5.6	-5.8	-6.6

CPI = consumer price index, GDI = gross domestic investment, GDP = gross domestic product.

Sources: General Statistics Office; Ministry of Finance; State Bank of Vietnam; International Monetary Fund; staff estimates.

In response to an improved investment climate, FDI commitments were strong in 2004, reaching $4.0 billion, or almost one third higher than in the previous year. Net FDI rose from $1.2 billion to $1.7 billion. Foreign exchange inflows were pushed up by official development

assistance and by private remittances through official channels. These private remittances rose from $2.6 billion in 2003 to about $3.2 billion in 2004.



In the 4 years 2001 - 2004, more than 5.9 million people have got jobs. The number of jobs created every year is about 1.475 million on the average. Growth created jobs for an estimated 1.6 million people in 2004, lowering the unemployment rate in urban areas from 6.4% in 2000 to 5.8% in 2003 and to 5.6% in 2004 while the rate of working time used in the rural areas has accordingly increased from 74.2% to 78.3%. These workers' remittances contributed an estimated $1.5 billion, equivalent to 3.5% of GDP, to the national economy

The Viet Nam Government remains committed to ensuring high growth and faster and sustainable poverty reduction. It is preparing a new 5-year socioeconomic development plan (SEDP) 2006–2010, which is expected to be Viet Nam's new national strategy for poverty reduction and growth, incorporating the fundamentals of its Comprehensive Poverty Reduction and Growth Strategy (CPRGS). Viet Nam has gained internationally recognized successes in the area of poverty reduction and hunger alleviation. The poverty rate has been strongly reduced, in particular the number of poor households decreased from 58.1% in 1993 to 37.4% in 1998, 28.9% in 2002 and 24.1% in 2004. It means, from 1993 to 2004, Viet Nam reduced the number of poor households and hungry families by more than 60% and nearly 70% respectively. Strong economic growth helped reduce the number of households in poverty by 300,000 to 1.4 million. This is as measured by the national poverty standard, which puts households below the poverty line if they have consumption spending of less than D80,000-D150,000 (depending on the location) per person per month It is worth to say that in 5 years 2000 - 2004, the poverty rate in the areas of various ethnic minorities (such as the Central Highlands and the North West) was reduced much more quickly than in other regions of the country.

Viet Nam has achieved notable results in the fields of universal education; promotion of gender equality and women's position; children health care; protection and improvement of women's reproductive health; prevention and control of HIV/AIDS, malaria and other diseases; environmental protection; provision of basic essential infrastructure and

services for extremely disadvantaged communes; improvement of living standards, preservation and development of ethnic minority cultures and vulnerability reduction etc.

Table 1.3. Gross domestic product at constant 1994 prices by economic sectors

No.	Year	Total (billion VN dong)	Agriculture, forestry and fishing (billion VN dong)	Industry and construction (billion VN dong)	Service (billion VN dong)
1	1990	131.968	42.003	33.221	56.744
2	1995	195.567	51.319	58.550	85.698
3	2000	273.666	63.717	96.913	113.036
4	2001	292.535	65.618	106.986	119.931
5	2002	313.247	68.352	117.125	127.770
6	2003	336.242	70.827	129.399	136.016
7	2004	362.092	73.309	142.601	146.182

Sources: Viet Nam Statistical Yearbook 2004

Figure 1.1. Structure of GDP 2004 at current prices by ownership (%)

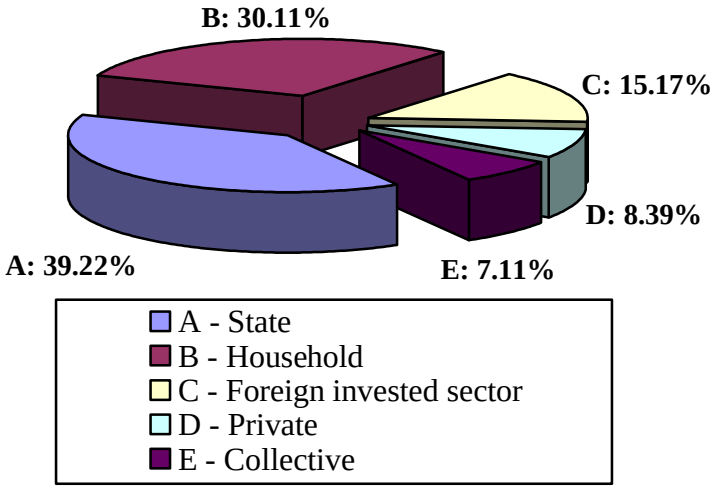
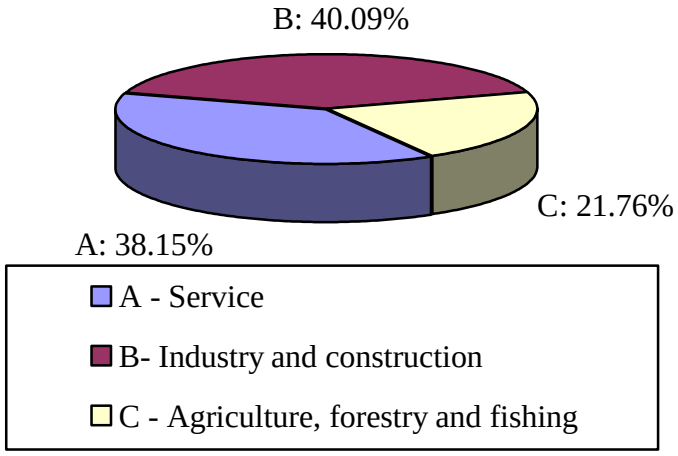


Figure 1.2. Structure of GDP 2004 at current prices by economic sector (%)



Sources: Viet Nam Statistical Yearbook 2004

Key socioeconomic development challenges for the next 5 years (2006-2010) include (i) sustain high economic growth and poverty reduction; (ii) create jobs for new labor market entrants; (iii) reduce inequality through targeted poverty reduction; (iv) support social development by improving health and education services, gender equality, and social inclusion; (v) protect the environment; and (vi) improve governance to ensure these challenges are sufficiently and efficiently addressed

The next 5-year socioeconomic development plan (2006-2010) has a target of 7.5-8.0% annual average GDP growth, broken down into 3.0-3.5% in agriculture, forestry, and fisheries; 10.0-15.0% in industry; and 7.2-7.5% in services. The aim is to create 8 million additional jobs and reduce the number of poor households. The plan is expected to achieve the Government's Comprehensive Poverty Reduction and Growth Strategy and Viet Nam Sustainable Development Goals--the local version of the Millennium Development Goals. Given that the country has achieved rapid economic expansion and poverty reduction over the past decade, the targets seem plausible, provided that the Government ensures that total investment stays at about 35% of GDP, improvements are made in the productivity of capital, and economic growth benefits all sectors of society.

In next 5 year (2006-2010) the Viet Nam's government policy will focus on the following measures:

- First, continue to strongly renovate and restructure the economy, especially the agricultural production, in order to increase productivity and efficiency in this sector, and to increase income of the people in rural area.
- Second, accelerate restructuring the banking sector to build up a sound banking system to meet the need of credit, monetary and financial services of the economy.
- Third, accelerate restructuring and renovation aimed at developing and improving the effectiveness of SOEs.
- Fourth, promote reasonable consumption and effectively mobilizing domestic saving for development investment.
- Fifth, improve the quality and reputation of exports, stimulate export promotion.
- Sixth, focus efforts on solving critical social problems and making clear progress to the social situation.

Viet Nam Initial National communication Under the United Nations Framework Convention on Climate Change

In order to fulfill the commitment described in the Articles 12.1, 12.5 of UNFCCC and following the guidelines "Preparation of the Initial National Communication" for Non-Annex I Parties that was approved at COP-2 dated 19 July 1996, the Government of Viet Nam assigned the Hydro-Meteorological Service, nowadays Ministry of Natural Resources and Environment of Viet Nam as a National Authority, to implement the project "Viet Nam: Preparation of the Initial National Communication to the United Nations Framework Convention on Climate Change (UNFCCC) - GF/2200-97-54" with the financial and technical support from the Global Environment Facility (GEF) and the United Nations Environment Programme (UNEP).

The results of GHG emission inventory and projection of Viet Nam are given in the table 1.4.

Table 1.4. Estimated GHGs emissions to 2020 by sectors

Year	1994		2000		2010		2020	
	Mill. tCO2	%	Mill. tCO2	%	Mill. tCO2	%	Mill. tCO2	%
Energy	25.64	24.7	49.97	46.8	117.3	78.7	232.3	86.5
Forestry and land use change	19.38	18.7	4.20	3.9	-21.70	-14.6	-28.40	-10.6
Agriculture (*)	52.45	50.5	52.50	49.2	53.39	35.8	64.70	24.1
Industrial Process	3.81	3.7	?	?	?	?	?	?
Waste	2.56	2.4	?	?	?	?	?	?
Total	103.8 (**)	100	106.7	100	149.0	100	268.6	100

***Sources**: Projection of GHG emission from energy and agricultural sector by this study Forestry form ALGAS, 1997.*
(*) Agriculture includes only rice cultivation and livestock sub sectors

(**) Not including emissions from industrial processes and waste, which occupied about 6.2% (6.4 million tons) in 1994?

The National Greenhouse Gas (GHG) inventory of 1994 was carried out for the following main emitters: energy, industry processes, forestry and land use change, agriculture, and waste sector. The methodology of inventory follows the guidance of IPCC version 1996, and complies with the guidelines for preparation of National Communications for Non-Annex I Parties.

Table 1.5. GHG inventory in 1994

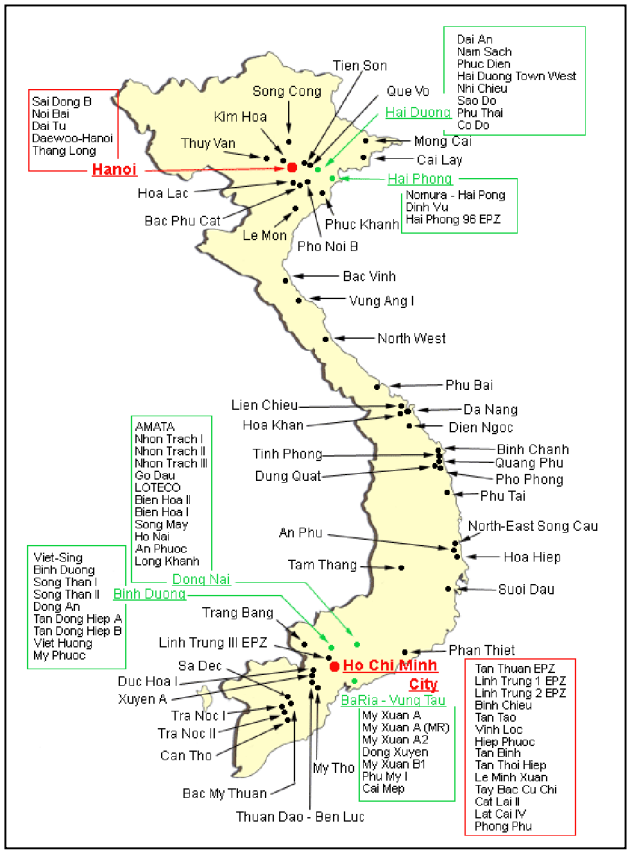
Sector	Amount CO2 equivalent (thousand tons) (CO2+CH4+N2O)	(%)
1. Energy	25,637.09	24.7
2. Industrial processes	3,807.19	3.7
3. Agriculture	52,450.00	50.5

4. Forestry and land use change	19,380.00	18.7
5. Waste	2,565.02	2.4
Total emissions	103,839.30	100.0

Based on BAU scenario, estimated GHG emissions for 2010 is 140 million tons and for 2020 are 233 million tons of CO2 equivalents.

1.6. Industry

Viet Nam's energy endowments including, coal reserves (37 billion tons/ 3.88 billion tons proven), oil (2.3 billion tons/ 615-967 million tons proven), gas (1,300 billion m3/ 600 billion m3 proven), and hydro (300 billion kWh/ 50-70 billion kWh technical-economical potential).



Viet Nam, with GDP growth of 8% in recent years and forecast growth at 7%, Viet Nam's, demand for energy will be continue to grow rapidly. Final energy consumption in Viet Nam was 17.8 million TOES in 2004, which represents an annual average growth rate of 10.8% since 1991. Viet Nam is expected to achieve an annual average growth rate of 7.0-7.5% from now to 2010 and about 7.0% over the period 2011-2020 Viet Nam exports coal and crude oil and imports petroleum products.

Future energy policy considerations in Viet Nam include, social economic development, security and defense, energy independency, regional energy cooperation, safety and efficiency, environmental pollution, a open and competitive energy market, investment incentives, energy for rural and mountainous areas, and science and technology development. In addition, the Government is also formulating investment policies and incentives for energy development and seeks to diversify investments in using tools such as BOT, BTO, JV, IPP to mobilize various capital sources at home and abroad.

In 5 years from 2000 to 2004, industry continues to be developed (see table 1.6; its production structure and quality of products have been improved.

Industrial activities consist of mining and quarrying; manufacturing and production and distribution of electricity, gas and water.

Table 1.6. Growth rate by economic sectors (at constant 1994 prices)

(%/year)

Type / Year	GDP	Agriculture, forestry and fishery	Industry and construction	Service
2000	6.79	4.63	10.07	5.32
2001	6.89	2.98	10.39	6.1
2002	7.08	4.17	9.48	6.54
2003	7.34	3.62	10.48	6.45
Prel.2004	7.69	3.5	10.2	7.47

Source: Viet Nam Statistical Yearbook, 2004.

During 2000-2004, the value added of the industry sector had the highest annual growth rate, 10.13% per year, and increased sharply from VND 96,913 billion in 2000 to VND 142,601 billion in 2004.The growth rate of industry was always higher than GDP.

The industrial output value in 2004 was worth VND 354,030 billion (1994 price) increasing by 10.2%. Main industries still maintained their output and high growth rates: coal 16%, crude oil 15%, natural gas 114% etc.

Industry and construction: The investment requirement is estimated as VND 370 – 400 thousand billion, of which, the funding requirement for

a) electricity is VND 85 – 95 thousand billion;

b) cement is VND 30 – 35 thousand billion; chemicals and fertilizer is VND 58 – 65 thousand billion;

c) oil and gas is VND 55 – 60 thousand billion.

Efforts are to be made in supporting investment, renovate technology, modernize production sectors in stages, and firstly develop the sectors that have competitive advantages, win over the domestic market and vigorously promote export such as processed agricultural, fishery and forestry products, textiles, leather, shoes, electricity and information technology products, selected machinery and consumer products. Build in selective manner some heavy industry facilities (oil and gas, metallurgy, manufactures, basic chemicals, fertilizer, construction material, etc) information technology and telecommunication industries.

- To rapidly develop industries capable of promoting their competitive advantages, taking hold of domestic markets and pushing ahead exports, such as agricultural, forest and aquatic product processing, garment, leatherwear and footwear, electronics and informatics, certain mechanical products and consumer goods, etc.
- To selectively build a number of heavy industry establishments: petroleum, metallurgy, mechanical engineering, basic chemicals, fertilizers, and building materials, etc. in rational sequences conformable with the capital, technology and market conditions, and capable of promoting efficiency.

- To vigorously develop hi-tech industries, especially information, telecommunication, electronic and automation technologies.
- To give priority to turning the informatics software industry into an economic sector with an outstanding growth rate.
- To develop necessary defense industry units, combining defense with civil industries.
- To plan for a rational industrial apportionment nationwide. To efficiently develop industrial parks and export processing zones, set up a number of hi-tech zones, and form major industrial clusters and open economic zones.
- To extensively develop small and medium industrial establishments with diverse trades and crafts. To renovate and upgrade the technology in existing establishments with a view to improving productivity, quality and efficiency. To appropriately apply potentially labor-intensive technologies. To develop various forms of integration among small, medium and large enterprises, among raw materials production and product processing and marketing on the basis of ensuring harmony of interests. To increase the local contents in subcontracting and assembling industries. To enhance operations for product quality control, industrial property ownership protection, and environmental protection.

1.7. Energy

Viet Nam has the potential to become a regional coal, oil and natural gas supplier. Ongoing exploration has led to several coal, oil and gas discoveries in recent years. Much of Viet Nam's large population relies heavily on *non-commercial* biomass energy sources such as wood, dung, and rice husks. As a result, Viet Nam's per capita *commercial* energy consumption ranks among the lowest in Asia. The country's commercial energy consumption is predicted to rise in coming years, primarily due to increases in the use of natural gas.

OIL : Viet Nam has 600 million barrels of proven oil reserves, but that total is likely to increase as exploration continues. Crude oil production averaged 403,300 barrels per day (bbl/d) in 2004, making Viet Nam the third-largest oil producer in Asia.

NATURAL GAS : Viet Nam has proven gas reserves of 6.8 trillion cubic feet (Tcf), but is expected to contain up to 10 Tcf. Viet Nam's natural gas production and consumption are rising, with further increases expected as additional fields come on-stream. Natural gas is currently produced entirely for domestic consumption. The Cuu Long basin, a source of associated gas from oil production, is the largest Viet Namese natural gas production area.

COAL : Viet Nam contains coal reserves estimated at 3.6 billion tons, the majority of which is anthracite. Production has increased dramatically, with Viet Nam producing over 14 Mt in 2002, 11 Mt more than in the previous year. As a result, Viet Nam exported a record 5 Mt of coal, primarily to Japan and China , in 2002. Other export markets for Viet Namese coal include Thailand , the European Union, Mexico , and Brazil . Vinacoal hopes to produce 30 Mt of coal in 2005, exporting at least 11 Mt.

ELECTRICITY: Although Viet Nam's per capita electricity consumption is among the lowest in Asia , demand has risen in recent years, straining the country's limited generating capacity. Rapid commercial sector growth, population migration to major cities, and elevated living standards has all contributed to a growing demand for electricity. In 2002, Viet Nam had a total electric generating capacity of 8.3 gig watts (GW) and generated 34.5 billion kilowatt-hours (kWh) of electricity, of which 60% was hydropower.

In the Viet Nam energy structure in 2004, oil occupied 46.5%, coal 34.5%, hydropower 9.4% and gas 9.6%. Total energy exploitation has increased from 7.1 MTOE in 1990 to 43.6 MTOE in 2004, in which:

- Clean coal production has increased from 4.5 million tons in 1990 to 25.05 million tons in 2004 with the average annual growth rate of 22.7%.
- Crude oil exploitation has increased from 2.7 million tons in 1990 to 20.3 million tons in 2004 with the average annual growth rate of 15.5%.
- Natural gas exploitation reached approximately 4.67 billion m^3 in 2004.
- Electricity generation has increased from 8.7 billion kWh in 1990 to 46.2 billion kWh in 2004 with the average annual growth rate of 12.7%, in which hydropower has increased from 5.37 billion kWh in 1990 to 18 billion kWh in 2004. Commercial electricity has increased from 6.2 billion kWh in 1990 to 39.7 billion kWh in 2004 with the average annual growth rate of 14.2%.

In past ten years, economy of Viet Nam increased quickly with average growth rate of 7% per year. In order to meet the energy demand of the national economy in general and electricity demand in particularly. The energy sector has developed a lot of big projects in coal, oil, gas, and electricity sub sectors.

By the end of 2004 Viet Nam had a installed power capacity of 11.000MW, generated about 46 TWh; coal production achieved 27 mill tones, oil production is 20 mill tones; average growth rate of energy is over 10% per year.

However efficiency of energy use in economy and household sectors are still low. Energy intensity for GDP is higher than countries in region.

The Viet Nam was a good model for energy investment, with several examples of good investment. Viet Nam is process of opening its policies for economical development so have to build development programs, mend and make new regulation, reform institutions and administration etc.

Energy consumption of Viet Nam is quickly creasing. Research results of the National projects on energy saving and efficiency, such as National project on energy conservation in period of 1994-1997, National program of energy in period of 1996-2000 headed by MOSTE and some subprojects on DSM, lighting, headed by Ministry of Industry in recent years, showed that energy saving potential in a lot of energy use is very big. Government and also many relevant sectors are concerning to create good conditions for implementation of energy efficiency. (Decree No 02/2003/ND-CP dated 03 September 2003 on "efficient and saving energy use"). Country target program on saving and

efficiency energy use in period of 2006-2015 is prepared by Ministry of Industry and relevant others and submitted to the government, foreseeing to begin in 2006 year. Target of program: enhance awareness, promote and compel to implementation saving and efficient energy use.

1.8. Agriculture

Viet Nam is an agricultural country, 80% of its population are involved in agriculture. The arable area is 7.3 million hectares, equals 22.2% of the country total land. Population density is 234 people/km^2 in 2000.

Versatile and various climates of the regions create a variety of vegetation and domestic animals (originated in the temperature area, sub-tropical and tropical areas). Droughts in the dry season, flood and storm in the rainy season, effected regularly to agricultural production.

Viet Nam has 13 main soil groups in which the red-yellow soil occupies 15.8 million hectares, the alluvium soil, the grey soil, the alum and salted soil covered 2.93, 2.48,2.14 and 0.99 million hectares respectively (data from the National Institute for Agriculture Planning and Projection).

Viet Nam is predominantly an agricultural economy based on food crops, industrial crops and livestock husbandry. The ratio of agricultural production in the total economy has gradually been declining with the growth of the economy. The average growth rate of gross agriculture production for 1995-2000 is 4.4% p.a. Within the agricultural sector, the ratio of cultivation sub-sector and the animal husbandry was 79% and 18% respectively in many years. However since 2000, these figures have started changing to 78 and 19 percent. The increase in animal husbandry share in gross agricultural output value under the condition of continuous growth of absolute value in cultivation is of great significance.

Targets for the period to 2010:

(1) Agricultural value growth rate: 4-4.5%/annum, GDP growth rate: 3.3 –3.5%/annum.

(2) Rural economy growth rate: 7.5-8%/annum.

(3) Forest coverage: 43-44% of the total natural space, of which the coverage of special - use forest and protection forest is 43-45% of the total forest land space.

(4) Assurance of national food safety to meet the diverse demand of the people for foods and provisions and special attention paid to the ethnic minority people in the mountainous and remote areas; 45 million tons of production of food seed, of which there are 39 million tons of rice and 6 million tons of corn.

(5) Established comparative advantages to be promoted along the promotion of export and improvement of export quality. By 2010, the value of agricultural and forestry export will reach USD 7 billion (increased by 12%/annum on average).

(6) Making best use of available conditions in combination with scientific and technological advances to develop further production of plants and animals to substitute

imports and exploitation of the domestic market for products such as cotton, tobacco leaves, corn, soya bean, cooking oil, paper material, milk etc…

(7) Rural economic structure:

- Agriculture : 50%;
- Industry, small industry and handicrafts, services: 50%

(8) Value of production on 1 ha of agricultural land : VND 30 million/year;

(9) GDP per capita in rural area : 2 times that of 2000;

(10) Agricultural labour : 50% of the rural workforce.

Estimated investments for the period 2006 - 2010 are:

	Total investment (Billion VND)	To be directly managed by the MARD (Billion VND)
Total 5 years	**146,050**	**30,580**
Irrigation	37,900	20,600
Agriculture	7,300	4,000
Forestry	30,000	3,400
Sald Industry	3,000	1,000
Research	2,000	1,000
Training	800	600

1.9. Forestry

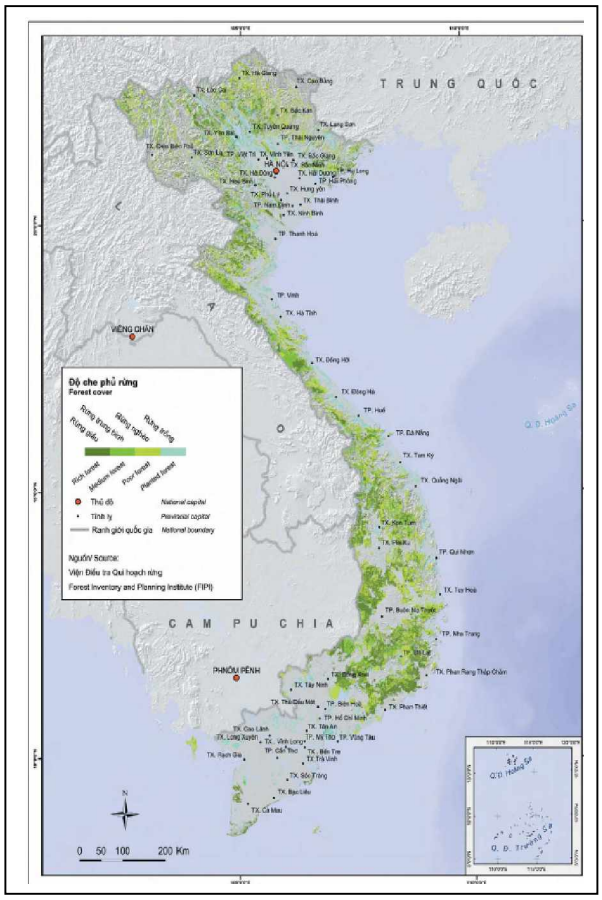
Viet Nam has a total area of 331.123 km2. According to 2004 estimates, currently 36 percent of the country's land is covered by forest. In 2003, Forests have been classified into 3 categories: production forests, (watershed) protection forests, and special use forests, which covers forests managed for biological diversity conservation and protected for other purposes. Most recent data indicates that 4.6 million hectares are classified as production forests, 5.7 million ha as protection forests, and 1.8 million ha as special-use forests. In condition of existing forest areas in 2003 following:

No.	National/ Agro-Ecological zone/ Province	Percentage of forest coverage (%)	Total forest areas designated as national permanent forest estate (ha)	Area of production forest (ha)		Area of protection forest (ha)		Area of special use forest (ha)		Shifting cultivation areas (ha)
				Natural	Planted	Natural	Planted	Natural	Planted	
	National	37.1	19401085	3087651	1232658	4585564	748558	1611323	96192	653188
1	Northern mountain and highland	41.37	7648332	699425	518672	1960082	263499	334026	21320	365660
2	Red River Delta	12.97	169496	1143	12827	21225	35686	36846	20732	590
3	Northern Central	45.19	3738471	522624	250267	894999	159339	491666	9273	20276
4	Southern Central Coast	39.56	2928805	414030	156513	853958	118226	182249	8743	76749
5	Central Highlands	54.88	3830700	1353332	82663	718617	34689	431486	9808	173996
6	Southeast South	19.09	603473	96165	50021	110457	85062	96214	10616	7205
7	Mekong River Delta	8.46	481808	932	161695	26226	52057	38836	15700	8712

However, this is under review and in the process of being completed. According to initial surveys, there are about 20 planned protected areas that are not organized or managed. Therefore, they are being seriously degraded and no longer meet the criteria for SUFs.

Initially, Viet Nam was richly endowed with high-quality forest, covering virtually the whole country, but by 1943 the forest cover of Viet Nam had been reduced to only 14,3 million (M) ha, or 43 % of the national land territory. Subsequently, the total forest decreased very rapidly, especially during the war and the period of 1976-1985. Beside forest loss, every year, thousands hectares of the forests are degraded.

As of February 2003, there were 126 special-use forests (SUF) planned and gazette covering 2,541,675 ha in area (according to decisions issued by the Prime Minister, related ministries and Provincial People's Committees). The current SUF system is classified as follows:



Category	Number	Area (ha)
I. National Park:	***27***	***957,330***
II. Nature Conservation Areas:	***60***	***1,369,058***
IIa. Nature Reserve:	49	1,283,209
IIb. Species/Habitat Areas:	11	85,849
III. Land/Seascape Areas:	***39***	***215,287***
Total	**126**	**2,541,675**

Forest loss and degradation are major reasons for desertification and land impoverishment, creating a wide range of negative impacts and challenges for economic development, the society, and its environment, such as causing more serious flooding and drought, creating difficulties in forest product supply, reducing arable land, and finally worsening rural poverty and unemployment.

Major national programmes for afforestation, reforestation, and improved forest management have included Programmes 327, 556, and 661. In 1993, the Government started the Programme 327, "Regreening Open Land and Barren Hills," for the period 1993-2000, with the objective to afforest barren land and open treeless hills throughout Viet Nam. In 1995, a revised programme, named Programme 556, was adopted.

In 1998, National Assembly agreed to adopt the ambitious 5 Million Hectare Reforestation Programme (5MHRP) for the period of 1998-2010. The 5MHRP is implemented by the Government's Decision 661 (and thus often referred to as Programme 661). This decision was further endorsed by the Ninth Party Congress. The 5MHRP is estimated to cost about US$ 2,5 billion. The main objectives of the 5MHRP are as follows:

- Establishing and restoring 2 M ha of protection forests and 3 M ha of production forests to increase the forest cover to 43% by 2010, to ensure environmental protection requirements;

- Ensuring the forest products supply for development (every year 15 M m3 of timber and 20 M steres of fuel wood), thereby reducing the pressure on natural forests; and
- Implementing efforts for poverty alleviation, hunger eradication and development of rural mountainous areas, by creating forestry-related employment for 2 M people, and increasing the income of people living in forest areas.
- Prior to the establishment of Programme 327, Government estimated that the forest cover had declined to 28,2 % in 1990. According to 1999 national statistics, the total forested area was 10.88 million ha, of which 9.5 million ha were natural forest and 1.39 million ha were plantations, while the bare hilly land was as much as 9.0 million ha. In 2003, the total forested area is about 12.094 million ha, of which 9.878 million ha are natural forests and 1.914 million ha are plantations.

As of 2003, the 5MHRP has achieved approximately 2 million out of the planned 5 million ha of improved forest management or rehabilitation. The majority of the achievements have been in the area of protection and special use forests, whereas performance for the production forests is lagging behind the targets. Consequently, the Ministry of Agriculture and Rural Development is now undertaking a study to look at how the implementation of the 5MHRP can be improved.

According to official statistics, forest cover has increased by 1.5 million ha, reaching 36,1% in 2004 (MARD 2004). Nonetheless, it is generally acknowledged that the quality of natural forests continues to be degraded. Among the production forests, currently only 9% are classified as rich forests (with the timber volume of 150 m3/ha) and 33% as medium forests (with the timber volume of 80-150m3/ha).

Forestry's contribution to the national economy is under-valued. The official estimates are that forestry contributes only about 1 % to GDP. Such estimates, however, do not account for forestry's contributions to industrial production, firewood (which contributes 7% of national energy needs) or to a range of environmental goods and services, such as carbon sequestration, eco-tourism, or biological diversity conservation. These figures also do not include the contribution of timber extracted "illegally," which could account for over 50% of national round wood supply.

The forest sector has been actively engaged in preparation of its 5-year plan (2006-2010), to serve as a contribution to the MARD 5-year plan (5YP) and National Socio-economic Development Plan (NSEDP). In line with the CPRGS, as well as the forthcoming National Forest Strategy, the forest sector 5YP focuses on achieving goals of economic growth, environmental sustainability, improvement of social conditions including poverty reduction, and improved forest sector management. Considerable efforts have been taken to link the 5-year planning process with the preparation of the new National Forest Strategy, which will include action plans to implement the strategy (with a detailed plan for the first 5 years).

Some Possible Success Indicators for 2005

- Forestry, Poverty, and Rural Livelihoods Study completed
- Forestry and Gender issues study completed
- Outputs of poverty and gender studies provide inputs into new strategy

- New National Forest Strategy (2006-2020) adopted by Prime Minister
- New strategy used to guide preparation of 5-year forest sector development plan for 2006-2010, with more focus on how the forest sector can contribute to CPRGS implementation and national socio-economic development
- 5 Million Hectare Reforestation Programme (Decision 661) revised
- Trust Fund for Forests supporting one or more full-sized projects focusing on forestry-poverty linkages and/or other key TFF strategic priorities
- Forest Sector Monitoring and Information Systems (FOMIS): sectoral monitoring system being piloted, and improved, including indicators on poverty in forest-dependent districts
- Support to SFE reform, with a particular focus on reallocation of forest land currently allocated to SFEs to local communities and households
- Strategy prepared to improve research, extension, training, and education linkages
- Improving support to communities and households allocated forest land, i.e. extension, credit, seeds and seedlings, forest management guidelines, etc.
- Decentralisation of key forest sector and FSSP activities, with a particular focus on the northern uplands and central highlands. Activities may include:
    - Support to regional networks
    - Support to the national community forestry working group
    - Support to allocation of forest lands to communities

Review of Legislative and Institutional Framework

Viet Nam has no specific legislation or policy on climate change adaptation technologies in the very strict sense. However, there are laws, guidelines, standards and related policies, which one would need to take into account if there is an intention to introduce a new technology into the Viet Nam. The focus of this section is therefore not on TNA and adaptation technology transfer in stricter sense but on institutions, policies, guidelines and related framework that may be relevant to adaptation technology transfer.

The Viet Nam Government has issued specific policies in accordance with viewpoints and orientations on sustainable development in general and environmental sound technology in particular as defined in laws and the national socio-economic development strategy. These policies are defined in State management documents and promulgated according to the decentralization and power of administrations at different levels of the State management system. For example, the Government issues Decrees and the Prime Minister's decisions, Ministries (Ministries of Industry, Science and Technology, Planning and Investment, Finance…) promulgate circulars, inter-ministerial circulars, Ministers' decisions while provincial and city People's Committees issue regulations, rules and regulations of Chairmen of provincial and city People's Committees…..

Existing legal documents governing environmental protection include laws and sub-law documents such as decrees, decisions, circulars, directives, regulations… issued by state management agencies (Government, ministries, provincial and city authorities…) in accordance with their power. Existing laws which are directly related to climate change adaptation and environmental sound technologies include:

- The Law on Environmental Protection (1993, 2005)
- The Law on Natural Minerals (1996)
- The Law on Water Resources (1998)
- The Fisheries Law (2003)
- The Law on Oil and Gas (1993)
- The Law on Forestry Protection and Development (1991,2004)
- The Land Law (2003)
- The Civil Code (1995)
- The Penal Code (1999)
- The Law on Enterprises (2000)
- The Law on the Protection of People's Health (1989)
- The Law on the Encouragement of Domestic Investment (1999)
- The Law on Foreign Investment (2000).

The Government's Decree No.45/1998/ND-CP issued on July 1st, 1998 governing technology transfer states that technologies, which are not allowed to be transferred in Viet Nam include " those which fail to meet the requirements defined in Viet Namese laws in respect of occupational safety and health, human health and environmental protection" (Article 5).

Other Government documents including Decree No.51 /1999/ND-CP dated July 8th, 1999 governing the enforcement of the revised Law on Encouragement of Domestic Investment and Decree No.24/2000/ND-CP dated July 31st, 2000 governing the enforcement of the Law on Foreign Investment in Viet Nam also include similar prohibitions and discouragement.

At the central Government level, regulations on incentives and encouragement of clean technology are mostly clarified and concentrated in Decrees No.51/1999/ND-CP and Decree No.24/2000/ND-CP. Clean technologies and incentives and preferential for clean technology are defined in frames 4,5 and 6.

Frame 4: List of clean technologies subject to incentives and preferential treatment according to the Law on the Encouragement of Domestic Investment

- Production technologies using less energy, materials and fuels or reducing the volume of waste over a product; technologies which create products which consume less energy, fuel and materials than those of the same type.
- Clean technologies and technologies using or producing equipment which use wind, solar, geothermal, tide energy.

Source: Government Decree No.51/1999/N§-CP dated July 8th 1999 governing the implementation of the revised Law on the Encouragement of Domestic Investment

Frame 5: Regulations governing preferential for clean technology in domestic investment in Viet Nam

Article 21: Duration for the exemption and reduction of corporate income tax.

- Exemption for 3 - 4 years and reduction of 50% for 5 years

Article 20: Exemption and reduction of corporate income tax

- Tax preferential of 15 - 25%

Source: Government Decree No.51/1999/N§-CP on July 8th 1999 governing the implementation of the revised Law on the Encouragement of Domestic Investment.

Frame 6: Regulations on import, export and transfer of environmental friendly technologies in Viet Nam.

Article 72: Requirements for imported equipment, machines, and materials

1. Equipment and machines imported into Viet Nam for the implementation of projects must ensure standards, quality and be suitable to the requirements of production and environmental protection.

Article 80: Protection and encouragement of technology transfer

c. Saving materials and fuel; exploiting and using natural resource efficiently

Transfer of technologies, which have negative impact on the ecology and environment is prohibited.

Source: Government Decree No.24/2000/N§-CP dated July 31st 2000, governing the implementation of the Law on Foreign Investment in Viet Nam.

Apart from incentive and preferential policies for clean technology, the Government has also adopted tough measures to force industries causing severe pollution to renew technology toward environmental friendliness. On April, 22nd 2003, the Prime Minister issued Decision No.64/2003/QD-TTg approving a plan to dealt with establishments

which cause serious environmental pollution, under which relevant central and local agencies make a list of such establishments according to specific and consistent criteria. These establishments are requested to settle the problem by closing their production or moving to another area or applying environmental sound technologies or installing waste treatment systems. Among these solutions, the application of environmental sound technologies or the installation of climate change adaptation technology are especially encouraged. Technological innovation and climate change adaptation are also required even in the event that the industry moves to another area.

Education, training and public awareness

In recently years, Viet Nam is carrying out environment education programmes in universities and vocational schools.

Some universities in Viet Nam offer training of environmental engineers including engineers of environmental technology (Table 1.7).

Table 1.7. Universities offering training of environmental technological engineers in Viet Nam

Order	Universities	Training	Starting year
1	The Hanoi Construction University	Environmental engineers	1964
2	The Hanoi University of Technology	Engineers of environmental technology	1990
3	The HCM city University of Technology	Engineers of environmental technique	1981
4	The HCM city Van Lang University	Engineers of environmental technology and management	1995
5	The Hanoi Dong Do University	Environmental engineers	1996
6	The Hanoi Architecture University	Engineers of infrastructure technique and urban environment	1998
7	The Hanoi National University	Bachelors of environmental science	1995
8	The Hue University	Bachelors of environmental science	1995
9	The Hanoi National Economics University	Bachelors of economics and environmental management	2000

Training workshops on cleaner production and technology are mainly organized by the Viet Nam Cleaner Production Center with financial and technical assistance from international organizations (UNIDO, UNEP, UNDP…).

To date, the Viet Nam Cleaner Production Center has granted certificates of cleaner production to 100 trainees, across the country, who serves as an important initial human resource base for expanding and promoting the application of cleaner production and technologies.

Furthermore some short-term training courses on CC were organized for teachers and students from technical universities and for environment management officials from local, central agencies and enterprises. Many publications on CC, including the United Nations Framework Convention on Climate Change (UNFCCC), Kyoto Protocol, Climate change information documents, pamphlets...etc. are delivered to various experts and people through meetings, conferences, workshops, etc.

In the long term, Viet Nam is planning to integrate CC issues into education programmes. Many direct and indirect activities contribute to raise the public awareness on CC, such as:

- TV and radio programmes on CC broadcasted on central and local TVs and radio stations.
- "Energy Saving Programme" carried out by Ministry of Science, Technology and "Renewable Energy Programmes" by Ministry of Industry.
- "National Environment Week" organized annually to encourage people to participate in the environment protection activities.

In spite of these, only few people have received basis training on CC issues, many people still have a limited knowledge on CC. So that there are needs to work out and to implement a comprehensive national public awareness campaign on CC. The main goals of the campaign are to rise up public awareness on CC with the proposed strategy as follows:

- Encourage policy makers, managers to integrate CC issues in decision making process.
- Enhance public awareness and understanding of the science of CC and its potential impacts.
- Promote actions to support policy measures in GHG mitigation and adaptation to CC.
- Improve the expertise on technology transfer for specialists and technical staffs.

CHAPTER 2

THE TECHNOLOGY NEEDS ASSESSMENT PROCESS

Background

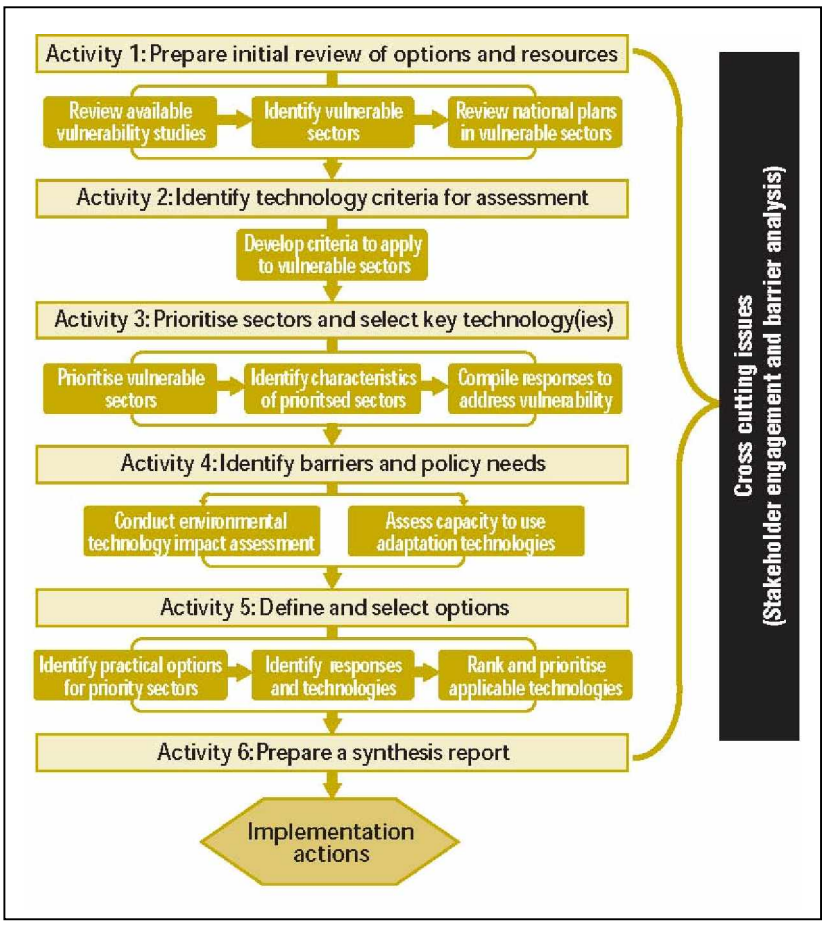
Article 4.5 of the UNFCCC states that developed countries who are members of the UNFCCC "shall take all practicable steps to promote, facilitate, and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other parties, particularly developing country parties, to enable them implement the provision of the convention."

Prior to the UNFCCC era, technology transfer had occurred in all socio-economic sectors but the focus was not to address climate change through adaptation to and mitigation of climate change although indirectly some of them met the climate change needs.

Article 4.5 further enhances the process of technology transfer to meet the UNFCCC objective. Technology transfer will also enhance the diffusion and use of appropriate technologies for the purposes of adaptation to and mitigation of climate change.

This section describes what is required in undertaking a TNA. Essentially, the process involves a common set of organising activities that should be closely linked to other relevant national development processes. At its heart, the TNA process should reflect national response to climate change technology needs that is informed by the private sector, the general public, and other stakeholders.

The TNA process directly addresses the question: "What are the key actions, priorities, and criteria with respect to GHG mitigation and adaptation to climate risks?". The Framework of Modified Technology Needs Assessment Activities, as Applied to Adaptation, which are illustrated in Figure below. The arrows between the activities should not be interpreted as indicating a fixed sequence of tasks, but rather as suggesting important conceptual links.

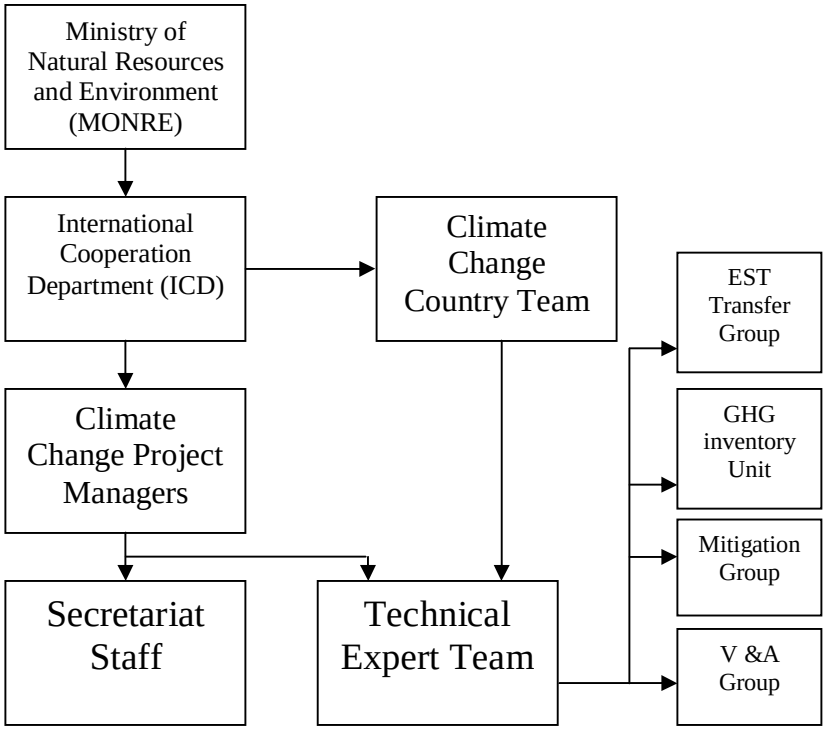


Institution Coordination Organization

After ratifying the UNFCCC, the Government of Viet Nam has assigned the Hydro-Meteorological Service (HMS) of Viet Nam, nowadays Ministry of Natural Resources and Environment with its ICD as a National Focal Agency Authority for taking in and implementing UNFCCC and KP in Viet.

The present institutional arrangement in the context of climate change is described in below chart:

CNECB's Meeting



It closely coordination with relevant government agencies, public institutions and private stakeholders, ICD of MONRE has been executing as coordinator and manager of almost all climate change projects. In addition ICD also implemented a great number of activities for raising public awareness and training expertise on CC with the support provided by working groups of experts from the ministries, departments, researches institutes, NGO's.

Stakeholder Engagement

Assessing the need for technology occurs through policymaking and decisions made among stakeholders –individuals, groups, organisations (e.g., government agencies, NGOs), and networks. The TNA process considers stakeholders as fundamental, since it is stakeholders who will sustain the implementation process.

The purpose of this step within the TNA is to ensure that key stakeholders are fundamentally engaged. The term 'key stakeholders' refers to those affected by climate change and those positioned most effectively to advance mitigation and adaptation priority actions

The Identify Stakeholders provides a starting point for identifying the range of stakeholders that should be consulted in a technology assessment. The extent to which all are represented will differ by country, but it is important that as many of these types of stakeholder as possible are involved from an early stage. As a practical matter, since such a large number of people are legitimately classified as stakeholders in some of these. The taskforce team identified a list of stakeholders that included government institutions, private sector, NGOs, academia, faith groups and international technical donors and institutions.

Government Departments and Agency with responsibility for policy formulation and regulation, management, includes:

Organization	Sub bodies	Role
Ministries		
MONRE	International Cooperation Dept.	National Focal Point Agency
	National Environment Agency	Environment monitoring
	Environment Dept.	Environment management
	Dept. of Hydrometeorology	Hydrometeorology management
	National HMS	Climate change monitoring
MOI	Dept. of Energy&Petroleum	Energy, RE management
	Dept. of Science&Technology	EE&ES management
MOST	Dept. of Science&Technology of industry	Science&Technology development in Industry
	Dept. of Science&Technology of Agriculture&forestry	Science&Technology development in Agriculture &Forestry
MPI	Dept. of Science, Technology, Education and Environment	Project validation
MOFA	Dept. of International organizations	Focal Point of foreign policies
MOF		Financing policies, fund, finance incentives
MARD		Agriculture, forestry and rural development
MOT	Dept. of Science&Technology	Environment management in transport
	Viet Nam Register	Gases pollution control of transport means
Provinces and cities		Local management

Sector industries, associations, and distributors (Households, small businesses, and farmers**)** that are involved in the provision of utility services (i.e., responsible for GHG emissions) or are sensitive to climate change impacts (e.g., tourism, agriculture, industry,

transport, water resources, forestry, …) and involved in the manufacture, import, and sale of environmentally sound technologies or other hard or soft technologies, appropriate for mitigation or adaptation and using the technologies and practices in question, and/or who are or could experience some of the effects of climate change, includes:

Enterprises	Sub bodies	Role
State owned at National level		
EVN	Dept. of Science& Technology	New tech. introduction
	Regional Companies	Elec. Transmission and distribution
	Dispatching Center	Data
	Power plants	End users
Cement Corporation	Dept. of Science&Technology	New tech. introduction
	Cement plants	End users
VINASteel (Steel Corporation)	Dept. of Science&Technology	New tech. introduction
	Steels plants	End users
VINACoal (Coal Corporation)	Dept. of Science&Technology	New tech. introduction
	Coal mines	End users
PetroViet Nam (Petro Corporation)	Dept. of Science&Technology	New tech. introduction
	Petro companies	End users
VINA Paper (Paper Corporation)	Dept. of Science&Technology	New tech. introduction
	Paper & pulp Mills	End users
Sugar Corporation	Dept. of Science&Technology	New tech. introduction
	Cement plants	End users
Other Entities		
Provincial level	Companies	End users
Private sectors	- Domestic companies - Foreign invested companies - Joint venture companies	End users
Finance	- State banks - Private and foreign banks - Funds	Financing
Foreign counterparts	- Carbon funds - Investors - Carbon buyers	Co-project developers

Institutions International organisations and donors Country divisions of international companies NGOs Labour unions, consumer groups, and media involved with the promotion of environmental and social objectives and that provide technical and scientific support to both government and industry, e.g. academic organisations, industry R&D, think tanks, consultants, etc., and responsible for investments of critical importance to climate policy, e.g., the energy sector, agriculture, forestry

The multilateral organizations such as WB, UNDP, UNEP, GEF, ADB, UNIDO, ESCAP, etc. and The bilateral counterparts NGOs important role in the field of climate change.

During stakeholder consultations, a Taskforce Technology Team with a chairperson was formed to lead the foundation of the technology transfer and needs assessment. Through consultations the Institutional Arrangements were agreed upon as follows:

- Institute of Energy
- Institute of Forestry Planning and Inventory
- Institutes of Agriculture Science
- Institute of Water Resources
- Institute of Brewery
- Institute of Mine Science Technology
- Universities of Politechniques (Hanoi, HoChiMinh, Danang).
- Universities of Forestry (Hanoi, Ho Chi Minh).
- Viet Nam Academy of Science&Technology
- Viet Nam Academy of Social Science

And others organizations. As Women Union, Young Union, Science technologies Associations, Farmer Union, etc.

Initial Technology Transfer and Needs Assessment Consultative Workshop.

An initial national consultative workshop for a wide range of stakeholders was held in Ha Noi, November 2004 at which h the scooping paper on climate change technology transfer and needs assessment in Viet Nam was presented. In addition some invited stakeholders were requested to prepare and present papers at the workshop.

The Third Workshop on “Technology needs assessment for GHG emission reduction”

The consultative workshop produced a number of outputs vital for the technology transfer and needs assessment process in the Viet Nam. The following are some of the outputs:

- Endorsement of the technology transfer and needs assessment process
- Stakeholders agreed on sectors to be considered
- Criteria for selection of the national technologies agreed upon

- The initial identification and prioritisation of technologies was undertaken
- Technology taskforce steering team endorsed
- Outline of the climate change technology transfer and needs assessment developed
- Chapter authors and peer reviewers identified

Criteria Establishment for Selecting Technology Priorities.

Criterions of technology needs identification for identification of technology needs is very important task in terms of prevention of the dangerous consequences of climate change. This is mainly explained by the necessity to efficiently use the natural resources of Viet Nam.

At the most general level, the criteria for selecting sectors and technologies for TNA will depend upon three factors, which are not necessarily mutually exclusive:

- **Contribution to development goals.** How much overlap exists between the technology and the already identified technology needs?
- **Contribution to climate change mitigation or adaptation.** How effective is the technology in reducing GHG emissions and/or increasing resilience to the impacts of climate change?
- **Market potential.** Is there a ready niche for the technology?

Each of the above factors in turn will entail deeper levels of analysis depending on the sector, and technology in question. For example, the contribution to development goals will likely involve an analysis of the benefits involved (e.g., food security, health improvements, protection from natural disasters, social acceptability, and potential for reducing non-climate impacts). An important consideration here is the environmental and cultural impact of the technology and may entail a more detailed analysis of climate change adaptation technology impact assessment.

The contribution to climate change mitigation will involve a quantification of the GHG emission reduction potential and/or the enhancement of carbon sinks. The contribution to climate change adaptation will likely involve an assessment of the degree to which climate change-related risks can be reduced.

The contribution to market potential will likely involve an analysis of capital and operating costs relative to alternatives, the commercial availability of the technology, and the technology's replicability, applicability, adaptability, and potential scale of utilisation.

Through a consultative process held at a scooping workshop, stakeholders agreed to use the three basic globally accepted criteria namely: Development benefits, Implementation potential and lastly Contribution to climate change response measures and goals. The basic criteria were sub-divided for depth and completeness taking national strategy on sustainable development into consideration as follows:

Table 2.1. Criteria for technology need assessment

Code	Key criteria	Sub criteria	Criteria content
A	Environment protection	A1. GHG reduction potential	The study is specialized in GHG reduction technologies
		A2. Local environment quality	Reduction of solid waste, liquid waster and air pollution-SD
		A3. Biodiversity and resource conservation	Mineral, water, land, forest and bio resources-SD
B	Economic development	B1. Initial investment	Specific investment-Investment per product. National circumstance: lack of capital
		B2. Payback period	High IRR – National circumtance
		B3. Low O&M cost and intensive	National circumtance
C	Good social impacts	C1. Good impacts to sioeconomic development of locals	Improving local education, health care, job creation, poverty reduction, etc.- SD
		C2. Less barrier on prevalence practice, psychology	Good public acceptance and participation
		C3. Contributions to science technology capacity	Better tech. Transfer, localization, manpower development-SD
D	Tech. Development	D1. Advanced but established tech.	Mature commercialization. No second hand – SD and high adaptability
		D2. Appropriate tech (but established)	Effective deployment, O&M, exploitation-SD
		D3. Up scalling	SD

Following criterions are applied while selecting the climate change adaptation technology:

- Economic sectors, which are important in terms of reduction of GHG emissions;
- Share of the selected sector in the structure of GDP;
- Assessment of existing technologies;
- Interaction with the other technologies;
- Permanency of GHG emissions reduction;
- Quantitative reduction of GHG emissions obtained once the technologies change;
- Environmental, political and socio-economic importance of technologies;
- Further improvement opportunities.

Priority Sectors and Sub-sectors.

The stakeholders during consultative workshop identified and prioritised the 6 sectors in the Viet Nam as follows: Energy, Agriculture, Industrial, Forestry, Transport, Household Service. This prioritisation will be reviewed with time to cater for new developments.

Table 2.2. Key priorities sectors for TNA in Viet Nam

Sectors	Activities
1. Energy production and refining of fuel (including power generation)	1. Energy production 2. Energy transmission and distribution 3. Production, refining, storage and transportation of oil and gas 4. Fugitive gas and gas recovery 5. Renewable energy application
2. Industry	1. Ferric and non-ferric metallurgy 2. Building materials production 3. Ore-free mineral products 4. Chemical industry 5. Food industry 6. Textile
3. Transport	1. Road transport 2. Railways 3. Water transport
4. Household & Service	1. Usage of electrical energy and heat
5. Agriculture	1. Plant-growing 2. Husbandry 3. Residues
6. Forestry	1. Reforestation 2. Afforestation

The main measures for GHG emission reduction can be classified as following:

+ Energy:

- Energy efficiency and saving (EE&ES)
- Fuel switching
- Renewable energy application
- Fugitive emission sealing.

+ Forestry:

- Reforestation
- Afforestation
- Forestry protection

- Forest fire protection
- Deforest prevention

+ Agriculture:

- Water management of rice field
- Animal feed processing
- Biogas and residue utilization

The above mentioned subsectors are selected according to following requirements:

- GHG intensive emission
- Economic and social important role
- Data available

Table 2.3. Areas to be selected for technology needs assessment

GHG sources / Sectors	Energy consumption	Industry process	Agriculture	Forestry	Waste
Energy production & fuel refining	**X**	**X**			**X**
Industry	**X**	**X**			**X**
Household&Service	**X**				**X**
Transport	**X**	**X**			
Agriculture			**X**		**X**
Forestry				**X**	

The Information barriers for TNA

Lack of technological awareness is an important barrier to the widespread use of technological solutions in the country. This is expensive as it leads to wrong selection and application of technology. Even where there are technically competent personnel, they lack access to global information, resulting in sub-optional choices leading to poor design of projects. Lack of non-technical information such as banking and insurance information are crucial for investment decisions and impede technological program.

Some related studies also give similar evaluation revealed main barriers and hindrances in the promotion of climate change adaptation technologies in Viet Nam

- Lack of awareness of TNA principles and advantages of this approach in terms of climate change control among high-ranking managers and decision-makers. As a result, overall costs including environmental cost in are not calculated in investment decisions.

- Inadequate information about the concept of TNA on the mass media. Therefore, industries are not put under strong pressure to reduce the negative impact of their operations on human health and the environment.
- Lack of human resources that can provide consultancy on TNA and technology transfer of climate change adaptation.
- Lack of information about the status of TNA and available climate change adaptation technologies as well as new trends of technology, product markets and technology suppliers. In fact, there a numerous reports, announcements and even WebPages featuring successful research and technical information about adaptation technologies but most of them are presented as part of a certain project.
- Poor observation and enforcement of environmental regulations and policy. Existing environmental regulations and standards mainly aim to urge producers to adopt solutions to climate change adaptation technologies rather than to put pressure on them to do so.

Sectors	Activities	Data status
1. Energy production and refining of fuel (including power generation)	1. Energy production 2. Energy transmission and distribution 3. Production, refining, storage and transportation of oil and gas 4. Fugitive gas and gas recovery 5. Renewable energy application	1. Lack of data from private sectors, IPP and SPP 2. Good data 3. Good data. Fund needed 4. Poor data 5. Scattered and inconsistent
2. Industry	1. Ferric and non-ferric metallurgy 2. Building materials production 3. Ore-free mineral products 4. Chemical industry 5. Food industry 6. Textile	1. Good data. Fund needed 2. Only for main products 3. No data 4. Poor data. Fund needed 5. Poor data. Scattering. Fund need 6. Poor data. Scattering. Fund need
3. Transport	1. Road transport 2. Railways 3. Water transport	1. Poor data 2. Good data 3. Poor data
4. Household & Service	1. Usage of electrical energy and heat	1. Poor data
5. Agriculture	1. Plant-growing 2. Husbandry 3. Residues	1. Available. Fund needed 2. Available. Fund needed. 3. Very poor data.

6. Forestry	1. Reforestation 2. Afforestation	Poor data. Fund needed

Lack of markets for climate change adaptation technology in a market economy is commodities. In Viet Nam, a technology market has just taken shape and is in the initial stage of development. The Government of Viet Nam recognizes that the absence of a science and technology market is a deficiency and a major obstacle in the development of science and technology. The Government of Viet Nam aims to speed up the establishment and development of the technology market. This means there should be more factors for this endeavor including commodities, supplying sources, demands, supporting services for buying and selling and technology transfer (information, consultancy, training…)

Markets for climate change adaptation technologies are almost absent have identified the following barriers in the transfer of clean and environmental sound technologies and related services:

- Few companies are willing to invest in new and climate change adaptation technologies.
- Many consultants are unable to access technology information while suppliers are not willing to help because they want to keep technological secrets
- Financial constraints remain a major obstacle while administrative procedures for loans from environmental funds are too complicated and cumbersome.

PART I:

TECHNOLOGY NEEDS ASSESSMENT FOR GHGs ABATEMENT

Introduction

The Viet Nam's TNA for abatement of GHG emissions aims at prioritizing of the less GHG emissions technologies. This assessment of technology needs has been made through a sector-by-sector approach, starting with the energy sector which, according to the Viet Nam's First National Communication and Inventory has the most significant contribution to the overall GHG emissions inventory. The Technology Needs Assessment covers sectors such as Household & Service & Forestry; Agriculture; Transport and Industry.

According to the IPCC guidelines for estimation of GHG emissions sources are considered under the energy category. For that reason, the GHG abatement analysis already performed in the frame of the Viet Nam's First National Communication and Inventory has considered the services, industry, and transport under the energy category. For the same reason, the TNA for energy sector considers also the services, industry, and transport sector under its focus.

For each sector under assessment, the analysis has passed through the following steps:

- Overview of options and resources (*this step covers (i) an overview of the each sector profile;(ii) policy and legislation framework for the sector under assessment; (iii) existing work carried out under the Viet Nam's First National Communication and Inventory and (iv) take the stock of technologies currently in use.)*
- Selection of key technologies
- Identification of barriers and policy needs
- Definition and selection of actions
- Stockholders

CHAPTER 3

THE TECHNOLOGY NEEDS ASSESSMENT FOR ENERGY SUPPLY

3.1. Overview of options and resources

The GHG reduction TNA for energy supply is established in the following general Vietnamese energy context:

- The Viet Nam Electricity Development Master Plan - Phase V for the year 2010 with perspective to 2020;
- The Viet Nam Coal Development Master Plan for the year 2010 with perspective to 2020;
- The Viet Nam Overall Energy Balance Development for the horizons 2010 and 2020;

Based on Viet Nam Overall energy Balance Development for the horizons 2010 and 2020 in the period after 2010, the basic primary energy sources in Viet Nam, in which hydropower will be critically exploited. If there would be no new important additional primary energy sources such as oil and gas, after the year 2010, it would be difficulty in primary energy supply for electricity generation. Therefore, the renewable energy sources (biomass, hydropower, solar, wind etc.) are of great importance in Viet Nam overall energy balance. A Renewable Energy Action Plan has been established with expected renewable energy share of 5% and 10% of total primary energy use forecast for the year 2010 and 2020. Besides that, the following primary energy sources have been considered for the period 2010 - 2020:

- Hydropower imported from Mekong River - based regional hydropower development project;
- Nuclear power;
- Coal imported from other countries (Australia, Indonesia etc.).

The above two first primary sources (imported hydropower and nuclear power) play the role of decisive importance in the GHG reduction for Viet Nam energy development in the future, while the third one (imported coal) is not favorable consideration of Vietnamese energy/electricity planners and decision makers.

3.2. Selection of key technologies

3.2.1. GHG Emissions from Energy Sector from National GHG Inventory (1994).

Unit: Million tCO_2 equivalent.

Year	1994 (inventoried)	2000 (estimated)	2010 (forecast)	2020 (forecast)	Growth Rate 1994 - 2020 (%)
Energy-related GHG Emissions (million CO_2e)	25.64	49.97	117.3	232.3	14.8
Share of Energy-related GHG Emissions in National total one (%)	24.7	46.8	78.7	86.5	-
Per capital energy-related GHG emission p.a. (tCO_2e/cap/yr).	0.368	0.644	1.337	2.374	-
Per capita national total GHG emissions p.a. (tCO_2e/cap/yr)	1.490	0.727	1.698	2.745	-

Sources: Institute of Energy, Institute of Geography.

Comments on the development of energy-related GHG emissions from the first National GHG Inventory carried out in year 1993:

- High growth rate of energy-related GHG emissions: averagely of 14.8% per annum for the period 1994 - 2020;
- Rapid increase of the share of energy-related GHG emissions in the national total one: from 24.7% increased to 86.5% for the period 1994 - 2020;
- Rapid increase of the per capita energy-related GHG emissions: from 0.368 tCO2e in year 1994 increased to 1.337 tCO2e in year 2010 and 2.374 tCO_2e in year 2020.

3.2.2. Main Orientations of Applying the GHG Reduction Technologies for Energy Supply.

Using modern technologies for energy conservation and high energy efficiency.

- Using the high energy efficiency technologies for all phases of exploitation - production - transporting - distribution - utilization of energy.

- Applying the energy demand side management (DSM) to increase the efficiency of energy end-use, reduce gradually the fossil fuel use, reduce the energy losses and save the energy.

Increasing the use of renewable energy sources for electricity generation.

- Medium, small scale and mini/micro-hydropower.
- New energy types: solar, wind, geothermal energy.
- Biomass (GHG-neutral) (rice husk, biogases) - based co-generation.

Switching from high GHG emission fossil fuels to the cleaner ones (for instant from DO to natural gas) and reducing the share of diesel, coal-fired and FO-fired thermal power.

3.2.3. Analysing and estimating of the demand on environmentally sound technologies used for electricity production

- Eliminate outdated technologies used by coal-and oil-fired thermal power.
- Increase the capacity and efficiency of existing thermal power plants.
- Import new coal-fired thermal power technologies with high thermal efficiency, low GHG.
- Apply the new & renewable energy technologies.
- Pay special attention to DSM programmes in oriented to energy saving and energy efficiency in electricity end-uses.
- Reconstruct and improve the current industrial steam boilers largely used by industries and residential & service sectors.
- Reduce the electricity loss and enhance the efficiency of electricity transmission & distribution.

3.2.4. Analysing and estimating the demand on environmentally friendly technologies used for coal mining

In the coal mining, a large amount of concentrated CH_4 is released to the atmosphere from open air and underground coal fields.

- Open air coal mining technology: Currently the CH_4 emission from this activity is not clearly estimated; and the CH_4 emission reduction technology is still not identified
- Underground tunneling coal mining: This coal mining technology is applied for producing about 30% - 40% of total coal production, while most machines used are outdated that cause a coal loss percentage up to 30% - 50%.

The GHG reduction TNA for coal mining shows two main technological options, namely:

- Modernizing the technologies used for detonating mines and drilling.
- Enlarging the application of hydraulic powered coal mining.

3.2.5. Estimating the demand on renewable energy technologies a. Characteristics of Renewable Energy Sources are:

- Clean energy, Multiform and decentralized renewable energy (mini-hydro-power, biomass, solar, wind, biogas energy etc.), Low level of exploitation.
- Mini-hydropower:
    (i) 1500 - 2000 MW (8% - 10% of total).
    (ii) Exploiting level: Supplying hydropower for 200,000 rural/mountainous households and saving 27,000 tons of oil/year.
    (iii) Current status of hydropower technology: Domestic machinery can manufactures the small hydropower equipment up to 2000 KW/unit capacity with automatic governor.
    (iv) Technological need: Technological localisation and cost reduction for manufacturing equipment.
- Solar energy
    (i) Up to 2002 in Viet Nam, installed capacity of solar energy: 702,402 Wp. Imported solar energy equipment/technologies (PV).
    (iii) Technological need: Centralized solar photovoltaic array to serve the community in combination with other energy type (hybrid system). Development of solar heating technology.
- Wind energy
    (i) Domestic machinery can manufacture wind equipment up to 3 KW capacities.
    (ii) Wind potential of Viet Nam is still not completely investigated.
    (iii) Technological need: Development of wind power technology in industrial scale.
- Biomass energy
    (i) Current status: Small-scale biogases-fired cogeneration centers.
    (ii) Technological need: grid-connected biomass-fired centralized large-scale co-generation center.

Orientations of applying renewable energy technologies to reduce GHG emissions.

- Develop large scale renewable energy centers that are managed by official professional management system.
- Enhance the share of renewable energy in overall energy balance up to 5% in year 2010 and 10% in year 2020.
- Develop off grid renewable energy application for remote areas.

The estimated GHG reduction potential by GHG reduction technologies is presented in the following table 3.1

Power generation from landfill gas

Landfill site in Ho Chi Minh city

Table 3.1. Synthesizing the need for GHG reduction technologies of energy sector and their GHG reduction capability determined for the period 2010 - 2020

Energy sub-sector	**Name of GHG reduction technologies**	**Site of applying the technologies**	**Estimated GHG potential (1000 tons CO_2/year)**
Coal mining & processing	ü Clean coal technologies ü Efficient & economic coal mining, transporting.	Quang Ninh Coal mining	960
Electricity production & transmission	ü Eradicate outdated old thermal power plants. ü Enhancing the efficiency of fire chambers of current boiler & reducing thermal loss.	Thermal power plants	4,900
Energy end-use sector	DSM	Energy end-use sector	7,400
Total			**13,260**

(i.e. 14% of total GHG emissions from energy exploiting production and utilization in Viet Nam

3.3. Identification of existing barriers and policy needs

3.3.1. Absence of GHG concerns in project consideration of energy planners and policy makers

Although Viet Nam has signed the UN FCCC and KP, the GHG reduction generally and the energy - related GHG reduction particularly is not in the prime consideration of Vietnamese energy/electricity development policy makers, planners and designers at national, sectoral, provincial and local level.

Consequently, the feasibility study of every energy projects is commonly and mainly based on technical - economic - pollution concerns without considering its GHG emissions.

3.3.2. High investment need of new and modern energy technologies

There is the second difficulty faced by of applying the modern energy technologies, that is the high investment needs of importing running and maintaining the new and modern technologies used for coal mining, gas and oil drilling and processing, electricity generation/transmission/distribution, as well as for developing renewable energy technologies;

3.3.3. Absence of a national coherent programme and policies for renewable energy development

Over the past two decades, many pilot projects have been undertaken in Viet Nam to demonstrate their technical feasibility for remote upland an mountainous power supply, especially for small-scale, mini/micro-hydropower supply, the barriers faced by applying the renewable/energy technologies for remote rural and mountainous areas) are:

- Absence of a national coherent program to develop promising renewable energy options using domestic and international expertise;
- Absence of a pipeline of financially viable projects that could be financed by Government or by multilateral and bilateral organizations;
- Absence of renewable energy-oriented technological services to serve the maintaining and repairing and the renewable energy equipment and fabricating their spare parts in order to keep reliable and stable running for them.
- Lack of an adequate policy and regulatory framework encouraging renewable electricity.
- Inadequate information about renewable energy technologies.
- Lack of commercial business to provide renewable electricity equipment and services.
- Lack of financing for consumers, businesses and developers.
- Inadequate resource and market data to plan a major program and to develop projects.

3.4. Definition and selection of actions

3.4.1. GHG reduction-oriented technological options for non-renewable energy supply

In orienting to energy-related GHG reduction, the following GHG reduction-oriented technological options and action programs should be considered and implemented:

- For the period from now up to the year 2010, the raising of energy saving and energy efficiency should be considered as the most important purposes of GHG reduction-oriented technological options with two main technological energy programs, namely the Demand Side Management (DSM) program for conventional energy/electricity exploitation, production and end-use as well as the Energy Conservation/Saving Program for all energy consuming sectors in Viet Nam.
- From the period after year 2010 up to year 2020, because of scarcity of conventional energy/electricity sources, in order to promote the energy supply in orienting to energy-related GHG reduction, the imported hydropower provided by Mekong River-based regional hydropower project and the nuclear power should be considered as two most important GHG reduction-oriented energy technologies;

3.4.2. GHG reduction-oriented technological options for renewable energy supply

In orienting to energy-related GHG reduction on the basis of developing the use of clean energy sources, the following *renewable energy action plan* has been suggested.

- Objectives and indicators.

  Objective: Providing electricity for economic and social development in remote areas.

  Indicators: Number of renewable electricity systems; number of isolated grids and of served households; per household electricity use, and number of renewable electricity facilities selling electricity to grid.

- Strategies and principles: Economically viable, Supplied on a commercial basis; Active contribution and participation to projects by communities and individuals Government acting as a market enabler.

  Long-term credit to improve projects financial viability limited grants assistance provided.

- Program components: RE policy and institutional development; Individual household/institutional system; Community isolate Hydro Grids; Grid-connected renewable electricity; Technology/market development and resource assessment.

- Expected results and costs is estimated total: US$ 46 - 91 million in Phase 1.

Provision of electricity to: 35,000 - 90,000 households off national grid forecast Installed capacity: 41 - 50 MW.

3.4.3. GHG reduction related policy instruments for promotion of energy supply

In orienting to energy supply-originated GHG reduction, the following economic instruments, control instruments-law, and institutional and financial arrangements are suggested:

Table 3.2.Environmental policy instrument related to GHG emission reduction

Policy Instruments	Application (examples)
Economic Instruments	
• Tax • Emission trading	• GHG emissions • Acid deposition
• Subsidy/tax relief	• Energy research • Energy conservation instruments • Fuel characteristics improvement • Efficiency improvement
• Direct public investment • Grant aid of financing at low interest rate	• Energy research • Co-generation • Demonstration plant of sustainable energy
Control Instruments - Laws	
• Public regulation; Law • Legal liability	• Toxic wastes • Emission limits • Fuel pollutant content limits
• Local negotiation	• Issues on local basis
• Purchase of kWh at guarantied price. • Obligation to purchase	• Renewable, Sustainable energy
Value	
• Self regulation	• Green consumers and producer

3.5. Stakeholders

Energy sub-sector	Name and preliminary description of energy technologies	Purpose of the technologies and forecast locations to use them	Preliminary estimating the GHG mitigating impacts of considered technologies up to year 2010 (Unit: 1000 tons CO_2 equivalent per annum)	Stakeholders
1	2	3	4	5
Coal mining and processing (Modernize the technologies to mine the coal and apply the hydraulic coal mining methods)	- Clean coal technologies with following methods: ♦ Gravity based. ♦ Surface property based. ♦ Dry method. - Large-scale coal mining technologies with high mechanized level. ♦ Modern and great coal mining equipment for reducing the natural resource losses (coal). ♦ Modern mining technologies used for underground coal mines. ♦ Hydraulic coal mining methods for underground coal mines.	- Eradicate the non-fuel waste and realize the good coal sizing, consequently, raise the efficiency of coal combustion process in fire-chamber of boilers; - Reduce the natural resource losses and CH_4 emissions from coal mining; Location of using these technologies: Quang Ninh coal field (occupying over 90% of anthracite coal demand of the country).	410 550	• VINACOAL (MOI) N,C/GD R,C/GC

1	2	3	4	5
Electricity Production (modernize the coal combustion technologies or fire-chamber of coal-fired thermal power plants)	- Gradually eradicate the old and outdated coal-fired thermal power plants and substitute high efficiency coal combustion technologies of modern fire-chamber for them. - Modernize the coal combustion technologies through improve the efficiency of fire-chamber of current boilers. - Apply the modern pulverized coal-fired boilers (PC boilers) with high efficiency, great unit capacity (up to 300 MW - 500 MW per unit) and high steam parameters.	- Modernize the current coal combustion technology; enhance the efficiency of fire-chamber of current boilers and reduce their specific coal consumption per kWh. ♦ Ninh Binh coal-fired thermal power plant: Reduce its current 788 g/kWh down to 325 g/kWh. ♦ Uong Bi coal-fired thermal power plant: Reduce its current 740 g/kWh down to 325 g/kWh. - Reduce their specific coal consumption from 454 g/kWh down to 325 g/kWh. ♦ Extension of 300 MW for Ninh Binh coal-fired thermal power plant. ♦ Extension of 300 MW for Uong Bi coal-fired thermal power plant. ♦ Construction of Hai Phong thermal power plant of 2 × 300 MW = 600 MW. ♦ Construction of Quang Ninh thermal power plant of 3 × 300 MW = 900 MW.	2412	• EVN (MOI) Viet Nam general Power Company. S, N, R, C - /GD S, N. R. C/GC • IPP (Non-government Independent Power Plant) C/PC • Government research institutions and centers C, N/GR • Universities C, N - GR

1	2	3	4	5
Improve the management of thermal mechanical system of thermal power plant to reduce heat losses and realize heat recovery	- Improve the technologies to repair, maintain for reducing the heat losses of stage of heat production and fuel transport as well as of motorized and heat-used equipment.	- For all heat consuming plants.	2500	• VINACOAL • EVN • Thermal Power Plants (Government or non-government independent)
DEMAND SIDE MANAGEMENT (DSM)	- Industrial and commercial Load Management. - New Commercial high efficiency code. - High efficiency lighting in commerce and industries. - High efficiency household equipment. - Apply the strict energy audit. - Apply the TOU meters and two pricing level meters.	- Realize a large-scale program on DSM with "hard" tools (code, law, regulation,) and "soft" tools (pricing, taxing, training, subsidizing,)	740	• MOI (energy end-using) industrial sub-sectors) (GD) • VINACOAL (GD) • EVN (GD) • Energy end-users (HH) • SMEs (PC or GC) • O
		Totaling	**13 272 thousand tons of CO_2 equivalents per annum** *(i.e. 10,8% o total forecast national GHG emission forecast for year 2010 for energy*	

			sector)	

Notes:
1. Level of stakeholders: HH - household and energy end-user level; C - Firm, plant or Company level (C); S - State/provincial level; R - Regional level; N - National level.
2. Type of stakeholders: GD Government department or ministry; GC - Government company; PC - Private sector company; PR - Private research association; GB - Government statutory body or commission; GR - Government research institution; PB - Private Board, association or federation; O - Others; SMEs - small and medium enterprises;

CHAPTER 4

THE TECHNOLOGY NEEDS ASSESSMENT IN SERVICE AND HOUSEHOLD SECTOR

4.1. Overview on options and resources

Energy consumption

Final commercial energy consumption of Viet Nam is quickly increasing, in 1990 year is about 7MTOE in 2004 year is 17,7 MTOE, average growth rate is about 10% per year. Total commercial energy consumption by fuels kinds is presented in table 4.1.

Table 4.1. Total final commercial energy consumption by fuels, MTOE

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Coal	2.03	2.58	2.93	3.21	2.79	3.23	3.74	4.01	4.2	4.6
Oil	4.17	5.05	5.34	5.78	6.56	6.97	7.45	8.67	8.95	9.2
Gas +LPG	-	-	-	0.09	0.25	0.26	0.42	0.42	0.51	0.55
Electricity	0.96	1.15	1.31	1.52	1.68	1.92	2.22	2.59	3.0	3.38
Total	7.16	8.78	9.58	10.61	11.28	12.38	13.83	15.69	16.66	17.73

In total of final commercial energy consumption oil products occupying about 50%, consuming mainly in transportation sector, after that in industry and residential sectors. Although Viet Nam exports crude oil, but all oil products are imported up to now. Coal consumption is increasing and occupied about 30%, electricity is about 19%.

Electricity consumption of Viet Nam increased very fast in recent years with average growth rate of 14-15% per year.

Table 4.2. Viet Nam electricity consumption by sector (TWh,%)

TT		**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
1	Industry	4614	5503	6163	6781	7590	9088	10394	12681	15205	17305
	Share (%)	41.3	41.1	40.3	38.4	38.7	40.6	40.4	42.0	43.6	43.6
2	Agriculture	632	643	691	715	582	428	478	505	555	636
	Share (%)	5.6	4.8	4.5	4.0	3.0	1.9	1.9	1.7	1.6	1.6
3	Household	4929	6136	7221	8849	10020	10986	12646	14333	15991	18239
	Share (%)	44.1	45.9	47.2	49.7	51.1	49.0	49.1	47.4	45.9	46.0
4	Non_Industry	1010	1092	1228	1380	1400	1895	2227	2078	3087	3503
	Share (%)	9.0	8.2	8.0	7.9	7.2	8.5	8.6	9.0	8.9	8.8

5	Commercial	11185	13374	15303	17725	19592	22397	25752	30228	34853	39683
	Share (%)	20.6	19.2	14.8	15.7	10.5	14.3	15.0	17.4	15.12	13.92
6	Capital consumption (kWh/year)	151	177	200	233	255	295	338	382	432	490
7	Losses (%)	21.7	19.3	18.2	16.09	15.53	14.03	14.0	13.8	13.5	13.3

4.2. Selection of key technologies

According to data of state statistics to 2004 year in whole country there are about 72 thousands of enterprises, thousands and thousands of big buildings, 15 mill households, etc. In which there are many kinds of energy consumption technologies with multiform for used function, type, size and using energy: electricity, using directly fuels as coal, oil, gas, wood, new and renewable energy, etc; and sources from different countries.

However it can estimate generally energy consumption technologies in Viet Nam are still a lot of old and backward technologies, they consume much energy, and energy saving potential is very big. Technologies presented following if can be used will save energy and reduce emission.

1. Lighting technologies

- Lighting technology using Compact fluorescent
  - Life of lamp: 10.000 h; Efficiency: 48 lumen/W
  - Electrical saving potential: 60-70% electricity comparing to incandescent lamp.
  - In public lighting using sodium lamp of 150-250WW to be saved 30-40% electricity comparing to normal fluorescent.
- Energy saving potential: Measures of energy saving in lighting
  - Short term: Management, exchange lamp
  - Medium term: Study and production high efficiency lamps with small size.
  - Long term: Investment to production high efficient lamps.

Electricity consumption structure in Viet Nam in household and service sector occupation about 45-60% of total.

	1999	2000	2001	2002	2003	2004
Electric. Consume. Total (Bill. KWh)	19,55	22,4	25,86	30,22	34,83	39,68
Household and service (Bill. KWh)	10,02	10,98	12,64	14,33	15,99	18,24
%	51,1	49,0	49,1	47,4	45,9	46

Lamp quantity estimated:

- From survey data of DSM project (MOI) in 2002 year
- From survey data of lighting project in 2001: Lamp quantity using in Viet Nam by 2004 year estimated about 100 mills. Lamps, in which: incandescent: 30 mills. Lamps; Fluorescent: 70 mills. Lamps
- Using compact lamp to replace incandescent saving 60% electricity
- Using compact lamp to replace fluorescent, saving 20% electricity.
- Estimate by 2010 exchanging 15% of incandescent lamps and 10% of fluorescent lamps.
- By 2015 exchanging 30% incandescent and 20% of fluorescent lamps.
  - Energy saving:

	2010	2015
Incandescent (bill. kWh)	0.35	0.53
Fluorescent (bill. kWh)	0.08	0.16
Saving total (bill. kWh)	0.43	0.69

  - The estimate of GHG emission reduction potential provide to electricity saving potential above and emission factor studied in CD4 CDM project 0.570kg CO_2/KWh and GHG emission reduction in follow table

	2010	2015
CO_2 reduction (10^3t CO_2)	245	393

2. Cooling and air-conditioning technology

- Using wide currency in household and service sectors
- Among past 25-30 years: Energy consumption reduced about 60-65% for refrigerator and 45-50% for air conditioning (see fig.)
- Energy efficiency (ER) of advance units achieved about 8, 9, 10, 11 BTU/W; ER estimated about 6-7 in Viet Nam.

Energy saving potential estimated of cooling and air conditioning sectors in Viet Nam

	2000	2005	2010
Cooling capacity total (Bill BTU/h)	3-3.5	4.2-5.0	6-7
Power capacity (MW)	400	550-600	750-850
Electricity demand GWh	1200	1600-1800	2500-2800

- If ER increases 10%, saving electricity with 2005: 160-180 mill KWh respective 160-180 bill VND; and 2010: 250-280 mill KWh respective 250-280 bill VND

Emission reduction potential based on use CO_2 emission factor from IPCC is 0,9kg CO_2/KWh for GHG emission reduction potential in cooling and air conditioning in household and service sectors as follow: 2005 year: 144-162 KtCO_2/year; and 2010 year: 225- 252 KtCO_2/year.

3. Cogeneration technology

The Cogeneration is a system that production simultaneous by electricity and heat, and includes boiler, turbine (back pressure or extract condensate) and consumers.

The Cogeneration technology has a lot of advances

- Energy efficiency is very high, about 50-60%, while EE of advance thermal power plant is only 40%
- Supplying simultaneously electricity and head for consumers; Suitable size for consumers; Using a lot of fuel kinds; Reducing GHG.

The estimate of GHG emission reduction potential for COGEN technology based on use emission factor from IPCC guideline 0,9kg CO2 per 1KWh to be provide

- Energy efficiency of cogeneration is 0,5, efficiency of thermal power plant is 0,37; That means efficiency of cogeneration is higher 30%
- GHG emission reduction of Cogen. is lower than thermal power plant about 30%, that means 0,3kgCO_2/KWh
- Viet Nam has about 310 MW of cogen in present, operation time per year is about 3200h and production 1 bill kWh/year
- Total account of GHG may be reduced 0,3 kgCO_2 x 1 bill KWh/year = 300.000 TCO_2/year
- Forecasted data by 2010, 1000MWW of Cogeneration will be installed, GHG total account will be reduced 0,3kgCO_2/kWh x 3, 5 bill KW/year= 1, 05 mill TCO_2.

4. Electricity engine and control (engine system)

- Viet Nam is using many electricity motors that are old generation, efficiency being low and consuming much electricity. Controlling motor is not used yet. Electricity motors consume about 60-70% total electricity consumption in industry. Using new electricity engine and control can save about 25-30% electricity in average. Electricity consumption in Viet Nam industrial sector by 2004 year is about 17, 5 TWh, that mean about 43% of consumption total of Viet Nam.
- Suppose that in 5 coming years, 10% of old motors are replaced by engine systems, it can save 0,43-0,52 TWh/year. GHG emission reduction potential may be achieve about 245000-296000 tones equip CO_2 per year.

5. Biogas Technology

- Technology transmits organic substance into biogas in which main gas is CH_4 to use for cooking, lighting, electricity production...Making good manure and clean environment
- Normal size of biogas shelter is 4-5 m^3 or 6-8m^3 for family and 40-50m^3 or bigger for farms.
- There are about 73,000 units and plan up to 2010, will be added about 180.000 – 200.000 units.
- The Estimate of CO_2 emission reduction potential based on use emission factor from IPCC for coal 26.8 tc/Tj being baseline.
  + Unit of 6-8m^3 can be given 3m^3 of biogas
  + Equivalent fuel per year is 785kg of coal, equivalent of 0.01804TJ
  + With existing units (73.000) can be reduced 141.328 tCO_2/year
  + With 2010 plan can be reduced 489.808 tCO_2 /year.
- Application capacity of technology: Investment is no big but receives a lot of benefits; There are families in country having good conditions for developing biogas; Having technical guide and finance support from government and international organizations.

4.3. Identification of barriers and policy needs

- About averages, the participant views of energy saving are different, people are a little considered, the energy companies are interested in increasing energy production, sale and profits, the energy saving not being their priority.
- The lack of information from outside countries also in country about energy saving technologies and knows how, good typical activities of energy efficiency.
- The lack of offices to implement new technology transfer and advice to carry out activities of energy saving.
- About finance, lack of fund to use new technologies, production modernization.
- Energy price is not suitable yet, power tariff in household sector is lower than in industrial sector, and coal price is relatively lower comparing to other fuels.
- Lack of policies and concrete mechanics to implementation energy efficiency, such as: measures for promoting energy saving; reducing tax for new technology transfer etc.
- Monopoly in energy activities is still high, that limited the investment in energy production and activities of energy efficiency.

4.4. Stakeholders

The activity of energy efficiency is a collection work, it needs the participation of much organization, and personals, and it may list as following

- Ministry of Industry being the focus office to guide implementation of energy efficiency use in whole country.
- Ministry of Construction has the responsibility to coordinate and implementation energy efficiency program in buildings.
- Ministry of Transportation has the responsibility to combine and implementation energy efficiency program in the transportation sector.
- Ministry of Education and Training head and combine with other organization to implementation energy efficiency training.
- Ministry if Science and Technology has the responsibility to implementation energy efficiency project programs
- Ministry of Finance having the responsibility of finance balance.
- Ministry of Plan and Investment having the responsibility of plan of finance and man power, calling investment from inside and outside country resources.
- Local governments of cities and provinces in whole country
- Viet Nam union societies of science and technology.
- Companies, Factories, enterprises buildings using much energy (about 1000 units)
- International organizations and others.

CHAPTER 5

THE TECHNOLOGY NEEDS ASSESSMENT FOR INDUSTRY SECTOR

5.1. Overview on options and resources

In industrial sectors, for time limitation, we only examine three industries: Cement, Steel, Construction materials because they consume most of energy in industry, with high GHG emission and they also play an important role in the process of national industrialization and modernization. The other sectors should be investigated further.

5.1.1. Cement

Cement production is highly energy-intensive, leading to significant energy-related and process CO2 emissions. Energy costs approximately 30-40% of the costs of cement production [4].

Global cement production in 1995 was estimated at 1.45 billion tons. Total (energy-related and process) emissions from global cement production in 1994 were estimated at 1.1 billion tons CO2, or 5% of global energy-related CO2 emissions in the same year. Cement production accounted for an estimated 1-2% of global primary energy consumption [4].

In Viet Nam the Cement sector is also biggest energy consumer in industry (17% energy in industry-1998) [2]. But energy efficiency in this sector is still low: 950Kcal/kg clinker and 100kWh/tone cement.

In 2002, total GHG emission from cement sector was 14,420 ktCO2 [3], accounted for about 41.2 % total GHG emission in industry. And in 2010, the total GHG emission from this sector will be 40,260 ktCO2 [3], about 50.8% of total GHG emission from industry.

5.1.2. Steel

The iron and steel industry is the largest energy consuming industrial sector in the world. In 1990, its global energy consumption was estimated to be 18-19 exajoule (EJ), or 10-15% of the annual world industrial energy consumption (WEC, 1995). The associated CO2 emissions were estimated to be 1,425 Mt (De Beer et. al., 1999). In 1995 this amount increased to 1,442 Mt CO2, equals about 7% of global anthropogenic CO2 emissions. When mining and transportation of ore and coal are included, this share is near 10% of total emissions. Fossil fuel combustion is the primary source of GHG emissions from iron and steel production, and energy costs about 15-20% of steel manufacturing costs [9].

In Viet Nam, steel was the second energy consumer (7.7%) and biggest electricity consumer (56%-1998) [11]. Energy efficiency is low only equal about 50% of advanced level.

5.1.3. Construction materials

This is one of the most leading industry sectors in term of production capacity. In new established market-driven condition during past 10 years, this sector has significantly developed and met the basic demand of infrastructure and civil construction of the country. In many past years, this sector maintains continuously high growth rate. The

main products of construction material production sector include: cement, iron, steel, and some types of the basic construction material as roof material, building glass, building sand, brick…

In Viet Nam, brick is the traditional construction material. About 60 – 70 % of brick output has been manufactured by traditional blast furnaces. This kiln consumes more fuel and pollutes surrounding environment. At present, ratio of fuel and electric expenditure in total brick production cost in Viet Nam ranges from 20% to 30% depending on the brick manufacturing technology, the traditional kiln has highest fuel cost, because of different reasons, occupies 31% in total brick production cost.

Generally in Viet Nam, brick manufacture mainly depends on small and medium manufacturing households with old technology. Energy consumption is relatively high, therefore high of GHG emissions. The total GHG emission from brick manufacture was 2,070 ktCO2 [16], accounted for 6.5% in total emission from energy sector in 1995. In 2002, GHG emission from this sector increased to 3,302.94 ktCO2, about 9.54 % of total emission from industry. By 2010, with growth of brick output as forecast, the emission will be increase much more, about 5,803.61 ktCO2, accounted for 7.33 % total GHG emission from industry sectors.

5.2. Selection of key technologies

5.2.1. Cement sector

1. Current condition of existing technologies

Installed capacity: to 2003, the installed capacity of cement sector is as 10 large cement units (rotary kiln) with total installed capacity 15.26 million tones/year includes: 6 state own plants of 9.4 million tones/year capacity; 4 Joint ventures of 5.86 million tones/year capacity; 55 small plants (less than 80,000 tones/year capacity) with vertical kiln technology with total installed capacity: 3.0 million tones/year; 40 clinker grinding units with total capacity: 4.35 million tones/year.

The cement production during last period is following

Table 5.1. Cement productions

Unit: Ktones

Sector	1995	1998	1999	2000	2001	2002
Cement	5,828	9,378	10,489	13,298	16,073	19,481
- State own	5,828	7,735	7,870	9,560	10,684	12,640
- Non state	0	7	11	97	252.	455
- Foreign	0	1,996	2,588	3,641	5,137	6,386

Source: Viet Nam Statistic Yearbook-2002

The production figure includes the imported clinker for domestic grinding. 3.33 Mtones (see table 5.2) to get 3.7 Mtones cement.

Energy consumption: Current average specific energy consumption includes Heat consumption: 950Kcal/kg clinker (***3.98GJ/t clinker***); Electricity consumption:

100kWh/tone cement; Electricity consumption for clinker grinding: 40kWh/t clinker. Total energy consumption (2002): 16.00 Mtones, with for clinker production (90% of cement): 14.4 Mtones;

Electricity consumption: (100kWh/t cement): 1600.0 million kWh/year, with Fuel consumption: 57,312 TJ/year (2.6 Mtones of coal-HV=5500Kcal/kg); Clinker grinding: Electricity consumption for grinding 3.33 Mtones of clinker is: 133.2 million kWh.

Evaluation of GHG emission from the manufacture of cement can be expressed as following:

Total emissions for cement production	= Process emissions
	+ emissions from fuel combustion
	+ (indirect) emissions from electricity consumed
	+ emissions from some kinds additive used
	+ emissions associated with additive preparation

The energy-related emissions of CH_4 and N_2O combined typically represent less than 0.5% of total energy-related emissions, so could be omitted from emission baselines without having a significant impact on either the stringency of the emissions baseline or on the uncertainty of credits.

Process emissions = Emissions from clinker production + emissions from additional lime used in masonry cement

For the evaluation it is commonly to use the IPCC (1996) [5] Emissions from clinker production = 0.5071 t CO_2/t cli * tons clinker produced.

Then, process emission of Viet Nam cement in 2002 will be: ***7.30 Mtones CO2***.

Fuel used in Viet Nam cement is mainly anthracite, with IPCC emission factor: [5] 98.356tCO2***/TJ*** and the fuel consumption of 57,312 TJ, the emission will be: ***5.64 Mtones CO2***.

Emission from electricity consumption with grid emission factor with OM&BM approach: 0.855 kg CO2/kWh. [6].Then (1600.0+133.2) MkWh of grid emitted: 1.48 Mtones CO2

Total GHG emission from cement sector: ***14.42 Mtones CO2 in 2002***

GHG Emission projection up to 2020

Table 5.2 shows the demand and production projection in development plan. The information is taken from Cement master development plan up to 2010 with outlook at 2020(done in 2002). The plan was approved by the Prime Minister in Nov. 18 2002 (Gov. decision No 164/2002/QD-TTg).

Table 5.2. Demand and production* volume (forecast and planned)

Indicators	2002	2005	2010	2015	2020
Demand growth	20	13	10	5-8	2.5-3
Demand-mt	19.7	29.1	48.6	63-65	68-70
Production-mt	16.0	22.0	49.8	62.8	68

Source: Cement master development plan-2002. And Production is not included the grinding output from imported clinker.

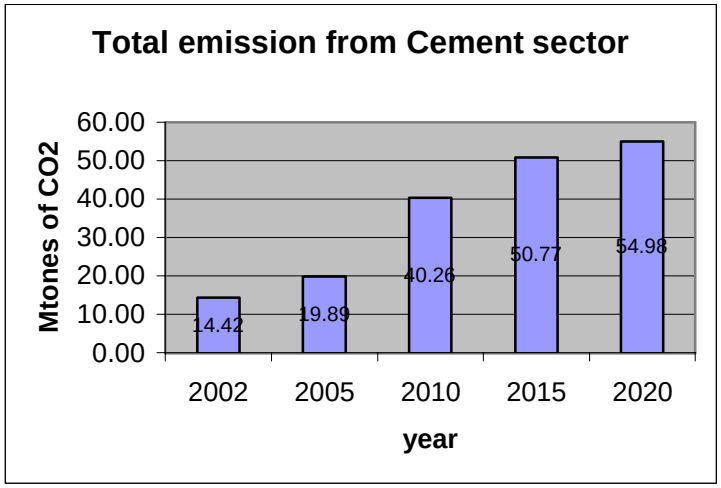
Technology target: heat consumption: 730Kcal/kg clinker. (3.06 GJ/t clinker); Electricity consumption: 95kWh/t cement; Dust in exhaust gas: 50mg/Nm3.

Table 5.3. GHG Emission from Viet Nam cement sector

	Unit	2002	2005	2010	2015	2020
Cement demand	Mtones	19.7	29.1	49.8	62.8	68
Cement prod.	Mtones	16	22	49.8	62.8	68
Clinker	Mtones	14.4	19.8	44.82	56.52	61.2
Import clinker	Mtones	3.33	6.39	0	0	0
Energy-fuel	TJ	57312	78804	137149.2	172951.2	187272
Electricity	MkWh	1733.2	2455.6	4731	5966	6460
Emission-fuel	Mtones CO2	5.64	7.75	13.49	17.01	18.42
Emission-electric	Mtones CO2	1.48	2.10	4.05	5.10	5.52
Process emissio	Mtones CO2	7.30	10.04	22.73	28.66	31.03
Emission-total	Mtones CO2	14.42	19.89	40.26	50.77	54.98

* Following assumptions are made for emission projection evaluation:

+ *Technology level in 2005 is same as in 2002: 3.98GJ/kg Clinker and 100kWh/t of cement.*
+ *Technology level in 2010 and after is the target values.*
+ *Process emission factor (0.5071TCO2/T clinker) is unchanged.*
+ *Grid emission factor also unchanged*



2. Identified GHG emission reduction technologies

Increasing the energy efficiency of cement production, *e.g.* by optimising heat recovery or installing an efficient pre-heater, the changes in the production process, *e.g.* by changing the process by which raw materials are ground, mixed and fed into the kilns from wet to dry, or changing the input fuel, *e.g.* by using an increased proportion of waste fuels.

Clinker blending: process CO_2 emissions could be significantly reduced per ton of cement produced by blending (mixing) clinker with an increased proportion of other products ("additives") in cement.

Table 5.4. Technology needs identification

Technology	Saving	Investment	Age
1. Large vertical roller mill for raw material crushing	30% Productivity: +60%	15MUS$ 200T/hr	1970
2. Vertical roller mill for coal crushing	25%	5MUS$ 20T/hr	1980
3. Pre-grinding roll crusher	19% Productivity: +50%	5MUS$ 100T/hr	1980
4. High-efficiency separator in the finishing process.	10%	1.2MU$ 3000kW type	1980
5. Modification of conventional suspension preheated to a five-stage cyclone suspension preheated	8.6%	1-2 MUS$ 2000T/D	1972
6. Small-pressure-drop suspension preheated	50%		1985
7. Burning of used tires as substitute fuel for cement kiln	10-13% fuel		1979
8. Waste heat recovery	6.5MW/3000T/D	2000US$/kW	1985
9. Change from west to dry process	Reduce 42% energy consumption		1970
10. Clinker blending	1% additives reduce nearly 1% emission		Very usual

3. Technology needs assessment.

Due to the lack of detail data the assessment can be made only for some identified technologies, for that the data are available. Assessment methodology is as follows:

- Baseline: BAU: Business As Usual. For emission from electricity consumption, the emission factor of grid, calculated as ½ OM+½ BM.
- GHG emission reduction options:
  + Refurbishment is applied for 65 existing cement plants with capacity of 18.26 Mt of cement per year. The refurbishment rate is suggested to finish the full refurbishment in 2012.
  + New built is applied for newly built cement plants with capacity added described in table 5.12. It is taken from Cement Mater Development plant.

Table 5.5. Added cement production capacity

	04	**05**	**06**	**07**	**08**	**09**	**10**	**15**	**20**
Production, Mt	18,8	22,0	27,9	35,3	42,0	47,6	49,8	62,8	68
Added capacity,	-	3,20	5,95	7,35	6,70	5,60	2,2	13	5,2

Table 5.6 gives the results of assessment.

Table 5.6. Technology assessment

Technology	**Tech. parameters**		**05-25 accumulated CO2 reduction of whole sector, $MtCO2_{eq.}$**		**Reduction cost USD/tCO2**	
	E. saving	**Cost**	**Refurbishment**	**New built**	**Refurbishment**	**New built**
1. Large vertical roller mill for raw material crushing	30%	15 MUSD/ 200t per hour	1.7	4.5	146.0	4.0
2. Vertical roller mill for coal crushing	25%	5MUSD/ 5t per hour	0.13	0.37	838.0	4.45
3. Pre-grinding roll crusher	19%	5MUSD/ 100t per hour	1.0	2.8	42.6	1.9
4. High-efficiency separator in the finishing process.	10kWh/t cement	1.2 MUSD/3MW	1.5	4.3	-35.7	-52.0

5. Modification of conventional suspension preheated to a five-stage cyclone suspension preheated	8.6%	2MUSD/1.4 Mt cement per year	8.3	24.1	-3.5	-5.3
6. Small-pressure-drop suspension preheated	?	?	?	?	?	?
7. Burning of used tires as substitute fuel for cement kiln	11.5%	3.4 USD/t clinker	1.5	4.2	-28.8	-28.8
8. Waste heat recovery	3.4 MW/1.4 Mt cement	1500USD/kW	2.6	7.6	-26.9	-26.9
9. Change from west to dry process	?	?	?	?	?	?
10. Clinker blending	?	?	?	?	?	?

5.2.2. Steel sector

1. Current condition of existing technologies

a. Installed capacity: According of the data of Department of Statistics, up to now, there are 160-170 metal - manufacturing small sized enterprises. Number of enterprises which has total workers less than 100 accounted for 80 %; 21 electric steel manufacture kilns with capacity 180 tones of product, output is 500,000 tones of steel crude; 17 steel rolling lines, yearly output is above 1,600,000 tones of composition steel-laminating and construction steel products;

Steel and iron factory in Thai Nguyen province

7 manufacturing facilities with main products are zinc-plating iron, black steel pipe and plating zinc steel pipe, yearly output is above 100,000 tones; 2 blast- furnaces for iron manufacture, annual production is about 50,000 tones of pig iron of different types; 8 mines of coal, iron- ore, refractory ground and other feedstock products, supply millions tone of raw material for sector annually.

The Viet Nam Steel Corporation has 14 member units and 14 joint venture companies co-operating with foreign countries in three regions of the country with the staff of nearly 20,000. The main products of Viet Nam metallurgy sector are only pig iron and steel, though Viet Nam is rich of mineral recourses and they are intensively exploited such as iron, mangan, zinc, titanium, chromium etc.

b. Production: The types of products produced in Viet Nam are:

- Long steel bars: cylinder, smooth steel bars, with diameter ranges from 5.5 to 50 millimeter (mm); streak steel bars: diameter ranges from 10 to 36 (mm)
- Shape steel: L25 – L125, U60 – U140, I110 – I120, rail 24
- Rope steel: plating steel ropes and black steel ropes, soft steel ropes and steel ropes have different hardness
- Painted and Zinc-plated steel plates
- The cast products by iron, steel.

Table 5.7. Iron, steel production of Viet Nam in 2002

Product	Unit	Quantity	Technology
Pig-iron is made from ore	Tone/year	50,000	From ore-blast furnace-coke coal
Crude steel	Tone/year	500,000	Electric kiln
Laminate steel, construction steel	Tone/year	1,600,000	Hot and cold rolling
Plating iron, pipe	Tone/year	100,000	Cast, roll

c. Energy consumption: Due to the lack of energy consumption data in Viet Nam, for further analysis we will take the average data from international sources and some data from Viet Nam Steel Corporation [13].

The energy consumption per ton steel produced is typically 19 to 40 GJ/tcs for an integrated steel mill using a BOF, and 30-45 GJ/tcs for an integrated steel mill using open hearth furnaces (De Beer *et. al.*, 1999). A scrap base minimal uses typically 7.7-12.5 GJ/tcs, a DRI (gas)-EAF typically 22-30 GJ/tcs and a DRI (coal)-EAF typically 30-40 GJ/tcs (De Beer *et. al.*, 1999; IISI, 1998).

The pig-iron in Viet Nam is mainly produced in Scrap-EAF, and the data from Viet Nam steel [13] shows that the specific energy consumption is 725 kWh/t, it is only 2.6 GJ/t less than 10GJ/t world average (see table 15), and much less than India: 18.8 GJ/t.

The rolling steel in Viet Nam is produced from pig-iron imported or produced from Scrapt-EAF. We take data from [13]: 107 kWh/t and 43 kg FO/t.

d. Evaluation of GHG emission:

Steel output of Viet Nam: ISP: 50,000 tones/year, Scrap-EAF: 450,000 tones/year, Rolling (hot): 1,600,000 tones/year. The emission factors for emission calculation can be taken as following:

- ISP: 3.7 tones CO2/tone of steel
- Scrap-EAF: Viet Nam grid emission factor [12] is 0.855kgCO2/kWh, then 0.914 tones CO2/tone of steel.

Roll steel: following the data of [13]: 43 kg FO with emission factor: 3.4 kgCO2/kg FO or 0.146 tCO2/t; 107 kWh/t with: 0.855kgCO2/kWh or: 0.092 toneCO2/t [12]. So, emission factor of roll steel is: 0.238 tones CO2/tone of steel

Total GHG emission of Viet Nam steel manufacture sector is given in table 5.8

Table 5.8. GHG emission of Viet Nam steel sector

Manufacturing	**Output (tone)**	**Emission factor TCO2/t steel**	**Emission TCO2**
ISP	50,000	3.7	185,000
Scrap-EAF	450,000	0.914	411,300
Rolling steel	1,600,000	0.238	380,800
Total GHG			977,100

e. GHG emission projection up to 2020

The detail data are not available. From the report of Viet Nam Steel Corporation, in near future the production will be expanded and the capacity added will be: 800,000 t/year of rolling steel; 1,500,000 t/year of pig-iron; 4.5 Mt ISP.

The added emission will be: 18.21 Mt. The main emission will come from ISP with 4.5 Mt capacities.

2. Identified GHG emission reduction technologies

There are several options for energy saving in steel production identified in [13]:

- Steel casting
  - + High capacity high frequency furnace.
  - + Continuous casting, coal and Oxygen injection.
  - + Material preheating by recovered waste heat.
  - + Melted iron input to EAF.
  - + Raw material cleaning.
- Steel rolling
  - + Road map to close down the small and inefficient plants.
  - + Using big rolling machine.
  - + Continuous rolling.

+ Hot rolling and heat recovering.

+ Big size pig-iron for rolling (length 12 m).

+ Water circulation.

+ Using foggy FO.

Some identified above technologies have more detail information. They are listed in the table 5.9:

Table 5.9. Identification of technology needs

Technology	Saving	Investment	Age
1. DC arc furnace use water to cool the furnace wall	5-10% electricity 40-50% electrodes		1990
2. High frequency melting furnace	12-13%	1MUS$ 1000kg/hr	1979
3. Drying and humidity control equipment for refine coke oven	Reduction 1% humidity, saving 18,000Kcal/Tcoal	18MUS$ 3.2MT/year	1983
4. BOF exhaust gas recovery device BOF: Basic Oxygen Furnace	250Mcal/Tsteel	18MUS$ 250T/hr	1962
5. Raw material preheated for electric arc furnace	70Mcal/T	8MU$ 150T/shief	1981
6. Heating furnace with regenerative burners	10-30%	0.25MUS$/pair	1990
7. Ladle heating apparatus with regenerative burners	56%	1.2MUS$	1990
8. ES operating electric arc furnace	13%		1980

3. Technologies needs assessment

Due to the lack of detail data the assessment can be made only for some identified technologies, for that the data are available. Assessment methodology is as follows:

- Baseline: BAU: Business As Usual. For emission from electricity consumption, the emission factor of grid, calculated as ½ OM+½ BM.
- GHG emission reduction options:

Refurbishment is applied plants with suggestion of new technology penetration rate with all existing steel plants of total capacity 1.7 Mt and 100% penetration in 2011. (Table 5.10 gives the results of assessment)

Table 5.10. Technology assessment

Technology	Tech. parameters		05-25 accumulated CO2 reduction of whole sector, $MtCO2_{eq.}$	Reduction cost USD/tCO2
	E. saving	Cost	Refurbishment	Refurbishment
1. BOF exhaust gas recovery device.BOF: basic Oxygen Furnace	80kWh/t	18 MUSD/ 200t per hour	0.991	-48.6
2. High frequency melting furnace	12.5%	1MUSD/ 1t per hour	1.084	312.7
3. Raw material preheated for electric arc furnace	70Mcal/t	8MUSD/ 150t per batch	0.638	-44.4
4. Drying and humidity control equipment for refine coke oven	306 MCal/t coal	18 MUSD/ 3Mt/year	0.157	8.6

5.2.3. Construction material sector

1. Current condition of existing technologies

a. Production capacity and current technologies: This is one of the most leading industry sectors in term of production capacity. Total production of some construction materials from 1995 to 2002 is shown in table 5.11

Table 5.11. Situation of construction materials production from 1995 to 2002

Product	Unit	1995	1999	2001	2002	Growth rate (%/Year)
Glass (non-state)	ktone	77.0 (12 .0)	105.9 (22.2)	114.9 (24.5)	116.7 (25.1)	6.12
Porcelain sanitation (non-state)	Million products	187.0 (169.0)	219.7 (202.7)	314.1 (287.7)	327.3 (300.0)	8.32
Brick (non-state)	Million pieces	6,892 (5,769)	7,830.7 (5,848.4)	8,910.5 (7,236)	11,009.8 (8,366.1)	6.92

Fire tiles (non-state)	Million Tiles	561.0 (495.0)	386.2 (330.8)	356.4 (328.1)	360.3 (330.2)	
Roof plate (non-state)	1000m2	14,791 (69)	19,572 (589)	43,522 (12948)	46,600 (13900)	17.82
Building glass	1000m2	4,751	15,658	33,717	35,600	33.32

Source: Viet Nam Statistical Yearbook - 2003

In this report, we only focus on research in brick producing technology; brick is the construction material that has the highest demand, brick production is one of highest GHG emission processes. Annual, brick output is about 8 to 11 billion pieces. About 60 – 70 % of this output has been manufactured by traditional blast furnaces. This kiln consumes more fuel and pollutes surrounding environment. In recent years, a vertical shaft brick kiln (VSBK) with high efficiency has been developed and its number has been drastically increased. However, 2/3 of total brick, tile output is still manufactured by traditional kiln used old technologies.

b. Energy consumption: The 30% - 40% of brick output had been manufactured in state owned sector and foreign investment. Big proportion of the enterprises with modern tunnel brick kiln model using coal, fuel oil or natural gas.

Traditional brick – kilns with small capacity, have manufactured 60% - 70% of brick output and it has multiform structures, the fuels used depending on fuel resources. In the Northern areas, coal is mainly used, because it is widely available and cheap. In Central area and Southern – Eastern areas, firewood is mainly used, in the Cuu Long River plain; the main fuel is rice husk. At present, there are in Viet Nam about 7000 – 10,000 traditional brick – kilns; there are three typical kinds as follows:

- Traditional vertical kiln using coal in the Northern area
- Traditional vertical kiln using firewood in central area and Southern – Eastern area
- Sphere kiln using rice – husk in the Cuu Long River plain.

Table 5.12 shows data of energy consumption of some types of widely used brick - kilns in Viet Nam

Table 5.12. Energy consumption of brick – kilns in Viet Nam

Type of kiln	*Fuel*	Energy consumption **(MJ/kg brick)**
Traditional vertical kiln in the Northern area	Coal	1.5-2
Traditional vertical kiln in the Southern area	Firewood	4.1 – 5.2
Sphere kiln in the Southern area	Rice husk	3.8 – 10.1
Loop kiln	Coal	2.2 – 3.1

Tunnel kiln	Coal, oil, gas	1.5 – 2.4

Source: Nguyen Xuan Quang and Nguyen Thi Anh Tuyet

Table 5.13. Coal consumption of some types of brick-kilns

Type of kiln	Fuel consumption (kg coal /1000 bricks)	brick size (Kg/brick)	Fuel LHV (MJ/kg)	Energy consumption (MJ/kg)
Tradition brick kiln	150	1.85	19.26	1.562
VSBK	85	1.87	19.26	0.876
Trieu Duong tunnel brick kiln	160	1.6	22.45	2.245
Binh Dinh tunnel brick kiln	120	1.6	22.2	1.665

Source: VIE/00/004 project

Generally, energy consumption in brick production sector in Viet Nam is largely variable, from 0.876 – 2.245 MJ/kg, it depends on type of kiln and clay used in unbaked brick manufacture.

c. Evaluation of GHG emission: Total volume of gases and CO2 emission from brick production in 2 years 1995 and 1997 in Viet Nam is shown in table 5.16

Table 5.14. Volume of GHG emissions from brick production in Viet Nam

Year	Total CO2 emission of energy sector (Million ton)	Brick output (Million pieces)	TonCO 2/ million pieces	CO2 emission from brick manufactur e (Million ton)	Share in total emission from energy sector (%)
1995	31.7	6,892	300	2.07	6.5
1997	45.5	7,262	300	2.18	4.8

Source: VIE/00/004 project

d. GHG emission projection up to 2020: Construction material demand growth rate projection is given in Table 5.15

Table 5.15.The growth rate of some main construction materials in past years

Glass (%/Year)	*Civil porcelain (%/year)*	*Firebrick (%/Year)*	*Roof plate (%/Year)*	*Construction glass (%/year)*
6.12	*8.32*	*6.92*	*17.82*	*33.32*

It is forecasted that the growth rate will be maintained in the future. Following assumptions are made for emission projection evaluation:

- Technology level in 2010 is the same as 2002 and after 2010 the technology of VSBK will fully substitute the traditional technology
- Growth rate from this time to 2020 is expected to be about 7.3%

Table 5.16. GHG emission from brick production sector in Viet Nam (period 2002-2020)

	Unit	**2002**	**2005**	**2010***	**2015**	**2020**
Provide brick	Million pieces	11,009.80	13,601.24	19,345.38	27,515.40	39,135.82
Volume CO2 emission	Kton	3,302.94	4,080.37	5,803.61	4303.41	6120.84

******* *Used entire the technology of vertical shaft brick kiln*

2. Identified GHG emission reduction technologies.

Only two technologies currently identified for brick production. They are:

Table 5.17. Kiln types with EE and better fuel combustion

No	**Technology**	**Saving (1000 VNd)**	**Investment (million VNd)**	**Age**
1	Vertical shaft brick kiln	80,200.2	80	2001
2	Dry cellar and tunnel fire one uninterrupted channel			1992

Source: Brief introduction of vertical shaft brick kiln

: Nguyen Quang Senh (Viglacera Company)

3. Technology assessment

Results compared VSBK with traditional kiln in fuel consumption are shown in table 5.18

Table 5.18. Fuel consumption of vertical shaft brick and traditional kiln

Parameter	VSBK	Traditional kiln	Fuel saving
Fuel consumption (kg/brick)	0.085	0.15	0.065
Annual brick output (1000 brick)	3,886	3,886	
Firewood volume for per kiln start	400	200	
Disqualified %	8	10	
Production cost-VND/brick	138	116	
Investment cost-VND/brick	90		

Note: kiln operates 330-day/ year, capacity: 11776 brick pieces/day

Source: VIE/00/004 project

The capacity of traditional brick kilns in 2002 is 7,156 million pieces is suggested to be replaced by VSBK fully in 2013. In this case, the total emission reduction will be 3,852 kt CO2eq. With reduction cost about 2.62 USD/tCO2eq?

5.3. Identification of barriers and policy needs

The barriers to implementation of GHG emission reduction technologies include the general barriers of advanced technology transfer and specific barriers of GHG reduction technologies.

5.3.1. Regulatory barriers

- There is a regulation of EE and ES issued as government decree in 2003. It is good measure to enhance the EE&ES activities, hence the GHG emission reduction. But by our observation still the concrete actions are being taken very slowly. Many issues such as standards, codes practice, labeled etc. are still being developed but not come into force. It is general barrier for EE&ES technology development and for GHG emission reduction technologies development.
- Some important industrial branches are still under strong government regulation, like cement, steel, oil etc. Under regulation not only their product sale price but also the price of input for them, like coal price, oil price or electric price. Most of enterprises in these branches are state owned; the leaders are not willing to introduce new technologies that will complicate their life, their position that is lasting only limited period.
- Regulatory specific barriers to GHG emission reduction technology transfer is the lack of legal frame work of Climate change and CDM activities. The first government legal document on CDM implementation is still under preparation.

5.3.2. Economic system and sectoral structure

- State sector is dominated. As mentioned above, in all important industrial branches, the state owned enterprise is dominated. The leaders are mostly do not care about the benefits and look at short term strategy corresponding to the term of their position. That is very big barrier. State enterprises are normally under complicated structure, coming from Ministry, corporation, company the factory. Decision making is long process and it is every body thing and means no body thing.
- Private sector is being developed very quickly now, but still small sized. They are more flexible and more active in technology transfer, but they are lack of manpower, capital hence mostly has no vision to long term business.

5.3.3. Low awareness

- People can know some general advanced technologies, but when coming to more detail such as technology specifications, suppliers, qualities, prices or design etc. it is difficult to find out the information sources or the trusted consultation. It is in general subject and it is worse in climate change and CDM subjects. Low developing consultative and energy service capacity is serious barrier for technology transfer.

5.3.4. Capital

- Lack of capital is common barrier in all developing countries and especially in Viet Nam. And the lack of capital and financing system in the new and less
- Understanding activities of climate change and CDM is more evident even only for project development.

5.3.5 Supplier

- There is difficulty to find out the appropriate domestic supplier of GHG emission reduction technologies.

5.4. Definition and selection of actions

We restrict the consideration only in climate change adaptation technology aspect where the process can be controlled by Ministry of Natural Resources and Environment.

5.4.1. Capacity building

Under national projects and international projects there were many workshops, training courses etc. organized for capacity building. During the project implementation a group of experts also got the chance for education. But till now most the training materials are too general, it is high time to come to sectoral specifics aiming to create the core team of experts in each main industrial sector. They should and only they can initiate the technology transfer process starting from need identification to implementation. There is also a need to have in each ministries, province and financing institution experts, who understand subjects of climate change and CDM.

As the basement for development there is a need to create several excellent centers (NGO, private, research).

5.4.2. Policy and incentives

Climate change and CDM is new branch of activities and only at beginning stage. It needs special policy and incentives for development.

5.4.3. Funding

The new deal faces bigger risk. To manager the risk and to encourage the development some fund should be allocated to support the pioneer.

5.4.4. Demonstration

The strongest effect of advocacy is the success of real projects. If Viet Nam can have a CDM project registered and CER delivered, every thing will be moved quickly.

5.5. Stakeholders

There are three categories of stakeholders identified: policy makers, implementations and supporters relevant to GHG emission reduction technology transfer and development.

The most important policy makers in these activities are in MONRE, MOI, MOST, MPI, MOF, MOFA, and MARD. At provincial level they are in DOI, DONRE, DOST, DARD. They have triple missions: initiators, supporters and regulators for the projects.

The important supporters are the multilateral organizations such as WB, UNDP, UNEP, GEF, ADB, etc. The maximal effective utilizations of their aids with better coordination will be a good contribution to the technology development.

Community organizations. In Viet Nam they have strong voice in all levels. Some technologies cannot be implemented without their support, especially that need wide participation.

CHAPTER 6

THE TECHNOLOGY NEEDS ASSESSMENT FOR TRANSPORT SECTOR

6.1. Overview on options and resources:

Recently, the transport infrastructure of Viet Nam consists of over 2000 km of roads, nearly 3.000 km of railways, over 40.000 km of inland-waterways, nearly 100 ports and 18 international/domestic airports; this well developed infrastructure is creating basic conditions for the development of the transportation to almost of the areas of the country and with the world.

Volume of passengers and freight transport was following (see table 6.1 - table 6.4):

Table 6.1. Volume of passengers carried by type of transport

mill. persons

Year	Total	By type of transport			
		Railway	Road	Inland waterway	Aviation transport
1990	376.5	10.4	293.2	72.1	0.5
1995	563.0	8.8	441.7	108.9	2.4
2000	761.7	9.8	621.3	126.5	2.8
2001	805.2	10.6	655.4	133.9	3.9
2002	853.7	10.8	699.3	137.7	4.4
2003	1106.2	11.6	926.2	161.7	4.5
2004	1186.2	12.8	999.7	166.2	5.6

Table 6.2. Volume of passenger's traffic by type of transport

mill.persons.km

Year	Total	By type of transport			
		Railway	Road	Inland waterway	Aviation transport
1990	15,252.4	1,913.0	11,432.8	1,167.1	457.6
1995	24,504.8	2,133.3	16,526.3	1,699.4	4,094.3

2000	33,000.8	3,199.9	23,192.4	2,136.9	4,383.0
2001	36,359.7	3,426.1	24,237.7	2,484.1	6,110.7
2002	39,388.6	3,697.2	26,010.2	2,481.4	7,101.4
2003	43,786.3	4,069.0	29,180.8	3,282.4	7,112.0
2004	48,650.5	4,378.0	31,730.7	3,440.0	8,948.0

Table 6.3. Volume of freight by type of transport

thous.tons

Year	Total	By type of transport				
		Railway	Road	Inland waterway	Maritime transport	Aviation transport
1990	88,414.9	2,341.0	54,640.2	27,071.0	4,358.7	4.0
1995	101,715.5	4,515.0	92,255.5	28,466.9	7,306.9	32.0
2000	206,010.3	6,258.2	141,139.0	43,015.4	15,552.5	45.2
2001	223,310.0	6,456.7	151,483.0	48,488.2	16,815.3	66.8
2002	241,041.8	7,051.9	163,126.4	52,299.7	18,491.8	72.0
2003	261,401.1	8,385.0	175,856.2	55,258.6	21,811.6	89.7
2004	284,929.4	8,829.4	192,562.5	59,071.4	24,363.6	102.5

Table 6.4. Volume of freight traffic by type of transport

mill.tons.km

Year	Total	By type of transport				
		Railway	Road	Inland waterway	Maritime transport	Aviation transport
1990	17,766.2	847.0	2,446.1	2,502.1	11,966.9	4.1
1995	25,328.1	1,750.6	5,137.6	3,015.5	15,335.2	89.2

2000	45,469.8	1,955.0	7,888.5	4,267.6	31,244.6	114.1
2001	49,810.2	2,054.4	8,095.4	4,672.4	34,829.8	158.2
2002	56,431.7	2,391.5	8,650.1	4,968.2	40,250.1	171.8
2003	60,992.0	2,725.4	9,402.8	8,140.5	43,512.6	210.7
2004	67,261.9	2,790.8	10,305.5	5,591.8	48,335.9	237.9

In order to meet the annual transportation need the Transportation Sector has consumed approximately 2.5 - 3.0 millions tons of fossil fuel (gasoline, diesel oil, FO) holding approximately 30% of the total amount of fossil fuel imported, in which road transport sector combusted about 60% among the transport sector. So, emission of GHG by the road transport activity is the highest in the transport sector in Viet Nam.

6.2. Selection of key technologies:

Taking into account the characteristic of transport sector in Viet Nam, we should concentrate on the road transport in order to reduce the GHG emitted by transport activities. The main technologies for GHG emission reduction in road transport activities include:

6.2.1. Developing the public transport system (bus), limiting the number of moto-scooter/motorcycle in the cities of Viet Nam

At present in the cities of Viet Nam, the public transport system (bus, taxi) only meets 8-9% of moving needs of people, and the main transport means are motor-scooter/motorcycle (55 - 60%), the other means (walking, bicycle, car) occupy approximately 30 - 35%. The public transport system can save fuel and reduce GHG emission because the unit of fuel consumption for bus (calculating according to passenger.km) is lower in comparison with car and motorcycle. The strategy target of Urban Transport Development in Viet Nam in the stage from now to 2020 is:

- To 2010: The bus meets 30% of the need
- To 2020: The bus meets 40 ÷ 45% of the need

6.2.2. Constructing and operating the public railway system in Viet Nam

At present the railway network in Viet Nam includes 07 main lines that have the length nearly 3.000 km with 3 types of the rails: 1.000mm, 1.435 mm and the double rails; there isn't electrification railway yet. In general, the transport of passenger by railway only holds approximately 1, 5% of the passenger volume and about 13% of the passenger volume traffic in comparison with the road transport. Now, there isn't yet urban public railway system. The development of public railway in the big cities is the important solution to reduce GHG emission in the transport sector. The main reasons are as follows:

- The capacity of passenger transport by railway is bigger in comparison with road transport.

- The unit of fuel consumption (DO) of for rolling-stock is less in comparison with road transport.

According to the transport development plan of Viet Nam to 2010 and oriented to 2020 the structure of urban transport of passenger is as follow:

- In 2010: The bus (30%); The urban railway (0%); The other means (70%)
- In 2020: The bus (40 ÷ 45%); The urban railway (25%); The other means (30 - 35%)

To 2020 if the transport of passenger by urban railway met 25% of need the fuel using for the public transport of passenger would decrease very much and, obviously, the amount of greenhouse gas emission would decrease in the transport sector. In the case of the electric railway transport, there will none greenhouse gas emitted.

6.2.3. Using LPG for the transport means in Viet Nam

According to the statistics up to 30 April 2005 in Viet Nam, there are approximately 549.000 cars and more than 13 millions of motorbike. The road transport means in Viet Nam mainly use conventional fossil fuel such as gasoline and diesel oil. Recently, LPG fuel has just applied experimentally in some taxi companies in Hanoi, Ho Chi Minh and Vung Tau cities. The switching from gasoline/diesel oil to LPG is able to carry out in the following ways:

- Bi-fuel: The means can use conventional fossil fuel or LPG
- Dual- fuel: The means can use conventional fossil fuel and LPG at the same time.
- Dedicated: The means are converted to use LPG only and can not use conventional fossil fuel.

Among solutions of using the cleaner fuel for road transport means, the use of LPG is a most effective solution for GHG emission reduction in road transport.

For switching from the conventional fossil fuel (gasoline, diesel oil) to LPG for transport means in Viet Nam, the plan for the technology application should be developed in following directions:

- Establishing the legal framework to develop the LPG supply network for the transport means including:
  - + The standards for designing and installing the LPG supply station for the transport means.
  - + The standards for designing and installing the fuel converter for the transport means presently using the conventional fossil fuel.
  - + Designing, manufacturing and installing the fuel converter for cars.
- Establishing the network of the installation and maintenance stations for the fuel converters and the LPG supply stations.
- Training the staff for installing and maintaining the fuel converter on the transport means.

- Advocating advantages of LPG uses.
- Setting up incentive measures for LPG uses.

6.2.4. Implementing the road map of exhaust gases standards for road transport means

The decision on implementation road map of exhaust gases standards in road transport was issued by Prime minister in October 2005. It aims to reduce air pollution by road transport means. The targeted pollution limit is defined following the EU limit (Euro 2). This road map will be completely implemented in 2008.

6.3. Identification of barriers and policy needs

- High investment capital of the urban public railway transport system.
- Prevalent habit of using the private transport means.
- Incompletion of urban public transport system.
- Lack of LPG supply stations network for transport means.
- Lack of center for exhaust gases control.

6.4. Definition and selection of actions

6.4.1. Railway transport development

- Raising the rate of passenger and passenger.km from railway transport.
- Developing high speed train over 120km/h.

6.4.2. Transport development in big cities

- Improving the transport infrastructure in the big cities.
- Ensuring 25% of urban land for transport infrastructure.
- Limiting growth rate of motorbike under 10% per year.

6.4.3. Cleaner fuel transport means development

- Setting up appropriate policies on the land, tax, investment.
- Encouraging the use of the transport means using cleaner fuel (such as LPG).

CHAPTER 7.

THE TECHNOLOGY NEEDS ASSESSMENT FOR FORESTRY SECTOR

7.1. Overview on options and resources

Over 60% of Viet Nam's land area, some 16 million ha, is classified as forestland, and most of the forests are located mainly in the mountain zone. They have the most important erosion preventing, soil protecting and water- regulating functions and are a source of industrial raw materials and food products.

Forestland in Viet Nam is divided into three categories for administrative purposes: production forests, protection forests and special use forests.

7.1.1. Changing forest areas

Deforestation has been widespread for several decades, and remains a serious problem.

Table 7.1. Changes in forest cover between1943 to 2003

1,000 ha

Year / Types	1943	1976	1980	1985	1990	1995	1999	2002	2003
Natural forest	14.000	11.077	10,486	9,308	8,430	8,252	9,444	9,865	10,004
Plantation forest	0	92	422	584	745	1,050	1,471	1,919	2,090
Forest cover	43.0	33.8	32.1	30.0	27.2	28.1	33.2	35.8	36.1

Source: National 5 million hectare reforestation program 1998-2010, Hanoi 2001

- Between 1943 -1990 there was a steady and rather rapid decline in natural forest coverage. Although the area of plantations increased, it was too small to compensate for the decline in natural forests.
- Since 1990, the loss of natural forest has been much slower, only 36,000ha per year on average during the period 1990-1995. At the same time the area of plantations increased rapidly.
- Between 1995 to now, the areas of both natural forest and plantations increased rather rapidly.

Wood biomass reduction and worsening land status resulted in a reduction of air carbon accumulation by trees, shrubs, and soils, and an increase of soil carbon emission due to land erosion and degradation.

7.1.2 Forest development strategy

The aims of Forest development strategy to 2010: **Forest lands: 16 Mha, (48,3%),** from which is Protection forests: 6,0 Mha, (18,2 %); Special use forests: 2,0 Mil ha, (6,1 %); Production forests: 8,0 Mha, (24,3 %).

The regreening of barren land for watershed protection and effective conservation of ecosystems biodiversity and environment condition

Returning barren lands to efficient productions in order to alleviate poverty and promote sustainable development, especially in mountainous rural areas forestland.

7.1.3 1998 GHG inventory in forestry and land use change sector

CO2 absorption by biomass growth	- 43,47 Tg
CO2 absorption by biomass growth	+ 44,69 Tg
CH4, N2O Emissions (estimated in CO2 equivalent)	+ 3,49 Tg
CO2 absorption by natural regeneration	-12,04 Tg
CO2 emission from soil	-17,73 Tg
Total	**+ 10,40 Tg**

Compared with 1994 Greenhouse Gas statistics, the amount of CO_2 emission in 1998 about 9 tones of CO_2.

7.2. Selection of key technologies.

7.2.1. The identification of Technology needs assessment for forestry and land use change sector:

- The Identify that the Forests are major carbon dioxide storage facilities.
- The goal is to increase forestry productivity,
- The Objectives of reducing GHG emission can be met without compromising the goal of " National five million hectare reforestation programme (1998-2010)"

New plantation in Ha Tay province

The technologies needs for reducing GHG emission in forestry and land use change sector:

7.2.2. Forest protection immediate tasks are to strictly protect 12.094,518 hectares of forests, includes 10,004,709 hectares of natural forest and 2,089,809 hectares of plantation. The forest protection work requires not only forestry technology solutions but also economic and social regulations. The forest protection work is annually entrusted to the units and households.

7.2.3. Afforestation : The targets of afforestation up to the year 2010 are:

- Protection forest and special use forest: 2 million hectares
- Productive forest: 3 million hectares.

At present, thanks to hybridation of Acacia, Eucalyptus, the productivity of afforestation can reach 20m^3/ ha per year. Here are the results of some models types:

- Eucalyptus uro by intensive methods at the age of 7 - 8 reach 16m^3/ ha/ per annum.
- Eucalyptus caiman grown by seeds, intensive methods, at the age of 8 - 9 can reach 16m^3/ ha/ per annum.

Acacia mangium grown by seeds at the age of 8 can reach 17 - 18 m^3/ ha, per annum and can reach 20 - 25m^3/ ha/ per annum thanks to intensive planting.

The whole country had more than 6,771 million hectares of bare ground without forests including grassland, bushes, regeneration plants, rocks denuded of forests, which needs afforestation. Additionally, should recover the forest on 2 million hectares of barren forestland.

7.2.4. Natural forest recovery technology

Recovered natural forests bring much value in the fields of stable forest ecology, biological diversity, protection function, forest fire and insect prevention and fight. These recovered natural forests are considerably than the newly planted forests.

In order to accelerate the speed and to boost the quality of naturally recovered forests may put into effect the sylvicultural technological option solution of forest enrichment.

7.2.5. Planting scattered trees

Planting annually about 250 - 300 million trees all over the country, equal to 100,000 hectares.

7.2.6. Forest fire prevention and fight technology

In Viet Nam, there are about 5 million hectares of flammable forests comprising pin forests, cajuput forests, eucalyptus forests, bamboo forests, and dipterocarpus forests.

Forest fires left lots of fatal consequences on environment. Forest fires quickly consumed natural resources, destroyed tragically animal habitats, worsened and reduced forest stability, broke and destroyed the ecological balance.

Some general solutions to forest fire prevention and fight

- To boost awareness among the people, to make propaganda to the community of local inhabitants about the importance of forest fires prevention and fight handle.
- To establish the network of forest fire warning units on the basis of well informed documents supplied by hydro meteorological, weather forecast stations at all levels from the center to localities.
- To develop the system of telecommunication which is very useful and essential to forest fire forecast warning, to devise a scheme for fighting and preventing forest fires in a successful way.
- To carry out the silvicultural technological steps to reduce flammable materials.

- To erect and put up fire hindrance barriers, channels, canals, water reservoirs, guard towers with the functions of protecting the forests.
- To be equipped with modern machines run by the state.

Principal technology groups of solutions aiming at lessening GHG on forest sector are: Existing Forest protection, afforestation

7.3. Identification of barriers and policy needs

A lack of science research establishments

- A lack of local employees with high level to implement several projects.
- The obstacles in potential and finance
- The forestry projects with a long period of business rotation cycle of 30 - 40 years are not yet attractive for investors

7.4. Definition and selection of actions

To speed up forest plantation, regreen bare land, protect existing forests as well as new forests; increase the protective function of the forests and protect the environment and biodiversity; create favorable conditions for sustainable national development; and increase the forest cover to 40% of the national territory.

To prevent deforestation, to promote forest protection and care, to annihilate harmful insects, to carry out afforestation (on degraded and barren forest land) and to promote natural forest regeneration, the programmers of planting in the urban and rural areas

- To raise the efficiency of forest harvest, timber processing and the use of wood. To raise the efficiency of the use of forest products.
- To enhance and to raise the productivity of trees aiming at decreasing the mount of agricultural production land.

Classification of Land and Forests in the field to identify the forest land and classify it into the three categories (special-use, protection and production)

Research and application of advanced technologies for forest development:

- Search for, test and apply advanced techniques for forest rehabilitation through assisted natural regeneration.
- Study suitable planting techniques, apply intensive techniques in planting,
- Study the suitability of different tree species, the issue of seed quality
- Supply of seeds and seedlings and forest extension services

7.6. Stakeholders

At national level: Ministry of Agriculture and Rural Development (MARD); Department of Agriculture and Rural Development (DOA); Forest Inventory and Planning Institute (FIPI); Forest Science Institute of Viet Nam (FSIV); and others.

At international level: Food and Agriculture Organization of the United Nations (FAO); United Nation Development Program (UNDP); Netherlands Development Organization (SNV); and others.

CHAPTER 8

THE TECHNOLOGY NEEDS ASSESSMENT FOR AGRICULTURAL SECTOR

8.1. Overview on options and resources

The 9th National Congress of the Communist Party of Viet Nam has set up the direction of agricultural development in Viet Nam.

The goals of agricultural sector are:

- To satisfy the basic material, spiritual and cultural needs of all the people of Viet Nam, both present and future generation, through the wise management of natural resources;
- To develop all high valuable tree kinds via the intensive cultivation, new plantation in order to respond to the requirement of raw materials for processing industry.
- To form the regions of concentrated breeding, the firms of processing food-stuffs with several shape/scale types.

Strategic objectives are:

- To build diversified, commodity agriculture, develop in sustainable way, speedily access and effectively apply new scientific and technological achievements, high technology, and increase competitiveness in domestic and international markets.
- To build new rural areas with developed infrastructure, modern direction and rational economic structure: agriculture – industry - developing services.
- To ensure employment, poverty eradication, a civilized, democratic and equitable rural society, and wealthy life.

Immediate objectives are:

- Growth rate of agricultural production: 4 - 4,5% per year
- Growth rate of industry, services in rural areas: 10-12% per year
- Food production: 40 millions ton per year
- Export turnover: US$ 9-10 billion by the year of 2010 in which agricultural – forestry productions occupies US$ 6-7 billion.
- Effective exploit and use of wasteland and bare hill.
- Development of industry and service in rural areas and rural agriculture economy structure continues to shift following direction in which more than 50% of agricultural rural labor force transfers to industry and services; 100% of communes has primary schools, secondary schools, and health centers, and to make compulsory to everyone at primary and secondary education in some important regions; basically eradicate all serious venereal diseases and almost all households could access to electricity and clean water.

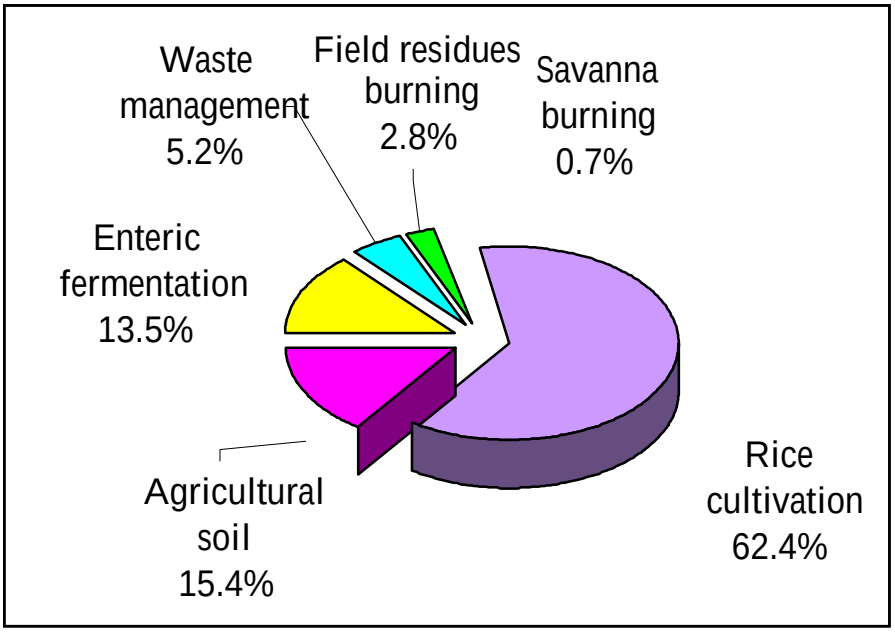
1994 GHG inventory in agricultural sector

The total of GHG emission from agricultural sector is 52.45 Tg CO2 equivalents. Rice cultivation is a highest sources of CH4, 32.8 Tg CO2 equivalent, occupy 62.4% total of agricultural sector GHG, followed by livestock, 9.8 Tg CO2 equivalent contributing 18.7%, and agriculture soil, 8.1 Tg CO2 equivalent, contributing 15.4%. The remain of sub-sectors: Field burning of agriculture residues and prescribed burning of savannas emit only 1.46 Tg CO2 and 0.4 Tg CO2 equivalents with 2.8% and 0.7% respectively. (table 8.1)

Table 8.1. 1994 GHG emissions from agricultural sector

Sub sector	CH_4 (*thousand tons*)	N_2O *(thousand tons*)	Total CO_2 equiv.(*million tons*)	% of total
Rice cultivation	1,559.7		32.75	62.4
Livestock - Enteric fermentation - Manure management	 336.6 129.0	 0.001	 7.07 2.71	 13.5 5.2
Agricultural soil land		26.0	8.06	15.4
Prescribed burning of savanna	15.9	0.2	0.40	0.7
Field burning of agriculture residues	51.7	1.2	1.46	2.8
Total	2,092.9	27.4	52.45	100

Figure 8.1. 1994 GHG emission inventory



8.2. Selection of key technologies:

8.2.1. The identification of TNA for Agricultural sector

The following approach was used to identify technology needs for GHG reduction in agricultural sector:

- Noting that the global environmental objective is to reduce GHG emissions.
- Identify that the goal is to increase agricultural productivity, supported by country program: "Making intensive cultivation of food crops and bio-diversification of the agricultural system".
- Incorporate global environment objectives in national development objectives.
- Aware that the global environment objectives of reducing GHG emission can be met without compromising the goal of increasing productivity in the agriculture sector.

Agriculture is the main source of methane (CH4) and nitrous oxide (N2O). Methane emission from rice cultivation and livestock occupied 81% total emission from agriculture in 1994. A significal fraction on the CH4 and N2O emitted from agricultural systems could be avoided if some combination of agricultural management practices listed in table 8.4 were adopted in rural areas.

The following are the significant potential technology needs identified to date for reducing GHG emission from livestock and rice cultivation

Table 8.2. The technologies needs for reducing GHG emission in Agricultural sector (livestock and rice cultivation)

No	Technologies	Potential for GHG reduction	Economic efficiency
1	Nutrient management for rice cultivation	M	L
2	Water management from rice paddy	H	M
3	Changing the cropping pattern from two-rice-crop to three crops system (Rice-upland crop-rice)	L	M
4	Directly sowing of rice paddy	L	L
5	Using biofertilizers on the field crops	L	M
6	Improved nutrition through mechanical and chemical feed processing providing to animal	M	M
7	Production enhancing agents for animal	M	M
8	Improved nutrition through integrated supplementation -MUB	M	H
9	Manure management by using digester's biomass for fuel woods in rural areas	M	H

L: low; M: medium; H: high.

However, three of nine technologies have been identified as the most promising technologies and are listed below:

- Water management from rice paddy
- Improved nutrition through integrated supplementation – feeding Molasses Urea Block (MUB)
- Manure management by using digester's biomass for fuel woods in rural areas.

These are the most potential methane reduction technologies and suitable for sustainable development in rural areas, promote agricultural production and bring about economic and environmental benefits to farmers.

8.2.2. Assessment of technology needs in Agricultural sector

a. Water management from rice paddy:

In Viet Nam, the rice production is still playing an important role for economic development. Rice production is 32.5 million tons in 2000 and will increase up to 40 million tons in 2010, 44 million tons in 2020. Intensive farming continues and application of new rice seeds is made to reaches the average output of more 4 tons/ha a crop.

Up to now, there are more 5 millions hectare of rice field under irrigated in the whole country, however it is only one per seven of irrigated area under controlling water irrigation and draining.

The development efforts should be focused on management irrigation water with the system of draining rice fields during the growing season in the areas with secures irrigation supplies. The objective of this technology is to have active irrigation and drainage in rice fields based on the water requirements for rice. Water during the two periods – first: the end of tillering and second: 15-20 days after flowering would be drained out from rice fields to increase rice production and reduction of GHGs emissions. The experiments for measuring CH_4 emission from rice paddies with intermittent draining technology was carried out in Viet Nam during 1998 - 2002.

Table 8.3. The experimental results on water management with intermittent draining for reducing CH_4 in Viet Nam

Location	Methane reduction (Spring season) $kgCH_4/ha$	Methane reduction (Summer season) $kgCH_4/ha$	Total year ($kgCH_4/ha$)
Red River Delta	28.8	45.7	**74.5**
Central Coast	24.7	40.6	**65.3**
Mekong River Delta	15.3	28.6	**44.3**

This experiment showed that the intermittent irrigation technology at two rice cultivation stages contributes greatly to reducing methane emission on rice fields. With the different fertilizer application, the methane emission reduction for two cropping season in Red River Delta, Central Coast, Mekong River Delta is 74.5, 65.3,

44.3 kg CH4 per ha/ year respectively. This reduction is equivalent to 8-11% methane emission of rice fields compared to continuously irrigate.

It is estimated that the rice areas with water management would be 5 million hectare by 2020 including 1.1 Mha in Red River Delta, 0.6 Mha in Central Coast and 3.3 Mha in Mekong River delta under this technology.

The total amount of CH4 reduction is expected of 149,938 t CH4/ year, or 3 Mt CO2 equivalent/year.

b. Improved nutrition through integrated supplementation - feeding Molasses Urea Block (MUB).

The objective of this technology is to increase quantity and quality of the processed food for ruminant animals and proportion of micro-matters for higher meat and milk production, meanwhile, to reduce GHGs emission.

Manipulation of methanogenesis in the rumen is also possible through MUB feeding where poor quality roughage is used. Research in India and Bangladesh demonstrated that milk production in cows was doubled when MUB were given with straw based diets (Islam and Begum, 1997) which could be seen as an indicative of reduced methane emission. Strategic supplementation with MUB could promote efficient fermentation digestion and thereby decrease methane generation per unit digestive feed by 30 % to 50% of digestible energy.

In Viet Nam, studies concerning feeding supplement of MUB were carried out with the results that supplementation of MUB tends to increase ruminant gained weight by 10-18%, milk production by 13 – 15%. This technology is cost efficient, as the principle ingredients of MUB were locally available at low prices such as molasses, lime, cement, mineral, and groundnut pond....

With MUB provision, ruminant feeding time will be reduced. Estimated time will be 3 months shorter in comparison with without MUB. In this case, methane emission reduction by providing MUB is estimated about 11 kg CH4/ head/year. It is expected to provide MUB for 3.6 M head of buffalo and 5.8 M head of cattle in 2010. The GHG reduction potential by this technology is 103.6 Gg CH4/01 year, or 2.17 M ton CO2 equivalent/ 01 year.

c. Manure treatment by using digesters in rural areas.

The objective of this technology is to use biogas (formed from decomposition of animal waste/manure) as an alternative cooking and heating fuel for households in rural areas. It reduces the expenditure for firewood in rural areas and improves environmental sanitation.

Digesters are designed to enhance the anaerobic decomposition of organic matters and to optimize methane production and recovery. Small-scale digesters typically require a small amount of manure and are relatively simple to build and to operate. Therefore, they are an appropriate strategy for small - medium farms. These digesters are also suitable for countries with limited technical and financial resources such as Viet Nam. So that the number of installed digesters has been increased from 10.000 digesters in

2000 to 80.000 digesters in 2004.

It is expected that biogas digesters will be largely installed in rural areas of Viet Nam with a number of 300,000 plants by 2010 and reaching 500,000 plants by 2020. The GHG reduction potential is 14 Gg CH4/ year or 294 Gg CO2/year equivalents.

8.3. Identification of barriers and policy needs

8.3.1 Water management from rice paddy

- The incompletion of irrigation system, especially draining system causes difficulties for implementing this technology.
- The farmer rice cultivation tradition is to keep water in the field.
- The irrigation canal and ditch system has not been strongly built.

8.3.2 Improved nutrition through integrated supplementation - feeding MUB.

- The feeding habits are still free grazing. There is lack of care about intensive farming in many areas of the country.
- The size of cattle and buffalo group is not large enough for this technology application.
- Storage for MUB is needed, however there is lack of storehouses.

8.3.3 Manure treatment by using digesters

- The farmer's investment capital is very limited.
- Viet Nam animal husbandry is still dispersed widely.
- Digester design appropriate for different regions is on going development.

8.4 Definition and selection of actions

The suggested actions in agriculture sector can be described as below:

- Studying and developing new agricultural farming techniques with a view of increasing agricultural production as well as mitigating GHG emission.
- Improving irrigation-drainage management system in rice fields.
- Strengthening capacities of agriculture research institutions.
- Improving agricultural data banks and processing facilities to serve specialized research in agriculture and climate change.

Table 8.4. The aspects of technical, finance, policy and institution to implement

Technology	Technical aspects	Financial aspects	Policies	Institutional aspects
Water management from rice paddy	1. Planning water conservation in the rice cultivation areas. 2. Expansion of high yield varieties of rice. 3. Saving water on irrigation with high effectiveness	Financial sources included: 1. Government investment for main pumping system and main irrigation canal. 2. Farmers investment (in-kind). 3. Investment from oversee organizations: (GEF, ADB, WB)	1. Land tenurial rights. 2. Soft loan for farmer. 3. Low irrigation fee	1. Joint committee between agricultural agencies and farmers. 2. Setting up the consumption irrigation water communities in rural
Improved nutrition through integrated supplement-action – feeding Molasses Urea Block (MUB)	1. Providing MUB for ruminant feeding for high yields. 2. Developing of advanced hybrid varieties. 3. Upgrading firms of producing the concentrated strains	1. Government investment for feed processing industry. 2. Farmers investment 3. Joint venture investment	1. Assured markets and price of animal products. 2. Bank for lending credit to farmers with low rate of interest	1. Setting up selling animal feed network to farmer. 2.Joint committee between agricultural agencies and farmers, business- man.
Manure management by using digester's biomass for fuel woods in rural areas.	1. Using biogas as an alternative fuel for households in rural. 2. Improving rural environment 3. Creating a sources of organic fertilizers for crops	1. Farmers investment 2. Oversee investors and donors	1.Bank for lending credit to farmers with low rate of interest. 2. Supporting the research for continuing and sustaining development of biogas	1.Joint committee of communities in rural areas 2. Establishment the institution for researching biogas and it's application in Viet Nam

Table 8.4 presented the aspects of technical, finance, policy and institutions to implement above-mentioned technologies in Viet Nam. These aspects are also made important contributions to reducing GHG in agricultural sector.

8.5 Stakeholders:

At national level: Ministry of Agriculture and Rural Development (MARD); Departments of Agriculture and Rural Development in Provinces/Cities (DARD); Institute of Agricultural Science and Technology (IASC); Institute of Soil Science (IOSS); Institute of Agricultural Economies; National Institute of Agricultural Planning and Projection.(NIAPP); Department of Water Resources Management, MONRE; Viet Nam Union of Science and Technology Association (VUSTA) and others.

At international level: United Nation Development Program (UNDP); Food and Foodstuff Agriculture Organization (FAO); Netherlands Development Organization (SNV); and others.

PART II:

TECHNOLOGY NEEDS ASSESSMENT FOR ADAPTATION TO CLIMATE CHANGES

Introduction

The TNA for adaptation to climate change is a continuation of the work performed under the Viet Nam's First National Communication and inventory. Unlike the Viet Nam's First National Communication and Inventory the TNA for adaptation is focused on Viet Nam's agriculture, water resources and coastal area rather than on its overall territory.

Why Viet Nam's costal area?

Viet Nam's agriculture, water resources and coastal area is the most important part of the country from the economic and human activity viewpoint. It generates a large number of services and goods that are valuable to the country. It has attracted many people and investors, especially for the tourism development opportunities.

The vulnerability analysis under Viet Nam's First National Communication and Inventory has shown this area as of high vulnerability to current climate. Expected changes in temperature and precipitation patterns as well as the expected increase in sea level are likely to impact significantly in this area. This is the main reason that the vulnerability and adaptation team has decided to narrow the focus of assessment to this area.

IPCC Methodological and Technological Issues in Technology Transfer, 2000

The coastal adaptation technology to climate change must be seen as part of broader coastal-management policy, which includes consideration of numerous non-climatic issues. It typically follows a continuous and iterative cycle involving four main steps:

- Information development and awareness raising;
- Planning and design;
- Implementation and
- Monitoring and evaluation.

To date, technology transfer for coastal adaptation has focused primary on the implementation stage: the actual hardware that can be employed to protect, retreat and accommodate. Coastal adaptation should also aim at increasing the extend to which mechanisms are in place and technologies, expertise and other resources are available to assist.

CHAPTER 9

IDENTIFICATION AND ASSESSMENT OF ADAPTATION TECHNOLOGIES NEEDS ON AGRICULTURE, WATER RESOURCES AND COASTAL ZONE MANAGEMENT

9.1. Overview on options and resources

The term adaptation means any adjustment, whether passive, reactive or anticipatory, that is proposed as a means for ameliorating the anticipated adverse consequences associated with climate change (Stakhiv,1993) [10]

The Intergovernmental Panel on Climate Change (IPCC) is aware that taking measures on reducing GHG emissions only is not enough to prevent the dangerous human impact on the climate change. Work on adaptation is of great importance for sustainable development, rational natural resources management and human health protection.

The V&A assessment within "Viet Nam - Initial National Communication under the UNFCCC" document showed that the agriculture, water resources and coastal zone management sectors are defined as the most vulnerable sectors influenced by climate change. So that appropriate adaptation measures and technologies could reduce or prevent unfavorable consequences of climate change, providing a general preparedness for climate change and a contribution to sustainable development.

The major factors of adaptation technology needs assessments are as bellows

- Adaptation can considerably reduce the climate change unfavorable impacts in the long and mid-term prospects.
- Increasing the adaptation potential is urgent to decrease vulnerability of the poor in rural regions, of too sensitive natural resources and national economy sectors.
- Measures and technologies can considerably reduce damages and expenditures.
- The adaptation potential is very different in different regions and socio-economic groups; however it is poor regions and poor groups that are most vulnerable, having great difficulties in the process of adaptation to climate change.

9.2 Selection of key technologies in agricultural sector

9.2.1 Background

The vulnerability assessment showed that a considerable dependence of the agricultural production on climate conditions and their variability. Every year, the unfavorable weather conditions and phenomena such as storms, flood, inundation, drought, and salt water intrusion ....cause considerable damage to the agricultural sector of the country.

In August 1996, large floods occurred on the Red River, 120 km of dykes was eroded by flooding combination with high tides. In November 1997, typhoon Linda struck the coastal area of Southern Viet Nam, thousands of fishermen's were killed and thousands of fishing ships and boats were damaged or sunk . In November 1999, two extremely heavy rain storms inundated a large area of central Viet Nam. Massive losses resulted.

With the change of climate conditions, the flood, drought, heavy rain, typhoon, salt water intrusion... will occur more frequently that could seriously affect agricultural production. The damages could be even worse in the future if appropriate protective measures are not undertaken.

9.2.2 The Key adaptation technologies in agricultural sector

a. Cultivation sub-sector:

- Increasing irrigation water use efficiency: Increasing irrigation efficiency by shifting from the low performing, surface and overhead systems, to high performance ones like the centre pivot and drip. On the other hand, reducing water consumption by adopting drought tolerant cultivars.
- Developing crop patterns suitable to climate change: Cropping seasons and cropping structure should be rearranged to take advantage of favorable conditions and avoid hazardous ones.
- Improving irrigation system: Gradually improving the existing irrigation and drainage pumping station network in the Red River Delta, Central Coast zones and constructing multipurpose reservoirs to increase low flows in dry season.
- Developing new species and varieties adapted to climate change: Selecting heat, drought and pest resistance crop varieties for improvement of crops yield and quality under climate change condition, it would be beneficial for crop adaptation..
- Creating and introducing local crop varieties, resistant to unfavorable climate conditions; establishing crop seed bank by setting up national research center for new species and varieties.
- Developing farming techniques appropriates to climate change: Changing the time of farm operation to better fit new climate conditions such as advanced sowing dates to offsets moisture stress during dry season.
- Changing farming practices to conserve soil moisture and nutrients, to reduce runoff and to control soil erosion

b. Livestock sub-sector

- Designing and constructing animal breeding farms and ranches with its facilities suitable for climate change.
- Improving feeding nutrition by using protein, vitamin and mineral supplements.
- Using feeding supplements such as MUB to reduce extensive grazing and to increase production.
- Developing animal interbreeding, selecting and applying technologies which are suitable to different ecological and climatic conditions.

9.2.3 Identification of barriers and policy needs

- Lack of access to information on adaptation technologies.

- Lack of investments and financial support for adaptation.
- Limitation of research capacity on adaptation technologies.
- Lack of comprehensive adaptation policy and legal framework

9.3 Selection of key technologies in water resources

9.3.1 Background

Water resources are vital for socio-economic development. Impacts of climate change on the water resources can cause risks, therefore assessment of the risks and adaptation technologies is very necessary.

Yaly Hydro Power in Gia Lai province

In assessing the impacts of climate change and adaptation technology on water resources, the representative basin approach is used. A basin is chosen from three hydro climatic zones: Red River Delta from the north river system; Mekong River Delta from the south river system and Central Coastal zones from the Central Coast river system.

The average simulation of CSIRO is used to develop simulation of climate change in Viet Nam for assessment of climate change impacts and/or development of adaptation measures and technologies in various areas.

The models (RRMOD- Rainfall Runoff Model, SSARR- Simulated Stream flow And Reservoir Regulation) are used for calculating and assessing the variation of annual run-off, low flow and flood flow according to the respective scenarios.

Viet Nam is located in down streams of two big international rivers: Mekong and Red Rivers. The Mekong river basin area is about 795,000 km^2 (including Tonlesap and Delta), annually; water runoff to the East Sea is 505 billion m^3. The Red River has a basin of 169.000 km^2; annually it transports to the East Sea 138 billion m^3 of water. So, for whole territory, the total runoff reaches 835 billion m^3.

The spatial and temporal distribution of runoff is very uneven. More than 80% of run-off concentrates in summer (5-6 months), the rest 20% of run-off distributes for 6-7 months in dry season. In some areas (for instance, in the mountainous areas of Thua Thien, Bac Quang provinces), run-off is high, the module reaches 75-80 $l/s/km^2$, but in some areas, run-off module is small and only reaches 10-12 $l/s/km^2$, such as in the rivers of Binh Thuan province.

Beside surface water, the ground water that can be exploited annually is 50 billion m^3, i.e. equivalent to module of 4.8 $l/s/km^2$ or the depth of ground water of 150 mm annually.

The Red River and Mekong River Basin

In 2070 annual run-off changes from +4% down to -19%, the change of low flow is rather significant from -2% down to -24%. Because daily rainfall increases from 12 to 19%, the peak discharge increases significantly and return period also decreases. The flood peak, which formerly had return period of 100 years, now only 20 years. The flood peak, which formerly had return period of 20 years, now only 5 years, etc., i.e. the frequency of flood occurrence would be higher.

The Medium and small rivers basin

The studies show that by 2070, the biggest decrease of annual run-off would be recorded in the East of South Viet Nam (29-33%), Central Viet Nam from Quang Binh to Quang Ngai province (23-40.5%), North Viet Nam and North of Central Viet Nam (2-11.5%), and biggest increase in extreme South of Central Viet Nam (49%), Central Highland (6-16%).(table 9.1)

Table 9.1. Change of annual run-off due to climate change impacts

Basin	Yo:At present (mm)	By 2070	Change (%)
- Ma & Chu	890	797	-11.5
- Yen	838	829	-2.1
- Hoang Mai	741	723	-3.5
- Ca	1,130	1,093	-4.3
- Rao Cai	1,440	976	-33.3
- Rac	1,730	1,596	-7.8
- Gianh	2,330	1,790	-23.2
- Ta Trach	2,362	1,350	-42.9
- Tra Khuc	2,072	1,256	-39.4
- An Chi	2,073	1,235	-40.5
- Hinh	1,677	2,511	+49.7
- Cai Nha Trang	1,420	1,504	+5.9
- Luy	438	653	+49.0
- Se San	1,310	1,397	+6.6
- Srepok	1,080	1,255	+16.2
- Ba	720	1,710	-4.0
- Dong Nai	1,119	794	-29.1
- Be	1,053	708	-32.8
- Sai Gon	656	363	-44.7
- Vam Co	447	221	-50.6

+ Yo (mm): the depth of annual run-off

+ For the case "at present", the data series of 1961-1990 was used

When air temperature increases by 1^oC, 2.5^0C, the potential evaportranspiration would increase by 3%, 8% respectively.

Water requirement for agriculture: Due to warming effect the water demand for food crops particularly rice crops will be increased. The studies showed that the projected increase in irrigation water requirement for rice paddy referenced to the base period water requirement due to climate change by 2070 would be 5.12 billion m3.

9.3.2 The key adaptation technologies in water resources sector

- Building reservoirs with the total additional capacity of 15-20 billion m^3 for containing floodwater to mitigate losses caused by floods, meanwhile, regulate water during low-flow season. The high priority should be given to the East of South Viet Nam, Central Highland and mountainous areas in North Viet Nam.
- Upgrading and rising the scale of drainage system;
- Increasing the irrigation system efficiency and introducing new methods of irrigation and water saving including rehabilitating and reconstructing irrigation systems to reduce water losses.
- Encouraging water-saving technologies in industry, agriculture, households and water management.
- Increasing the adoption of drought tolerant cultivars.
- Conducting studies in long-term water resources prediction.

9.3.3 Identification of barriers and policy needs

- The uncertainty related to the precise climate change scenarios to enable confident evaluation and qualification of impacts remains a major problem. It is thus very difficult to identify the most appropriate adaptation measures and the related technologies.
- The lack of financial resources and capacity of irrigation managers.
- The lack of knowledge and information on adaptation technologies in water resources

9.4 Selection of key technologies in coastal zone management

9.4.1 Background:

Viet Nam has more than 3,260 km of coastline and more than 1 million sq. km of sea lying in the Southeast Asian inter-tropical monsoon zone. The coastal and sea area covering nearly half of the provinces, one-fourth of the districts and one-sixth of the population of the country, is of great importance in terms of economic development and national defense. It is of great scenic beauty and typical of tropical eco-systems such as submerged forests, coral reefs and estuary and coastal swamps.

Climate change with potential impacts of sea level rise, as well as increase in sea temperature on coastal systems of Viet Nam is considered the most damaging. The impact is not limited to a narrow coastal zone but will even be more serious further inland. This is caused by the raise of the river beds and the backwater effects which has much more influence in the riverside area than near the sea where the river is usually very wide and deep due to tidal action. According to previous studies carried

out under the Asian Development Bank, GEF, and UNDP...it has been estimated that:

a. Flood and inundation:

Sea level rise by 1m would cause flood and inundation; about 40,000 km2 will be flooding annually. 17 million people will be subject to annual flooding; over 14 million of these will be in the Mekong delta provinces.

The wetlands affected and threatened by sea level rise could be as much 1700 km2 which are about 60% of Viet Nam's coastal wetlands. Most seriously area will be the forest of Ca Mau province, Ho Chi Minh City, Vung Tau and Xuan Thuy sea forest areas.

b. Mangrove forest

Sea level rise might make a large number of existing forests totally under water. Other climate change features would also affect characteristics and structures of mangrove. Warmer winter would create favorable conditions for development of mangroves in coastal zone of North Viet Nam, but in coastal zone of Central Viet Nam, the increasing dry, hot and drought weather would adversely affect the growth and development of mangrove forest. Aggregation and erosion occurring in many coastal places would increase and stronger wave that would adversely affect mangrove forest.

c. Residential areas and construction

Sea level rise would make a great area of land in the Mekong, Red River deltas and Central Coastal zone become narrower, unless an enough high dyke system would be built. On the other hand, storm surge would be stronger, threaten structures in the coastal zone and low lands.

Sea level rise would threaten industrial, transport and national defense structures that were designed according to present sea level. The increase of flood and inundation would negatively affect the foundations of structures. The increase of typhoons, tornadoes would require strengthening the resistance of structures that lead to increase of their costs.

d. Sea products and fisheries

Due to sea level rise, hydro-physical hydro-biological and hydro-chemical regimes would be degraded, and as a result, the existing coenobium would change its structure and components, supplemental reserve would reduce seriously. It is predicted that economic sea product capacity would reduce at least one third in comparison to the present.

Due to increasing temperature, benefit resources distribution would be more dispersed. Meanwhile, the number of tropical fishes with low commercial value, except tuna, would increase. The number of sub-tropical fishes (with high commercial value) would decrease or even disappear. Most fishes in coral reef would vanish.

9.4.2 Selection of key adaptation technology in coastal zone management

- *Full protection*: implement all-sided protection measures to maintain present situation, effectively response to sea level rise. This option requires making all

dykes higher and strengthening coastal management. To prevent salinity intrusion, pumping for drainage and making land foundation higher would be very necessary.

- *Accommodate*: reform infrastructures and habits of the people living in the coastal zone to adapt to sea level rise. To accept some losses, paying special attention to build "adaptive" infrastructures and transfer to suitable farming techniques.
- *Withdrawal (also called "Retreat"):* Avoid natural impacts of sea level rise by resettlement, moving houses, and infrastructures from threatened areas. This option would also include natural landward migration of wetlands as a response to sea level rise.

In accordance with reality, in each locality one or two above-mentioned strategies could be used and implemented. However, in nation-wide scale, there should be combination of all three strategies.

9.4.3 The key adaptation technology in coastal zone management

- *Full protection*: It would require to improve and enhance existing sea dike system of 2700 km and to build additional ones of 2000 km. A sophisticated system of sea dikes already exits in the northern part of the country. In the Mekong Delta, however, the existing sea dike system needs to be strengthened considerably to meet national standards devised for future climate change. The costs required upgrading the existing sea dike system and to build a new one is about US$ 870 million.

  Coastal erosion protection by groynes that they are structures placed perpendicularly to the shore to trap sediments often in direct response to an acute erosion problem. It will be constructed at the most serious threat beaches such as Hai Hau, Ngo Chien district's beach.

  Hand-placed rock sea walls are the ones that demonstrated to be an effective technology. Hand placed rocks to form sea walls are a common line of protection used. Placed correctly and maintained the sea walls for protecting waves and sea level rise.

- *Accommodate:* Raised lands for special industrial areas, which are part of the Government's development plans, will be raised; Raised houses raising in height of about 1m above the highest flood level will be required to improve the present safety level of the population in some areas. The total cost is estimated at US$ 3.7 billion;

  Pumping: Improvement of pumping system and pumping capacity to relieve floods in waterlogged areas where rainwater and infiltration water collects behind the dykes. Total cost for pumping installations and upgrading works is estimated at US$ 2 billion with an annual operating and maintenance cost required of US$ 200 million;

  Flood warning system: These systems provide real-time forecasts of high tides, surges and wave overtopping

- *Withdrawal (also called "Retreat"):*Replacement casements such as coastal access roads may need to be rearranged far in advance of their erosion/ submergence

  Setback building distance: This is a buffer zone between the shoreline and permanent structures, which protect properties in the event of sea level rise and more frequent flooding.

9.4.4 Identification of barriers and policy needs

- Limitation of institutional capacity, lack of infrastructure and insufficient legislations and regulations relating coastal zone management.
- High cost of coastal engineering projects.
- Development of an ICZM programme is still in an early stage.
- Coastal adaptation technologies cannot be extrapolated from one site to another because the very different conditions from one to other.
- Lack of integration of climate change issues and environment protection into coast zone management programmes.

CHAPTER 10

PARTICIPATION IN SYSTEMATIC OBSERVATION NETWORKS

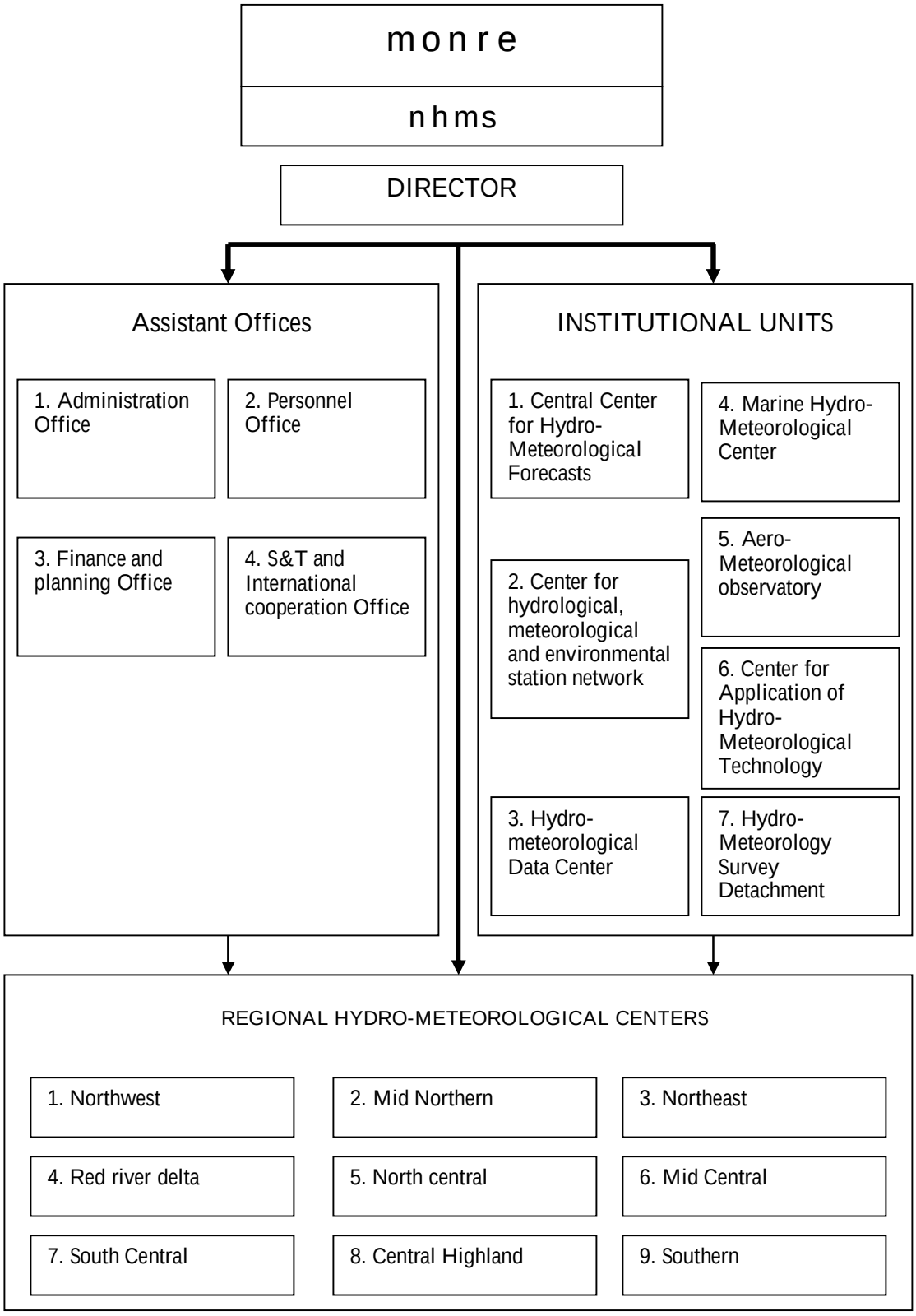
10.1 Hydro-Meteorological Networks

Located in the tropical monsoon area, adjacent to the East Sea and the North West Pacific Ocean, Viet Nam has diversified and prosperous climate resources, however it is also affected by a lot of natural disasters, especially typhoon, flood and drought. Hydro-meteorological activities in Viet Nam have been systematically carried out since ancient time.

In 1976, the Hydro-Meteorological Service (HMS) of Viet Nam was officially established in basis of corporation of Meteorological Agency and Department of Hydrology from the Ministry of Water Resources. HMS was an Agency directly under the Government of the S.R. Viet Nam and had the responsibility to provide information, data and materials on meteorology, hydrology and atmospheric and water environment including periodical meteorological and hydrological forecasts with different time ranges, the forecasts and warnings of natural disasters such as typhoon, flood and drought, etc. to meet the requirements of natural disaster prevention, preparedness and socio-economic activities.

In August 2002, the Ministry of Natural Resources and Environment (MONRE) was established. Since then, the National Hydro-Meteorological Service (NHMS) has been an institutional organization under MONRE and responsible for most functions and tasks of the former HMS.

Figure 10.1. Organization chart of NHMS



The NHMS's local units:

- 9 Regional Hydro-Meteorological Centers (RHMCs)
- 54 Provincial Hydro-Meteorological Centers (PHMCs)
- Observation station network

10.1.1 Meteorological stations network

Total 168 stations, divided into 3 categories:

Class 1: Weather watch: 24/24 hrs; Observation of: *Wind (direction & speed), Rainfall, Air pressure, Air Temperature, Humidity, Sunshine, Evaporations, Land Temperature (ground and deep layers); Cloud, Visibility, Ground conditions, Radiation (at some stations).* Data collection & transmission: 8 obs/day

Class 2: *Same as class 1*, but not doing the observation of radiation, air pressure (at some stations). Data collection & transmission: 4 obs/day

Class 3: *Same as class 2*, but not doing the observation of air pressure. Data transmission at request.

- Class 1: **57**
- Class 2: **65**
- Class 3: **46**
- Synoptic : **122**
- Climatic : **46**
- Radiation : **13**
- Agro. met. : **27**
- Belong to Global Observing System: **25**

The Water and air environment monitoring station network:

- Laboratories: 3
- Water of river, lake, sea, air environment stations: 143

The Aero- Meteorological Observation:

- Radiosonde stations: 3
- Wind-gauge by theodolite (Pilot): 7
- Ozone and UV : 3
- Weather radars: 6

The Marine Hydro-Meteorological Observation:

- Marine Meteo. Stations: 21

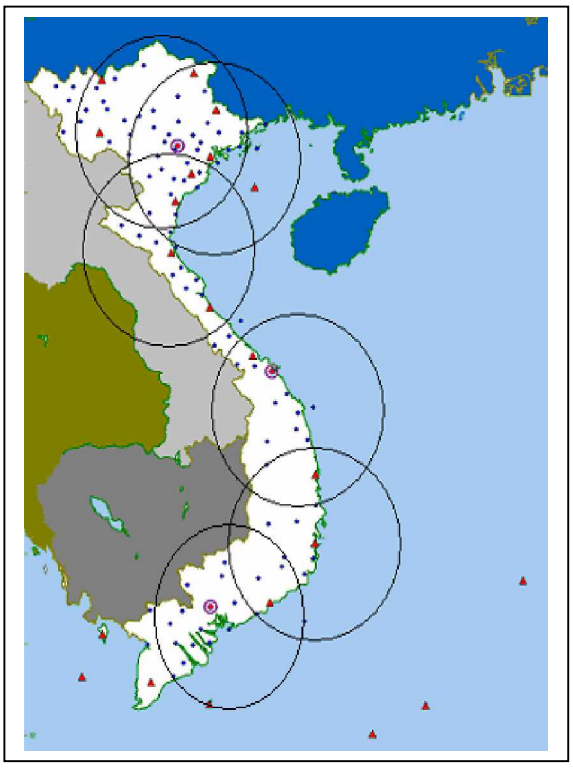


Figure 10.2. Weather radars network

- Marine Research vessel: 1

10.1.2 Hydrological stations network

Total: 232 stations, divided into 3 categories:

Class 1: Hydraulic condition watch: 24/24 hrs; Measurement of: *Water level, Discharge, Sediment load, Water temperature, Air temperature, Rainfall.*

Class 2: Same as class 1, but *not measurement of Sediment load*

Class 3: Same as class 2, but *not measurement of Discharge and Sediment load*

- Class 1: **60**
- Class 2: **20**
- Class 3: **152**
- Water level recorder: **88**
- Tidal influence: **100**
- Non tidal influence: **132**

Calibration of hydro-meteorological instruments: The National Hydro-Meteorological Service is equipped with good calibration equipments and is authorized by the Government to conduct calibration of such meteorological and hydrological instruments as air temperature, humidity, atmospheric pressure, wind speed and flow speed.

10.1.3 System of Hydro-Meteorological forecasts

The NHMS is responsible for providing information on hydro-meteorological, marine forecasts for the needs of natural disaster prevention and preparedness, social and economic activities.

The system of hydro-meteorological forecasts includes three levels:

- Central level realized by Central Center for Hydro-Meteorological Forecasts (CCHMF)
- Regional level realized by Regional Hydro-Meteorological Centers (RHMCs)
- Provincial level realized by Provincial Hydro-Meteorological Centers (PHMCs)

10.1.3.1 Meteorological forecasts

1. Services:

Weather services consist of short-range, medium-range and long-range forecasts. The following forecasts and warnings are issued by CCHMF to the public:

(a) Weather Bulletins are issued for different inland regions, some cities and coastal water areas of Viet Nam 3 times/day. A weather forecast for the whole country covers the rest of the day and/or the next day depending on the time of issue of the forecast, and a weather outlook for 48 hours.

(b) Tropical Cyclone Warnings issued 4 times/day increasing to 8 times/day depending on the relative position of TC center to threatened coastal areas. The warnings contain information on the location and movement of the tropical cyclone, its intensity and the likely effects on Viet Nam.

(c) Warnings of other meteorological hazards includes Heavy rain warnings are included in weather bulletins; Cold air surge warnings are issued 4 times/day providing warning of strong winds and cold weather; Very Hot Weather Warnings are included in weather bulletins

2. Forecasting tools:

The CCHMF constantly keeps a close watch on the changing weather situation to make a notification to RHMCs as well as to the public.

The main method used in weather forecasts is synoptic method in accordance with the usage of satellite imagery, radar imagery and NWP products.

Synoptic method: is performed by analyses of current weather charts, which are constructed from surface observations and radiosonde observations. The weather charts used in Viet Nam are composed of about 400 to 500 surface observations and approximately 200 to 300 upper observations over the World transmitted to the CCHMF by GTS.

Satellite imagery: During 5 years form 1997 to 2002 the satellite ground reception system at the CCHMF had been receiving high-resolution cloud images from GMS-5. Since the back up of GMS-5, 22 May 2003, the CCHMF has implemented the reception of GOES-9 IR1 data through Internet from the Japan Meteorological Agency (JMA) server.

In 2003, the polar satellite receiving station was maintained and enhanced to receive cloud images of 5 channels from NOAA-15, NOAA-16, and NOAA-17 satellites. Supplying high-resolution images and provided with the observation of 3.7 μm channel, NOAA satellite images enable very detailed observations of severe weather phenomena, particularly at night when visible images of GMS-5 were not available.

Since the transition to GOES-9 of Geo-stationary satellite, NOAA images have become especially important in operational weather forecasting and monitoring of severe weather systems such as Tropical cyclones.

The application of satellite images in rainfall estimation has been carried out at the CCHMF. Such kind of products is useful in assessing the rainfall situation and tendency over interested area, particularly where the conventional network of rain gauge observations is not dense. These products are provided to Hydrological Division to help in water level and flood forecasting.

Besides, additional satellite information, such as Quikscast, TRMM, TraP... accessed through internet web pages are used in procedure of TC forecasting.

Radar imagery: Radar observation network in Viet Nam is currently consisting of 6 weather radar stations, locating at Phu Lien, Viet Tri, Vinh, Tam Ky, Nha Trang and Ho Chi Minh city. Observations of three stations at Phu Lien, Viet Tri, and Vinh are regularly transmitted to the CCHMF each 3 hours.

NWP models: NWP products provide an objective tool for weather forecasts with estimations of the timing and intensity for weather system developments up to several days. Recently, meteorological forecasts are heavily dependent on NWP products.

Digital projects of global models have been received via internet form overseas meteorological centers, such as JMA since 1997 and Bureau of Meteorology (BoM), Australia since 2000.

Graphical NWP projects of UKMET, ECMRWF, USA, Korea... are referred to through web pages.

To further enhance the forecast accuracy in Viet Nam The NCHMF has begun operating a High Resolution Numerical Model (HRM). The HRM originally developed by DWD (for shared memory computers (base on the OpenMP standard) firstly were installed in WS IBM RS/6000 with 2 CPU in 2000). Later, this code was developed for distributed memory systems like Linux PC clusters (based on the MPI standard) by the Viet Namese HRM group in co-operation with a local Institute of Mathematics, Viet Nam Academy of Science and Technology (VAST). This new MPI version HRM had installed on a PC-based parallel computer with 8 processors and been running operationally since May 2002. The newest version of HRM model with horizontal resolution of 14 km is capable of estimating the development of relatively small scale weather features up to 72 hours. Besides this the ETA model obtained from NCEP ftp severs has also been running in experimental mode since middle of 2003.

Moreover, bar tropic model WBAR and some statistical models for tropical cyclone track forecasts are run in case of tropical cyclones.

To make the best benefit of the NWP application, digital products from HRM models and other models, such as GSM (JMA) and TLAPS (BoM) are displayed in the graphic form with different combination of information by using GrADS software. These products are put on Local Area Network inside CCHMF and also distributed to other RHMCs for guidance in daily operational forecasting. Some outputs from HRM model are served as initial conditions for other models such as WAM, hydrological models.

In this year, a NAWPIS (NCEP Advanced Weather Interactive Processing System) system obtained from NWS (NOAA) was successfully installed on PC-Linux at NCHMF (with the latest version GEMPAK 5.7.3). This system is a complex convenient tool for forecasters as it can produce observations maps, display NWP products and overlapping several products (NWP, satellite images, observations). NAWIPS system has been put into operations at CCHMF since June, 2004.

10.1.3.2 Hydrological forecasts

1. Services

Products of hydrological services contain short-range, medium and long-range forecasts for all rivers in Viet Nam territory.

(a) Hydrological bulletins on water level and discharge forecasts are issued everyday with lead time of 5 days in rainy season and of 10 days in dry season for 20 main rivers along the country. Monthly and seasonal forecasts: there is a prediction of maximum water level in a forecast period.

(b) Flood warnings with lead time form 12 to 48 hours are issued once/day and twice/day in case of emergency. Medium flood forecasts with lead time from 5 to 10 days are issued everyday for some main rivers in the North and in the Lower Mekong river.

(c) Warnings of other hydrological hazards on drought warning

2. Forecasting tools

Hydrological forecasts in Viet Nam are mostly based on conceptual models, and statistical methods.

- *Conceptual models*: There are several types of conceptual models such as SSARR, TANK, NAM operationally used in forecasting for several main rivers. New MARINE and Hydraulic models for short-term flood forecasting and flood control have been applied for Red and Da rivers.
- *Statistical models*: Multi-variable regression models and objective statistical models have been developed for some specific rivers, such as Da river, Red river, Thai Binh river, Mekong river.

For improvement of hydrological forecasts it is necessary to expand the observation network and the system for real time data collection. There have been considerable efforts to set up more hydrological stations and automatic stations for the observation network in Viet Nam, up to now there are about 232 hydrological stations scattered over the country. At CCHMF, software for the preservation of hydro-meteorological database, for hydrological data collection and processing has been developed and put into operation.

Recently, all researches mainly focus on developing new hydrological models with the use of new technology, such as GIS... to improve the capacity of flood forecasting.

In addition, the more attention is also paid to the Improvement of hydrological products to meet users' requirements and expectation, for example, the improvement of hydrological forecasting products for Hoa Binh hydro-electric power regulation (in Da river); the improvement of hydrological forecasting products for the building of new hydro-electric power Son La in Da river; the improvement of hydrological forecasting products for the irrigation of reservoirs in the North; and the improvement of hydrological forecasting products for Regulating of all hydro-electric power systems in Viet Nam.

3. Product disseminations:

To governmental offices: tropical cyclone warnings and flood warnings are directly sent through fax or by WAN to the Central Committee for Natural Disaster Prevention and other Ministries such as Ministry of Aquiculture, Ministry of Telecommunication, Ministry of Agriculture and Rural Development.

To the public: All the forecasts and warnings are sent to RHMCs through WAN; broadcasted on the Viet Nam National Television, Voice of Viet Nam, local Televisions, daily newspapers.

In recent years, CCHMF makes effective use of an Internet website (http://www.nchmf.gov.vn) for dissemination of all meteorological and hydrological information to the public.

To special users: forecasts and warnings are also supplied at cost to special users through fax or telephone. Such users include private firms, public utilities and hydro-electric power plants and other companies whose operations are meteorological and hydrological sensitive.

International telecommunication system of NHMS

- Hanoi - Moscow: 100 bauds
- Hanoi - Beijing: 75 bauds
- Hanoi - Bangkok: 1200bps
- PCVSAT: Hanoi - Beijing: 9600bps

Domestic telecommunication system of NHMS

- Telephone line
- WAN
- MetTV

Figure 10.3. NHMS's Communication network

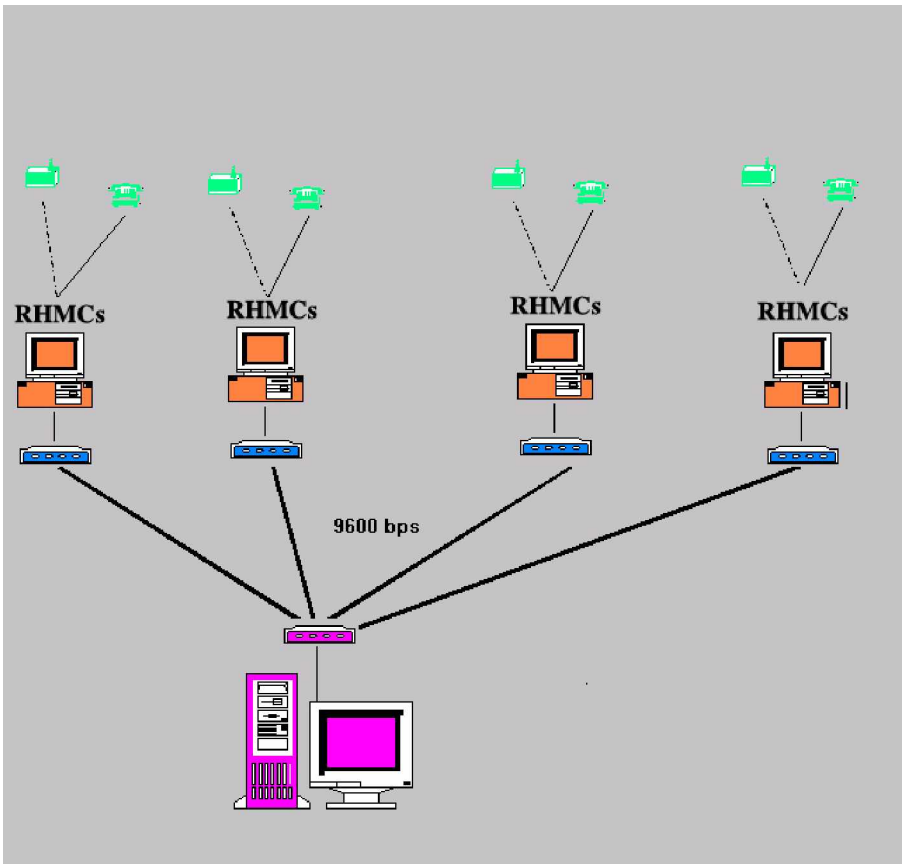


Figure 10.4. NHMS's WAN

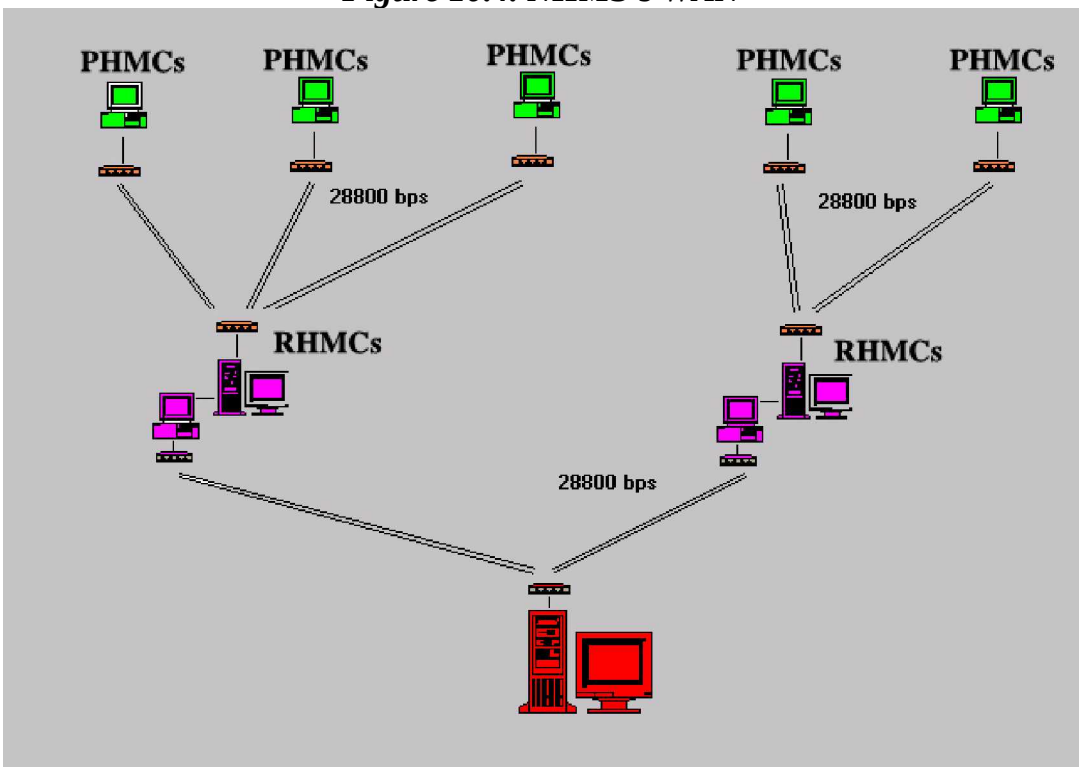


Figure 10.5. NHMS's MET TV

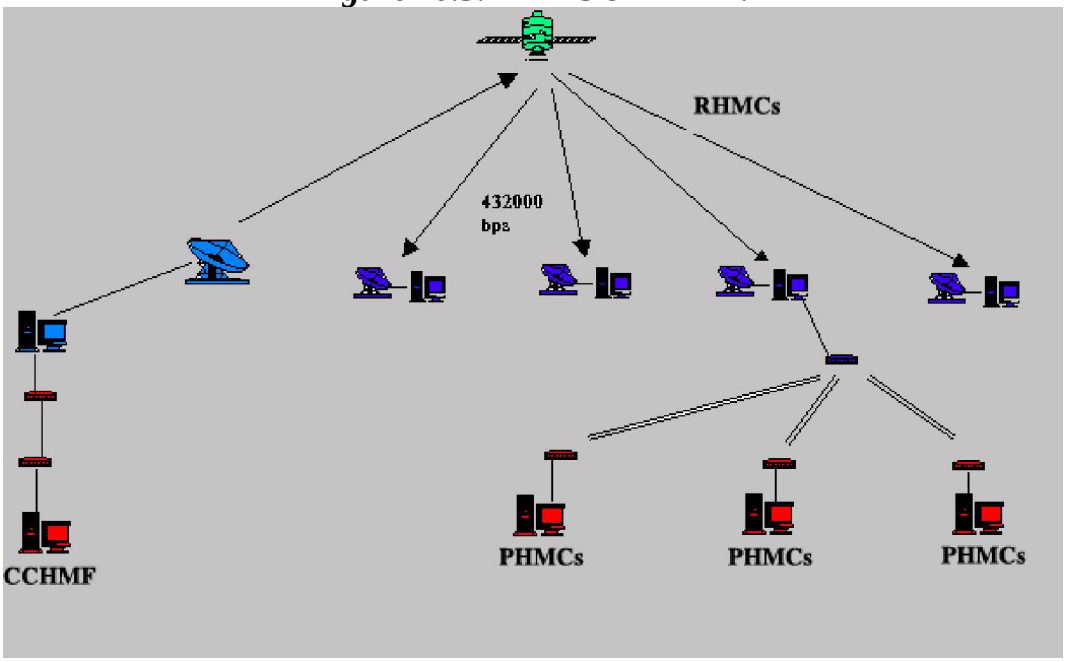


Figure 10.6. Data Processing system

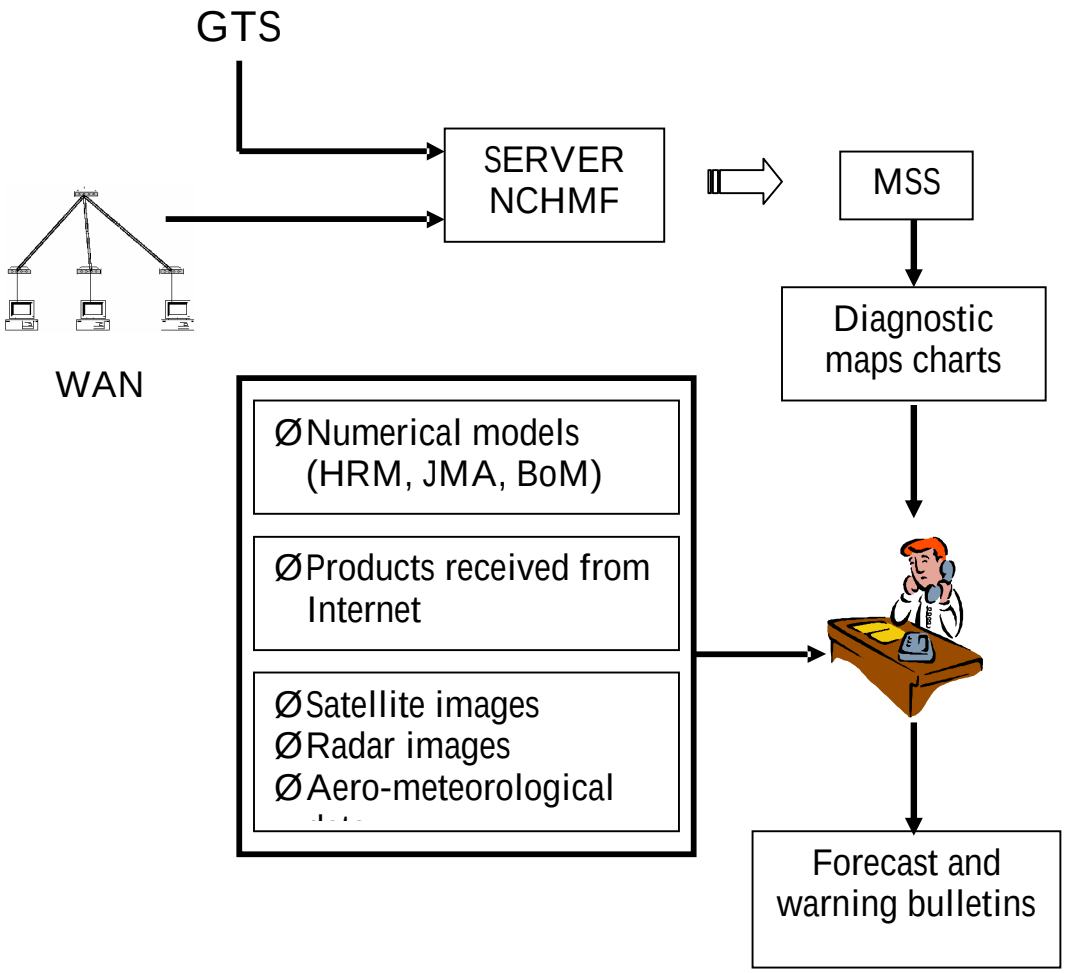


Figure 10.7. Forecasting system

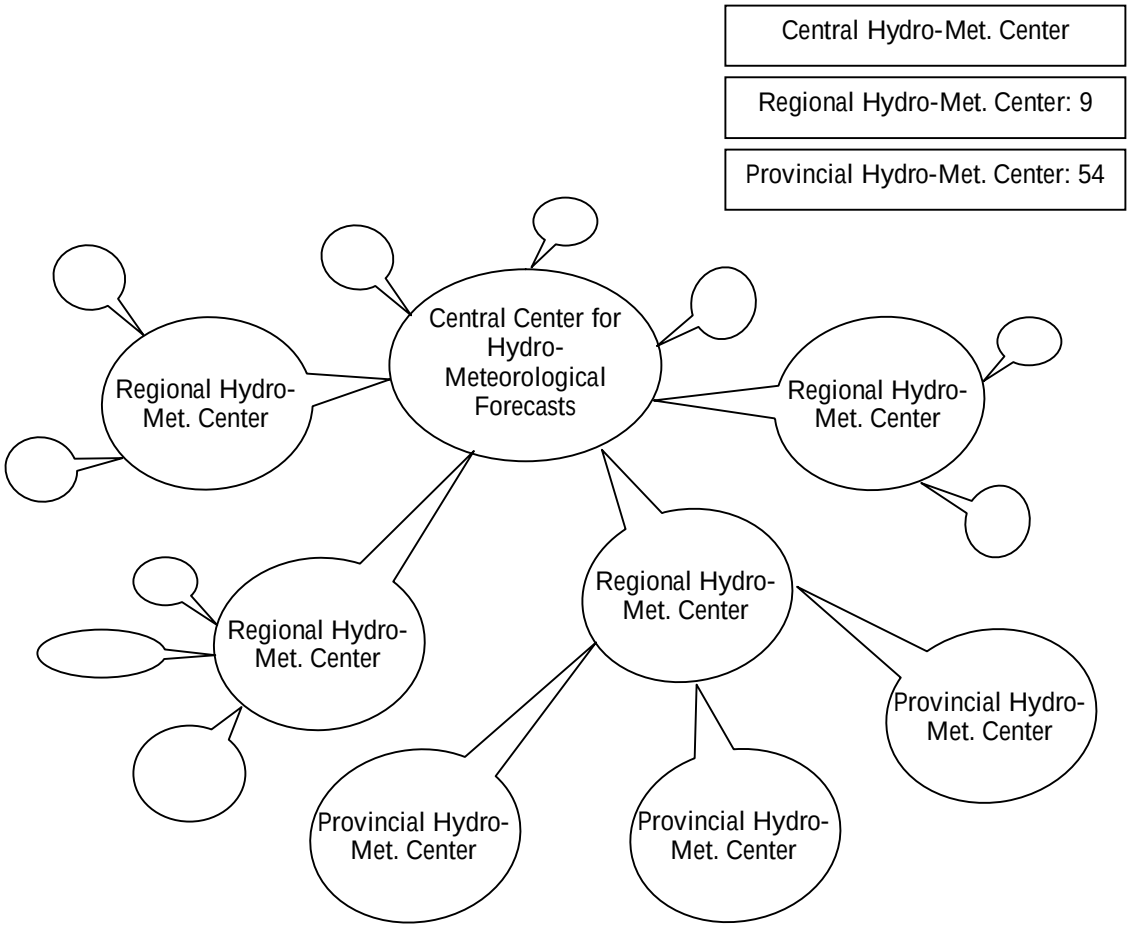
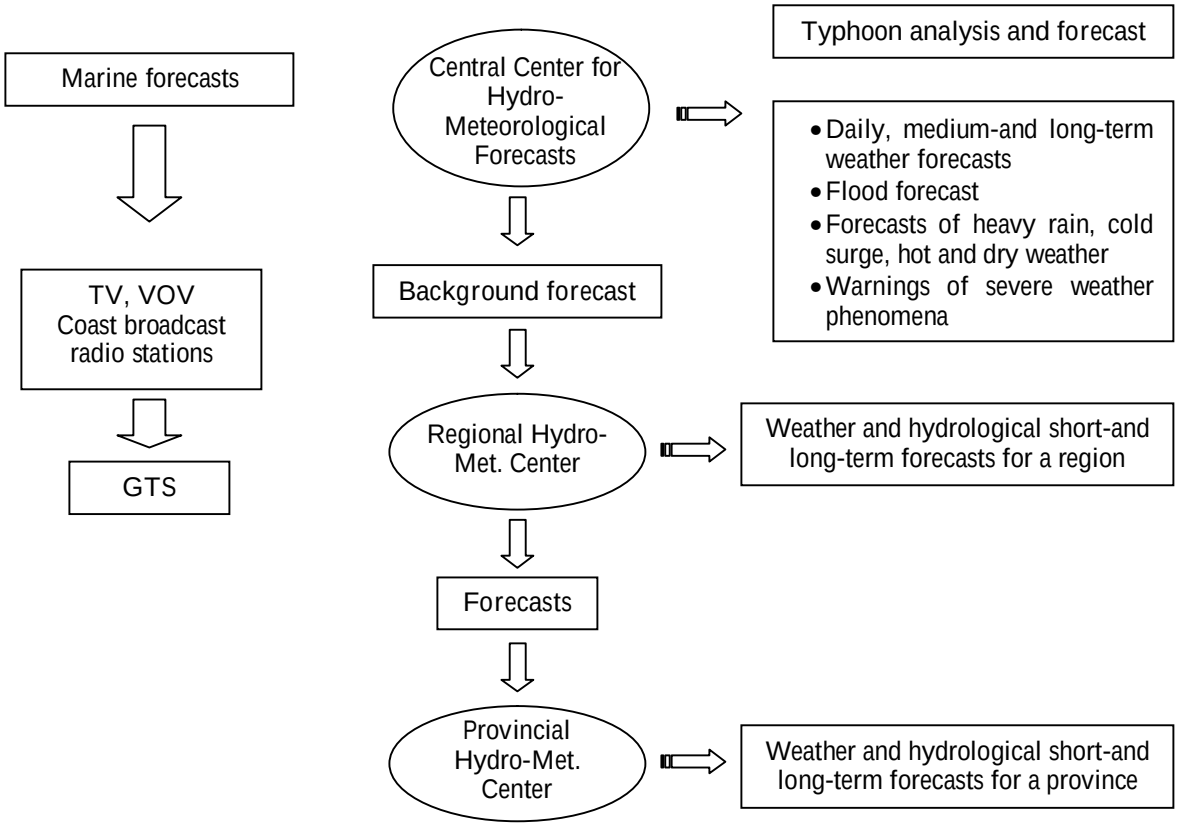


Figure 10.8. Functions of each forecasting level



Weather and climate bulletins

- Daily weather (land and waters): 3 times/day
- Warnings of severe weather
- Cold surge: 4 times/ day
- Typhoon and tropical depression: according to special regulations (up to 8 times/day)
- 10-day forecast
- Monthly
- Seasonal

Hydrological bulletins

- During flood season: 1 time/day
- Flood summary: According typhoon-flood alert regulation
- Medium-term flood forecast: 1 time/5 day (during flood season), 1 time/10days (during dry season)
- Monthly and seasonal forecasts
- Drought forecast

Forecasting methods

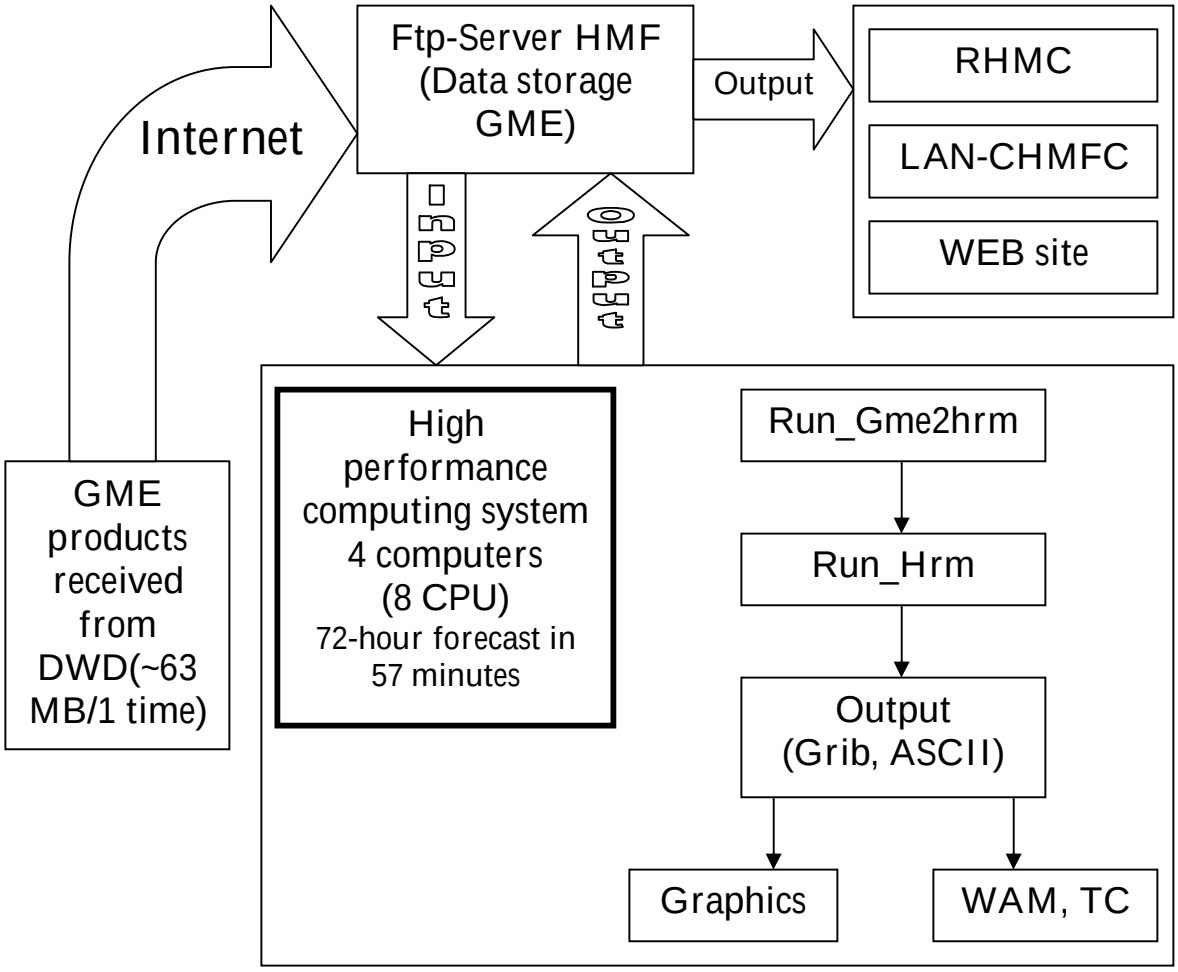
- Synoptic / statistical methods
- Numerical prediction models
- NWP products
- Utilization of Satellite images
- Utilization of Radar images

Numerical weather prediction models

- The Limited Area Model HRM (Germany) with resolution of 28 km (put into operation since May 2002).
- The ETA model (US) with resolution of 37 km (under test since mid of 2003).
- Barometric model WBAR for prediction of typhoon track (tested for 2003 typhoon season).

FLOWCHART OF GME-HRM MODEL

AT THE CENTRAL CENTER FOR HYDRO-METEOROLOGICAL FORECASTS



10.1.4 Research and international cooperation activities of the National Hydro-Meteorological Service (NHMS) of Viet Nam

Viet Nam has been the member of World Meteorological Organization (WMO) since 1955 and participated in Regional Association II (Asia), Typhoon Committee (TC), Sub-committee on Meteorology and Geophysics (SCMG), International Hydrology Programme (IHP), Mekong River commission (MRC). Viet Nam participates in the WMO Programmes such as World Weather Watch (WWW), World Climate Programme (WCP), Atmospheric Research and Environment Programme (AREP), Applications of Meteorology Programme (AMP), Hydrology and Water Resources Programme (HWRP), etc.

NHMS cooperates with international and regional organizations: UNDP, WB, UNEP, UNESCO, ESCAP, ADB, IHP, ASEAN... Besides, NHMS cooperates with GEWEX Asian Monsoon Experiment (GAME) and Soundings of Ozone and Water in the equatorial region (SOWER). These programmes provided NHMS with scientific equipment and expendables to make ozone and water vapour sonde observations in Viet Nam.

NHMS has bilateral cooperation with many WMO member countries in the world and in the region such as:

- Germany on tropical cyclone dynamics and problems of forecasting tropical cyclones.
- Australia on numerical weather prediction...
- Russia on enhancing MRL-5 radar, exchanging of ozone and ultraviolet data and researching marine hydro-meteorology.
- Japan on remote sensing studying and improving quality of weather prediction...
- America on flood forecasting, numerical weather prediction and marine hydro-meteorology researching
- China on typhoon forecast research
- Italy on early flood warning

Besides, Viet Nam also cooperates with France, Norway, Korea, Lao PDR, Cambodia and others.

10.2 The main barriers in developing the observations network

There are the following main barriers, which are characteristic to the observations network in Viet Nam.

- NHMS does not have enough modern and complete equipment.
- Many equipments, and devices used in the observation and monitoring networks are outdated and worn-out.
- Lack of highly qualified specialists

- The participation in the Global Climate Observing System and other networks in the world appear difficult.
- The assistance in consolidating and developing the observation and monitoring networks as well as improving meteorological and hydrological staff's technical knowledge, skills from International Organizations and developed countries is needed.

10.3 Development orientation of the National Hydro-Meteorological Service of Viet Nam up to 2015

The NHMS of Viet Nam conducts the implementation of hydro-meteorological infrastructure survey, collects and evaluates hydro-meteorological materials and elements; processes and supplying hydro-meteorological information, materials and forecast; appraises hydro-meteorological technical standards of projects on infrastructure construction, renovation, expansion and upgrading of hydro-meteorological constructions; organizes the registration, issuance and withdrawal of operation licenses of hydro-meteorological constructions in accordance with the provisions of law

Development orientation Goal of NHMS:

a) Enriching data sources (quantity, quality, in time) for weather, hydrological forecast and warnings:
    - Consolidating and upgrading observation network to meet requirement of storm and flood forecasting and warning activities;
    - Reequipping stations network;
    - Updating observation technology;
    - Strengthening hydro-met. Survey capabilities;

b) Improvement of forecast capabilities
    - Improvement of telecommunication facilities;
    - Interpretation of satellite and radar images
    - Familiarizing and mastering new observation equipment and technologies

c) Improvement of meteorological, hydrological, environment data collection, processing, archives and service system:
    - Improving the management system of meteorological and hydrological data to meet increasing needs of socio-economic activities, scientific research, etc.
    - Strengthening the material technical base for hydro-meteorological documentation.

CONCLUSIONS

The present document focuses on TNA for Energy, Industry, Transport, Forestry and Agriculture sectors and on the identification and assessment of adaptation technology needs in Agriculture, Forestry, Water resources and Coastal zone management sectors in Viet Nam.

This work will effectively contribute to the further climate change activities in Viet Nam and the preparation of the Viet Nam Second National Communication on Climate Change to UNFCCC Secretariat.

Technology needs assessments allow Viet Nam to identify their climate change adaptation technology transfer priorities and develop effective strategies to address them. They can be powerful instruments for focusing the attention of government agencies, the international donor community and private sector investors on a well-defined set of priority activities. These needs assessments will be most successful when they focus on technologies and actions that meet national development goals while also responding to climate change concerns, and when implementation actions complement existing development programs. Effective technology needs assessments actively engage all key stakeholders, including government officials, businesses, technical institutions, and international partners in the selection of technology priorities and design of actions to overcome barriers to technology implementation.

Experience has shown that the individual actions of the step-by-step methodology presented in this report are much less effective if performed in isolation. A comprehensive, integrated approach—spanning identification of priority technologies, evaluation of implementation barriers, design and implementation of priority actions, and follow-up evaluation—maximizes the chances of success for any technology transfer program since it not only results in well-informed, detailed technology transfer strategies but also provides the basis for countries to secure the technical and financial support necessary to implement their technology transfer activities.

REFERENCES

1. Asia Development Bank – Climate change in Asia: Viet Nam country report, 1994.
2. Bui Huy Phung - Identification of GHG redution technologies in Service and Household, Hanoi 2004.
3. Master plan for Cement development, 2002.
4. CTI - Methods for climate change technology transfer needs assessments and implemention of activities: Experiences of developing and transition countries, 2002.
5. Dang Kim Chi and Nguyen Van Siem - Environmental Effect due to the Usages of Fossil Fuel in Transport Sector - Research No. KHCN-09-05, Hanoi, 1998.
6. Ha noi Department of Science, Technology and Environment - VIE/00/004 project report/ set up a model of vertical shaft brick kiln with high efficiency, 2002.
7. Headed by Bui Huy Phung - Report of project on studying planning to use effectively energy resources in Viet Nam, Hanoi May 2005.
8. Hydro-Meteorological Service of Viet Nam - Viet Nam coastal zone vulnerability assessment, 1996.
9. Hydro-Meteorological Service of Viet Nam - Summaries of the results of research, observation and monitoring of climate change tendency in Viet Nam, 2000.
10. IPCC - Methodological and Technological issues in technology transfer, 2000.
11. Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, IPCC/OECD/IEA, 1996.
12. IUCN Viet Nam - Forest rehabilitation policy and practice in Viet Nam, 2000.
13. J.Sathaye and Stephen Meyers - Greenhouse gas mitigation assessment: A Guidebook, 1995.
14. Master Plan for Transport Development in Viet Nam up to 2020 - Decision No. 206/2004/QD-TTg of the Prime Minister.
15. Ministry for Nature Protection of the Republic of Tajikistan - Phase II of the initial National Communication: Capacity Building in Priority Areas of Tajikistan, 2003.
16. Ministry for Nature Protection of the Republic of Tajikistan - The first national communication of the Republic of Tajikistan under the United Nations Framework Convention on climate change, 2003.
17. Ministry of Agriculture and Rural Development - National Five million-hectare Reforestation Programme, 2001.

18. Ministry of Construction - Survey data of Institute of Science of Construction Material, 2001.
19. Ministry of Environment & Science of Ghana - Ghana's Climate change technology needs and needs assessment report, 2003.
20. Ministry of Environment of Republic of Indonesia - Identification of less GHG emission technologies in Indonesia, 2001.
21. Ministry of Industry - Draft of National Energy Policy, Hanoi April 2005.
22. Ministry of Industry - Draft of National Target programe on Energy Saving and Efficiency on period of 2006 - 2015, Hanoi, June 2005.
23. Ministry of Industry - Research of Environmental and Industrial waste water programme, 1999-2000.
24. Ministry of Natural Resources and Environment - UNEP/GEF project, Report on Expert's survey results on screenning and assessing the GHG emission reduction and addaptation technology need criteria, 2005.
25. Ministry of Natural Resources and Environment - Viet Nam Initial National Communication on Climate Change, 2003.
26. Ministry of Planning and Investment of Viet Nam - The strategic orientation for sustainable development in Viet Nam, 2004.
27. Mitra A. P - Methane emission in rice paddies in India, 1996.
28. National Communications Support Programme, 2000. Workshop Report on Vulnerability and Adaptation Assessment - Jacarta, Indonexia, May 2000.
29. National Politics Publishing House - Documents of the 9th National Congress of the Communist Party of Viet Nam, 2001.
30. National Project 1996-2000 - NSS on Sustainable Energy Development in the period 2000-2020.
31. Nguyen Mong Cuong - Climate change of vulnerability and adaptation assessment on agricultural sector in Viet Nam, 2002.
32. Nguyen Mong Cuong - Identification of technology needs for climate change adaptation in agricultural sector in Viet Nam, 2004.
33. Nguyen Mong Cuong - National GHG abatement strategy and action plan in agricultural sector in Viet Nam, 1999.
34. Nguyen Mong Cuong - The results of experiments on measuring of methane emission on rice fields under intermittent draining technology in Viet Nam, 2002.
35. Nguyen Thi Anh Tuyet - Brick and ceramic industry in China, Viet Nam, India, Philippines and Sri Lanka: A study on Energy and Environment Issues, ARRPEEC Fellowship Report submitted to Energy Program, Asian Institute of Technology, Thailand, August 2000.

36. Nguyen Tien Nguyen - Report of Identification of technology needs GHG reduction emission in the energy sector, CD4CDM Project, April 2004.
37. Nguyen Trong Sinh - Impacts of climate change on water resources and sustainable development strategy, 1994.
38. Nguyen Van Thong - EE options in Viet Nam Steel corporation, report at training workshop on CDM project development.
39. Nguyen Xuan Quang - Survey of brick production in Viet Nam.
40. OECD and IEA information Paper - An Initial View on methodologies for emission baseline iron and steel case study, June 2000.
41. OECD Cement baseline methology, 2001.
42. Pham Khanh Toan & Nguyen Van Hanh - Evaluation of technology needs GHG reduction emission in production, consumption of electricity and energy in Viet Nam. Project "Expedited financing for measures for capacity building in priority areas", July 2005.
43. Planning for the Development of Road Network in Viet Nam up to 2010 and Orientations till 2020 - Decision No. 162/2002/QD-TTg, dated 15th November 2002 of the Prime Minister.
44. Research Center for Energy and Environment. CDM project document of hydropower plant, 2004.
45. Shukla P. K - Climate change and India, Vulnerability assessment and adaptation, 2003.
46. Stakhiv.E - Evaluation of IPCC adaptation strategies, 1993.
47. Strategies on Developing the Viet Nam Railways up to 2020 - Decision No. 06/2002/QD-TTg, dated 07th January 2002 of the Prime Minister.
48. The European steel industry and the climate change, November 2000.
49. The Mauritius Meteorological Service (MMS) - Technology Needs Assessment and maintenance and enhancement of capacities for climate change activities in Mauritius, 2004.
50. The State Hydro-Meteorological Committee of Azerbaijan Republic, 2001 - Phase II of the initial National Communication: Capacity Improvement Activities on Climate change in the Priority Areas of Economy of Azerbaijan.
51. Tran Thanh Xuan - Impacts of climate change on rivers flow, 1999.
52. UNEP - Economics of Greenhouse Gas Limitations: Methodological Guidelines, 1999.
53. UNEP - Handbook on methods for climate change impact assessment and adaptation strategies, 1998.
54. V.M. Shastri - Steel sector and CDM potential, October 2003.

55. Viet Nam - NSS on CDM, 2004.
56. Viet Nam Statistical Yearbooks of 1990, 1995, 2000, 2002, 2003, 2004, 2005.
57. Viet Nam Thermal Association - Brief introduction of vertical shaft brick kiln, April 2004.

ABBREVIATIONS, MEASUREMENT UNITS, EXCHANGE UNITS

No	Abbreviation	Explanation
1.	^0C	Degree Celsius
2.	ADB	Asian Development Bank
3.	AFTA	ASEAN Free Trade Agreement
4.	AMP	Applications of Meteorology Programme
5.	AREP	Atmospheric Research and Environment Programme
6.	BAU	Business As Usual
7.	BOF	Basic Oxygen Furnace
8.	CC	Climate Change
9.	CCHMF	Central Center for Hydro-Meteorological Forecasts
10.	CDM	Clean Development Mechanism
11.	CH_4	Methane
12.	CO_2	Carbonic
13.	DARD	Department of Agriculture and Rural Development
14.	DNA	Designated National Authority
15.	DOI	Department of Industry
16.	DONRE	Department of Natural Resources and Environment
17.	DOST	Department of Science, Technology
18.	DRI	Direct Reduced Iron
19.	DSM	Demand side management
20.	EAF	Electric Arc Furnace
21.	EE	Energy Efficiency
22.	ES	Energy Saving
23.	EVN	Electricity of Viet Nam, a state own corporation
24.	FAO	Food and Agriculture Organization of the United Nations
25.	FIPI	Forest Inventory and Planning Institute
26.	FO	Fuel Oil
27.	FSIV	Forest Science Institute of Viet Nam
28.	GAME	GEWEX Asian Monsoon Experiment
29.	GDP	Gross Domestic Product
30.	GEF	Global Environment Facility
31.	GHG	Greenhouse Gas

32.	GO	Governmental Organization
33.	HMS	Hydro-Meteorological Service
34.	HWRP	Hydrology and Water Resources Programme
35.	ICD	International Cooperation Department
36.	IHP	International Hydrology Programme
37.	INC	Initial National Communication
38.	IPCC	The Intergovernmental Panel on Climate Change
39.	IRR	Internal Return Rate
40.	ISP	Integrated Steel Plant
41.	JMA	Japan Meteorological Agency
42.	KP	Kyoto Protocol
43.	MARD	Ministry of Agriculture and Rural Development
44.	MOF	Ministry of Finance
45.	MOFA	Ministry of Foreign Affair
46.	MOFi	Ministry of Fishery
47.	MOI	Ministry of Industry
48.	MONRE	Ministry of Natural Resources and Environment
49.	MOST	Ministry of Science, Technology
50.	MOT	Ministry of Transport
51.	MPI	Ministry of Planning and Investment
52.	MRC	Mekong River commission
53.	MT	million metric tons
54.	MTOE	mt of oil equivalent
55.	MUB	Molasses Urea Block
56.	MW	Mega Watt
57.	NGO	Non- Governmental Organization
58.	NHMS	The National Hydro-Meteorological Service
59.	NIAPP	National Institute of Agricultural Planning and Projection
60.	NSS	National Strategy Study
61.	NWP	Numerical Weather Prediction
62.	O&M	Operation and Maintenance
63.	PHMC	Provincial Hydro-Meteorological Center
64.	RE	Renewable Energy

65.	RECTARE	The Research Center for Thermal Equipment and Renewable
66.	RHMC	Regional Hydro-Meteorological Center
67.	SCMG	Sub-committee on Meteorology and Geophysics
68.	SD	Sustainable Development
69.	SNV	Netherlands Development Organization
70.	SOWER	Soundings of Ozone and Water in the equatorial region
71.	TC	Typhoon Committee
72.	TCS	Ton of crude steel
73.	TNA	Technology Needs Assessment
74.	TV	Viet Nam Television
75.	TWh	Tera Watt hour
76.	UNDP	United Nations Development Programme
77.	UNEP	United Nations Environment Program
78.	UNFCCC	United Nations Framework Convention on Climate Change
79.	VAST	Viet Nam Academy of Science and Technology
80.	VND	Viet Nam dong - currency unit of Viet Nam
81.	VSBK	Vertical Shaft Brick Kiln
82.	VUSTA	Viet Nam Union of Science and Technology Associations
83.	WAN	Wide Area Network
84.	WB	World Bank
85.	WCP	World Climate Programme
86.	WMO	World Meteorological Organization
87.	WWW	World Weather Watch

Unit		**Exchange Unit**
cm	Centimeter	
m	Meter	
km	Kilometer	10^3m
ha	Hectare	10^4m^2
km^2	Square Kilometer	10^6m^2
t	ton	10^6g
Kt	Kilo ton	10^9g
Tg	Tetra gram	10^{12}g
Mha	Million hectare	

THE LIST OF POTENTIAL PROJECTS FOR MITIGATING GHG EMISSIONS

Project 1. The Model Project for Renovation to Increase the Efficiency Use of Energy in Brewery in Thanh Hoa, Viet Nam

Location

No 152, Quang Trung Street, Thanh Hoa province

Project participants

- Thanh Hoa Beer Joint Stock Company (Project site of BTH)
- Ha Noi Alcohol Beer and Beverage Corporation or HABECO (Parent company of the project site)
- Research Institute of Brewing or RIB (A division of HABECO, Technical advisor to BTH)
- Ministry of Industry (Government office in charge of HABECO)
- Mayekawa MFG, Co., Ltd.

Activity

Overall renovation for energy conversation of a medium-size Thanh Hoa brewery company in Viet Nam

Capacity

Beer production in 2003 and 2004 is 42,000 kL. It is expected to expand beer production substantially to 53,000 kL driven by strongly growing demand in Viet Nam

Technology

Energy saving technologies used in the project are an integrated system of:

- Vapor Recovery Compressor or VRC
- Improvement of refrigeration efficiency & thermal storage
- Optimization of pasteurizer efficiency
- Biogas boiler

They are transferred from Japan

Time schedule

Project time schedule:

- Starting date of the project activity: 01/04/2006
- Expected operational lifetime: 30 years

Crediting period:

- Starting date: 01/04/2006
- Length: 10 years

Baseline methodology

Category of project activity:

- Large scale energy efficiency improvement project
- Demand side energy efficiency programs for specific technologies

Methodology: "Specific consumption rate projection for demand-site brewery energy saving processes". This a new methodology not approved by EB yet.

Baseline scenario is:

- Utilizing current level of energy saving system
- Continuation of current practices for wastewater treatment before increasing beer production capacity
- Utilizing aerobic wastewater treatment system

CO2 emission reduction

Total CO_2 emission reduction amount during 10 years is 121,257 tCO_2.

Project 2. Environmental Forestation in A Luoi District, Thua Thien Hue province

Location

Hue city, Thua Thien Hue province

Project participants

- A Luoi distric People's Committee
- A Luoi Farmer Union
- A Luoi State Forest Enterprise
- Netherlands Development Organization

Activity

This project is a reforestation project in A Luoi district

Capacity

3000 ha

Technology

Normal

Time schedule

Project time schedule:

- Starting date of the project activity: mid 2004
- Expected operational lifetime: 30 years

Crediting period:

- Starting date: end 2004
- Length: 7 or 10 years

Baseline methodology

Category of project activity: Sequestration (reforestation of degraded temperate grasslands or arid lands by tree planting and plantation for wood products)

Methodology: N/A.

Baseline scenario is continuous degrading bare land. Reforestation could not happen through budge constrains and low return on investment.

Estimated CO2 reduction

27,528 tCO_2/year.

Project 3. Song Con 2 Hydroelectricity

Location

Dong Giang district, Quang Nam province

Project participants

- Song Con Joint Stock Company
- Central Construction Corporation
- Research Center for Energy and Environment and Asian Carbon Group (project developer)

Activity

Hydro electricity generation

Capacity

57 MW

Technology

Normal

Time schedule

Starting date of operation: N/A

Starting date of construction: N/A

Expected operational lifetime: 30 years

Baseline methodology

Category of project activity: Renewable electricity generation for a grid.

Methodology: A new methodology will be proposed.

Baseline scenario is: Viet Nam national electricity grid.

Estimated CO2 reduction

110,448 tCO_2/year.

Project 4: Development of renewable energy

Background

Viet Nam has big potential of renewable energy: 2000 MW of small hydro-power, 80 MW of biomass power, 100 MW of household hydro-power, 1 MW household solar battery, rich wind power sources in coastal zones and islands.

Project on renewable energy aim at rapid application of new energy technology through elimination of barriers and reduction of implementation costs. The project includes 2 components: (i) Investment of technology (ii) Capacity building through exploitation of renewable energy sources. The project will also aim at mitigation of GHG emissions and raise living standard of the people in remote and isolated areas.

Project objectives

- To exploit renewable energy potential to serve socio-economic development and raise the living standard of the people, particularly in remote areas.
- To mitigate greenhouse gases emissions.

Activities

Investment of technology:

- Small hydropower network: 200 small hydropower systems in villages.
- Wind-diesel combination: Replacing the existing diesel systems in islands by wind-diesel combination systems with rational distribution mechanism.
- Small household-scale hydropower stations.
- Household-scale solar energy system.

Capacity strengthening to eliminate barriers

- Developing appropriate policies and supporting the use of this kind of energy.
- Developing trading skills, marketing strategy, distribution and consumption services.
- Developing technology and personnel training
- Encouraging demands, raising public awareness.

Expected outputs

- Set up electricity network using wind, solar and hydropower;
- Train technical staff in manufacture, distribution and consumption, etc.;
- Improve living standard of the people in the remote and isolated areas; Created employment for the
- Labors.

Implementation budget

Total budget: US$ 50,000,000

In which:	GEF:	US$ 10,000,000
	WB:	US$ 20,000,000
	Government inputs:	US$ 20,000,000

Implementation duration: 2005-2009

Project 5: Energy saving in industry

Background

At present, technology of Viet Nam industry is still backward with low energy use efficiency. The potential for energy saving is very high. In comparison with present high technology, energy saving potential in Viet Nam industry is 10-13%, in electricity saving is 4-6%. Therefore, the improvement of efficiency in industrial enterprises would significantly mitigate GHGs emissions.

This project is one of important projects of the on-going Energy Saving Program in Viet Nam. The project outputs could help big enterprises to save energy, decrease products' prices and increase their competitiveness as well as mitigate waste gas emissions, including GHGs emissions.

Project objectives

To demonstrate, introduce energy saving and efficient measures in industrial industries in order to mitigate energy consumption and protect environment.

Activities

- Auditing energy in 80 big plants, occupying 50% of energy consumption.
- Installing an energy management system.
- Educating and training staff.
- Demonstrating co-generation capacity

Expected outputs

The project is divided into 2 phases:

For the first phase, the estimated outputs are as follows:

- Install energy management systems at plants within the project framework;
- Train energy auditing staff and operators for energy management systems.

For the second phase:

On the basis of the results of the first phase, a demonstration model of co-generation at big well equipped plants will be established.

Implementation budget: For the first phase: US$ 3.3 million

Expected implementation duration: The first phase: 2 years

Project 6: Encouraging utilization of renewable energy in rural areas

Background

The project is implemented within the framework of Viet Nam Energy Saving Program. The project aims at popularization of knowledge of renewable energy forms, development of organization and management including institutional and financial mechanisms to introduce and apply new energy technologies, to assist elaboration of local technologies.

Objectives

- To develop cooperative program among relevant agencies to remove the barriers for utilization of renewable energy.
- To introduce renewable energy technologies.

Project activities

- Developing cooperative programs among relevant agencies.
- Developing legislative mechanism, strengthening implementing capacity to remove barriers in
- Utilization of renewable energy.
- Advertising, encouraging the enlargement of market of renewable energy technologies.
- Encouraging domestic design and manufacture of renewable energy equipment.

Expected outputs

- Strengthen capacity and raise awareness of utilization of renewable energy;
- Prepare pre-feasibility report on utilization of renewable energy in rural areas.

Budget

US$ 460,000

Implementation duration: 2005 - 2007

Implementing agencies: Energy Saving Program, Ministry of Science, Technology and Environment, Provincial Departments of Science, Technology and Environment, Viet Nam Electricity.

Project 7: Project on forest plantation on sandy soil in the coast of the Southern Central Viet Nam

Background

In 1998, the National Assembly of the Socialist Republic of Viet Nam approved the 5-million hectare forestation Programme. According to the programme, during the period of 1998-2010, among 5 million hectares of newly planted forest, there would be 60.000 hectares of coastal protective forest. It is mainly forest bands for preventing sand movement in the central coastal zones.

The coastal zone in the Southern Central Viet Nam, bounded by the coast and the National Road No 1, is mainly covered by sea sand. In this zone, there are many moving sand areas and unused sand dunes or few shrubs. That is why not only crops and infrastructure but also living habitats of the local people are threatened by sand wind and typhoons.

It is an urgent need to plant and improve coast protective forest in order to mitigate the losses caused by sand moving. This area is one of the first priority areas in the forestation programme of Viet Nam.

Project objectives

- To improve productivity of the cultivated lands located behind the newly planted forest and the improvement of environment would make a part of unused land due to sand invasion cultivable to produce more products for the local people.
- To provide a significant portion of firewood for the local people through secondary products gained from forest nursery practices (pruning, trimming).
- To create jobs and income for the local people involved in forest plantation and protection.
- To contribute to bio-diversity improvement and environmental conservation in large coastal zone.

Activities

- Planting 11,015 hectares of sea pines, sandalwood trees on the sandy soil of the Southern Central Viet Nam coastal zone at 55 planting sites.
- Building logistic bases for forest plantation (operation roads, temporary nursery gardens, houses, etc.
- Providing equipment and materials for forest planting.

Expected outputs

Plant 11,015 hectares of protective forest consisting mainly of sea pines, sandalwood trees in 4 provinces: Quang Nam, Quang Ngai, Phu Yen and Khanh Hoa. In which:

- Quang Nam: 4,043 hectares
- Quang Ngai: 1,959 hectares

- Phu Yen: 2,810 hectares
- Khanh Hoa: 2,203 hectares

Project budget: US$ 11.5 million

Expected duration: 5 years, starting in 2005, ending in 2009.

Project 8: Improving cooking stoves of the rural - mountainous community

Background

The 80% population of Viet Nam lives in the rural and mountainous areas. Normally, the people use biomass fuel such as firewood, agricultural residuals in cooking. The use of this kind of fuel would remain in many decades to come. The main reason is the alternative energy sources such as electricity, gas etc. are still very expensive or unable to be widely popularized in rural and mountainous areas of Viet Nam.

Forest is a main source of firewood for households. However, forest is exhausting day by day so far. Although firewood source is more and more limited, the use of firewood is wasteful and inefficient. Most of households use traditional cooking stoves - the opening stoves that have been used for thousands years. Low burning efficiency of these stoves leads to high fuel consumption and emission of harmful gases that may have adverse impacts on the health, particularly of the old, women and children.

Therefore, it is very important, necessary and urgent to introduce widely the improved cooking stoves (improvement in both burning efficiency and heat conductibility) suitable to traditional cooking habits of local people.

Project objectives

- To save fuel used for households;
- To release and reduce smoke and dust in kitchen of rural households.
- To reduce illness caused by emitted smoke from stoves.
- To contribute to protect forest resources.
- To mitigate GHGs emissions through reduction of fuel consumption.
- To create opportunities and jobs for poor people in rural areas, contribute to alleviate poverty as well as the hardship of women.

Activities

It is planned to carry out the project in nation-wide scale for 7 ecological zones with the following main activities:

- Developing institutional framework for cooking stoves improvement program of national scale.
- Conducting an investigation and feasibility study for pilot sites, carrying out widely application of improved stoves.
- Setting up systematic dissemination on mass media (radio, newspapers, television).
- Organizing training courses on improved cooking stoves.
- Transferring technology – marketing.

Expected outputs

- One million rural households could be able to use improved cooking stoves through direct and indirect financial support.
- Create jobs for about 3 thousands people through manufacturing and trading improved cooking stoves, contribute to poverty alleviation.
- Strengthen capacity for research and technology transferring institutions.
- Contribute to forest protection, especially the 5-million hectare afforestation program (up to 2010).
- Reduce about 30 % of GHGs emissions in comparison with the present thank to fuel saving.

Budget

The total budget is US$ 350,000:

- Project preparation and demonstration US$ 50,000
- Region-scale implementation US$ 100,000
- Nation wide scale implementation US$ 200,000

Expected duration

From 2005 to 2011, consisting of 3 phases:

1. 2005 - 2006
2. 2007 - 2009
3. 2009 - 2011

Project 9: Using biogas as fuel to mitigate greenhouse gas emission in rural areas

Background

The orientation of Viet Nam husbandry from now to 2030 is following: Developing husbandry following commodities production approach, focusing on raising pig, poultry, dairy cattle, cow and expanding husbandry areas as farm scale, delineating areas for concentrated husbandry. Up to now, Viet Nam has rather significant number of cattle heads and poultry. According to statistical data of 1999: pig: 19 millions, buffalo: 3 millions, cow: 4 millions, poultry: 179 millions. However, waste from domestic cattle is not processed, but often exposed to the sun or gathered in a neat heap resulting in pollution and bad condition of hygiene in rural areas. On other hand, most of rural inhabitants use straws, firewood, coal for cooking and this is also a significant CO2 emission source. Therefore, the building of biogas tanks in husbandry areas could not only process cattle waste to make environment clean, but also reduce firewood for cooking, liberate women's labor in rural areas.

Project objectives

- To build biogas systems containing cattle waste to generate methane used as fuel for cooking in rural areas in order to reduce methane and CO2 emissions.
- To protect clean environment in rural areas.
- To help farmers to save fuel consumption.
- To raise awareness of the people on environment and GHG mitigation.

Activities

- Popularizing benefits of the use of biogas instead of conventional fuel and raising awareness of the people on environment and GHG mitigation.
- Selecting technologies and models for building appropriate biogas tanks for specific locality.
- Building 500,000 biogas tanks with various volumes from 5 to 12 m3 in different rural areas, focusing on the concentrated husbandry areas.
- Organizing training courses for the technicians who will guide the construction and use of biogas stoves.
- Conducting measurement, monitoring the reduced methane emission thanks to using biogas.

Expected outputs

- Raise awareness of the farmers on environment and GHG.
- Build 500,000 well-operated biogas tanks, saved expenditure on cooking fuel for rural households.

- Reduce methane and CO2 emission from 2 sources: management of fertilizer and burning materials in the rural areas with the total of 2.7 million tones of CO2 equivalent during a period of 20 years.
- Improve environment in rural areas and liberate women's labor thanks to reducing cooking time.

Project budget: US$ 1,500,000

In which:

- Farmer's input : U S $ 300,000
- Government input : U S $ 500,000
- GFF input : U S $ 700,000

Expected duration: from 2005 to 2007.

Project 10: Research on co-generation technology (electricity and heat) from biomass fuel in Viet Nam

Background

Renewable energy, including biomass energy is considered as clean energy sources and solutions to mitigate GHGs. Because while burning biomass, there is the neutralization of CO2 emission, and SOx emission almost equals to zero due to the absence of sulfur in the composition of the fuel.

Viet Nam has big potential in biomass fuel source. Annually, the agricultural cast-off is more than 40 million tones, equivalent to about 20 million tones of coal dust. It is estimated that annually, the agricultural cast-off would increase about 2%. At present, there is more than 10% of the above cast-off such as rice husk, sugar cane dregs in rice and sugar mills that are very suitable for development of cogeneration technology (or combined electricity-heat generation). Thus, while applying the above mention technology, beside the adequate provision of energy to the mills, the surplus electricity would be added to the national electricity network or sold out directly to the surrounding additional charge. The potential of technical capacity from this fuel form is about 300 MW for the period from 2001 to 2010.

Objectives

- To strengthen capacity of sustained exploitation and effective utilization of the existing local biomass fuel in order to be less dependent on fossil fuel and to mitigate GHGs emissions.
- To create a reliable electricity and heat supply source with competitive, cheap prices (thank to reduction of transportation losses) for of rice and sugar mills, and consequently, to reduce production cost, improve product quality and to increase the competitiveness of enterprises.

Activities

- Assessment of the present status of biomass fuel development plan for energy co-generation in Viet Nam.
- Preparation of pre-feasibility and feasibility reports, building of demonstration models for 3 - 4 factories with capacity of 10 MW.

Expected outputs

- Generate electricity with expected potential capacity of 300 MW, being less dependent on coal.
- Neutralize CO2 emission (non-CO2 emission) by using the existing biomass such as rice husk, straw, sugarcane dregs, etc.; SOX emission would be almost zero because there is not sulfur in biomass fuel.

Project budget

Total: US$ 135,000 including:

- Phase 1: Assessment of current status and planning: US$ 60,000;
- Phase 2: Pre-feasibility and feasibility studies: US$ 75,000

Expected duration: 3 years, from 2005 to 2008. The period is divided into 2 phases:

- Phase 1: Planning from 2005 to 2006
- Phase 2: Preparation of feasibility report from 2006 to 2008.

Project 11 : Project on energy conservation and saving in small and medium-sized enterprises

Background

- The project is implemented within the framework of Energy Saving Program and GEF Strategy for the period of 2000 - 2010.
- The potential of energy saving and GHG mitigation in small and medium scale enterprises of Viet Nam is very high. It is estimated that the value may reach 13% for thermal energy and 6% for electricity energy.
- Awareness on energy saving is not yet high, financial capacity is low.

Objectives

- To support the saving of energy in the small and medium scale enterprises.
- To strengthen the implementing capacity and policy mechanism to facilitate the adaptability of efficient energy technology in small and medium scale enterprises.
- To set up Energy Information Center for small and medium scale enterprises.
- To monitor the implementation of energy efficiency and environment projects in small and medium scale enterprises.
- Activities:
- Identifying the sector of small and medium scale enterprises to be put under energy audit.
- Removing barriers of technology application and successful implementation in small and medium scale enterprises in order to reduce energy consumption and mitigate GHGs.
- Developing an education and training program for managers, auditors and experts in small and medium scale enterprises.
- Developing energy-saving projects for small and medium scale enterprises.

Expected outputs

- Fulfill energy audit in small and medium scale enterprises;
- Train energy auditors and energy managers for small and medium scale enterprises.
- Set up Energy Information Center for small and medium scale enterprises.

Estimated budget

US$ 1.5 million

Implementation duration: 2005 - 2008 (3 years).

Estimated after-project investment: US$ 5.5 - 8.5 millions

Project 12 : Wind power stations for the people in remote island (Coto island, Quang Ninh province)

Background

The Coto Island - one of the big islands in Quang Ninh province - is located in the archipelago in Northeast Viet Nam, about 60 miles from the land with the area of 3850 hectares. By 2000, the island's population is 2308. The island has rich economic potential. However, the living standard of people is still low with few supplementary jobs. The main income sources of the island's inhabitants are from agriculture and fishery. The cultural life is poor. Electricity for living is diesel generated. Because of the far distance, diesel supply is very difficult resulting in rather high price of electricity (VND 2,500 per kWh). The island could not access to national electricity network due to long distance from main land.

Wind power potential of the island: In Coto island, during winter, from October to March, the dominating wind is Northeast with frequency from 50% to 70 % per month and average speed of 5.5 mps. Thus, the places open to the northeast or favorable for northeast wind have very high wind power potential.

Project objectives

To generate electricity using wind energy in combination with diesel to reduce electricity price as well as to protect environment.

Activities

- Survey to prepare pre-feasibility and feasibility justifications
- Detailed design
- Install equipment, operate and hand over the project

Expected outputs

- Install wind motors with capacity of 500 kW (phase 2002 - 2005) and 1000 kW (phase 2005 - 2010).
- By the end of the first phase, 95 % of households could be accessible to electricity for living; By the end of the second phase, electricity supply could meet 95% demands for living and 90% demands for production.

Budget: The estimated budget is US$ 200,000

Estimated duration:

Phase 1: 2005 - 2008

Phase 2: 2008 - 2013

Project 13: Project on planting protective forest in the watershed of Ngan Sau, Ngan Pho Rivers

Background

Viet Nam is located in the Southeast Asia with a population of more than 70 million. About three fourth of its territory is hilly and mountainous areas. The existing forest area is 9.3 million hectares. Forest plays an important role in economy, society, ecological environment and national security. In recent years, the irrational utilization of forest resources resulted in unforeseen consequences. The high rate of forest degradation in both area and quality led to decreasing of forest cover in Viet Nam.

The degradation of forest quality, especially forest in river watershed has resulted in bad consequences such as unusual floods and inundation, soil erosion, etc. and that in their turn threat the sustainability of national economy, normal life of millions people in downstream and bio-diversity. The 5-million hectare forestation programme was approved by the National Assembly of the Socialist Republic of Viet Nam in 1998. According to the plan, among 5 million hectares of newly planted forest there would be 1,735,000 hectares of watershed protective forest planted during the period of 1998- 2001

It is an objective and urgent need to quickly restore forest in Ngan Sau and Ngan Pho river watershed in order to set up and stabilize the protective forest system in this area; to improve and raise the living standard of the local people and to contribute actively in flood/inundation prevention, stabilize political life and social security in the west boundary area of Ha Tinh province, in particular, and the country, in general.

Project objectives

- To develop and improve the protective forest system in Ngan Sau, Ngan Pho Rivers watershed in order to prevent soil erosion, protect water sources and local environment, to enhance the absorption sinks and minimize the possible impacts on droughts, floods and inundation.
- To increase forest coverage in this area from 51% at present to 64% by 2010.
- To improve forest quality, to increase the ratio of rich and medium forest from 31% at present to 46% by 2010.
- To create jobs for 5180 households living nearby forest area, to attract more than 8,700 labors into forest protection, planting protective forest and doing agro-forestry production.

Activities and expected outputs

Activities

- Protecting 84,410 hectares of the existing forest and 36,021 hectares of the newly planted forest (in the period from 2001 to 2012);
- Delineating areas for growing and restoring 20,442 hectares of forest during the period of 2001 - 2012, in which 5,214 hectares is in very important and 15,228 hectares is in important areas. XXX

- Planting forest and carrying out agro-forestry including planting concentrated forest and building forest gardens, forest farms in Huong Khe, Huong Son, Duc Tho districts.

Expected outputs

- Protecting 80,241 hectares of natural forest and 4,169 hectares of exist planted forest in project area.
- Planting 42,114 hectares of new forest, in which: Delineating areas for forest restoration: 20,442 hectares Newly planted forest : 15,579 hectares
- Building forest gardens, forest farms : 6,093 hectares

Project budget: US$ 7,01 million

Expected duration: from 2005 to 2014.

Project 14: Irrigation management of wetland rice field to reduce methane emission

Backgrounds

Viet Nam agriculture is based on two main branches: cultivation and husbandry. Cultivation plays an important role, in 1994, it produced 77.3% of total agricultural products. In cultivation, there are rather multiform cereal crops with various varieties. Rice is the main food cereal crop in Viet Nam. Together with application of new technology, Viet Nam regularly improves of the irrigation systems, particularly those for wetland rice fields. The channel systems at various levels (I, II and III, IV and V) are set up and put into operation to serve food and foodstuff production.

The National Strategy for improvement of irrigation systems to 2020 has been developed.

One of the main objectives is to ensure water used in agriculture with improved irrigation and drainage techniques in order to get high crop yield. Conservation of water resources is also one of main policies of the Government to attain sustainable development (Law on Water Resources).

This project aims at reducing methane emission by rational irrigation and drainage management with draining out water in two growing periods: stem spreading and before harvest. Meanwhile, the project also brings about the following benefits: (i) saving water and (ii) increasing rice yield - the targets mentioned in the National Strategy and National Agricultural Programme.

Project objectives

- To reduce methane emission from wetland rice fields.
- To develop a comprehensive technical manual for irrigation management in wetland rice fields with the aim of increasing rice yield.
- To strengthen capacity of technical and management staffs to implement appropriate irrigation techniques procedures.
- To raise public awareness on climate change.

Activities

- Setting up a mechanism, legislation from the central down to provincial levels in regulated irrigation management, meanwhile establishing the project-management committees at various levels;
- Conducting surveys and selecting the areas feasible for implementation of the regulated irrigation management.
- Conducting experimental measurement and monitoring on methane emission reduction from the wetland rice field.
- Building pilot active irrigation/drainage management systems.
- Organizing educational and training courses for water management technicians.

Outputs

- Detailed technical manual on water irrigation for wetland rice fields;
- Upgraded irrigation systems, especially those of third and fourth levels;
- Trained staff of water management, policymaking, project management and supervision.
- Strengthened capacity on water management.
- Project achievements are extended to other areas.
- Reduced methane emission: 37,000 tones during the period of 20 years.

Total budget: US$ 5,025,000

- Input from GEF is US$ 1,525,000
- Input from Viet Nam government is US$ 3,500,000

Expected duration: from 2003 to 2004 (02 years)

Project 15: Exploitation of geo-thermal energy in Viet Nam

Background

Viet Nam has potential in geo-thermal energy that can be utilized in electricity generation, particularly in various areas of Central Viet Nam. It is estimated that in this region, a capacity of 50 MW can be developed from geo-thermal hot water sources. However, it is necessary to evaluate this potential in details in order to make plan for further exploitation.

Project objectives

- To assess feasibility of developing 50 MW from geo-thermal hot water sources in provinces of Central Viet Nam.
- To establish maps on geo-thermal energy potential.

Activities

Exploration drilling to collect data on:

- Maps of regional geo-thermal energy; Evaluation of heat and temperature of geo-thermal liquid.
- Assessment of socio-economic impacts resulted from the construction and operation of geo-thermal energy plants.
- Development of plan and projection on the exploitation of the national geo-thermal energy.

Expected outputs

- Clearly identify potential of geo-thermal energy of the country.
- Comprehensive projection on exploitation of geo-thermal energy.

Implementation budget:

PDFB of GEF : US$ 300,000

Government inputs: US$ 100,000

Implementation duration: 2005-2008

THE LIST OF AUTHORS

1 Mr. Nguyen Khac Hieu

Deputy Director General, International Cooperation Department, Ministry of Natural Resources and Environment

2 Mr. Ninh Van Hiep

Director, Institute of Socio-economic Development for Rural and Mountainous areas

3 Prof. Bui Huy Phung

Viet Nam Academy of Science and Technology

4 Prof., Dr. Nguyen Tien Nguyen

Deputy Director, Research Center for Energy and Environment

5 Dr. Nguyen Van Siem

Science and Technology Department, Ministry of Transport

6 Dr. Pham Khanh Toan

Director, Institute of Energy, Ministry of Industry

7 Dr. Nguyen Van Hanh

Institute of Energy, Ministry of Industry

8 Mr. Hoang Manh Hoa

Senior Expert on Climate Change, National Office for Climate Change and Ozone Protection, International Cooperation Department, Ministry of Natural Resources and Environment

9 Mr. Nguyen Mong Cuong

Director, Research Center for Climate Change and Sustainable Development

10 Mr. Phung Tuu Boi

Viet Nam Forestry Science and Technology Association

11 Mr. Pham Van Khien

Institute of Agricultural Economics, Ministry of Agriculture and Rural Development

12 Dr. Nguyen Chi Quang

Ha Noi University of Technology, Ministry of Education and Training