THE GLOBAL TECHNOLOGY NEEDS ASSESSMENT

TECHNOLOGY NEEDS ASSESSMENT FOR CLIMATE CHANGE MITIGATION

VIET NAM

SYNTHESIS REPORT









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Viet Nam Technology Needs Assessment for Climate Change Mitigation

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PREFACE

Assessing, developing and applying greenhouse gas mitigation technologies is one of the key tasks set out in the Viet Nam Climate Change Strategy, with a view to improving competitiveness of major economic and industrial sectors and promoting low-carbon and green growth in Viet Nam.

The Global Technology Needs Assessment project, code 1215227, is funded by the Global Environment Facility (GEF) and implemented by the United Nations Environment Program (UNEP) (via the UNEP Risoe Center in Denmark). The project was derived from the Poznan Strategy on technology transfer and was carried out in two phases, with participation of 15 developing countries, including Viet Nam, in phase 1, and 21 developing countries in phase 2, to assist these countries in technology needs assesment for adaptation to climate change in accordance with Article 4.5 of the United Nations Framework Convention on Climate Change.

In Viet Nam, the implementation of the "Global Technology Needs Assessment" project was coordinated by the Department of Meteorology, Hydrology and Climate Change, Ministry of Natural Resources and Environment, in collaboration with experts and personnels from relevant ministries, sectors and institutions.

Within the framework of the Project, Report on Technology Needs Assessment for Climate Change Mitigation and Technology Action Plan for Climate Change Mitigation was developed, consisting of three main parts:

Part 1 - Technology Needs Assessment for Climate Change Mitigation contains information on assessing, identifying and selecting priority greenhouse gas mitigation technologies in energy, agriculture, and land use, land use change and forestry (LULUCF). These sectors have been identified as the main sources of greenhouse gas emssions in Viet Nam.

Part 2 – Technology Action Plan: containing information related to identifying barriers to technology transfer, preliminary solutions to overcome barriers and project proposals for to develop priority mitigation technologies.

Part 3 – Crosscutting issues in technology needs assessment for climate change mitigation and development of technology action plan for selected technologies.

So far, the Project has succeeded in achieving its objectives. The outcomes of the Project will contribute to effective response to climate change and development toawards low-carbon economy and green growth in Viet Nam.

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ACKNOWLEDGMENTS

The Report on Technology Needs Assessment for Climate Change Mitigation and Technology Action Plan for Priority Climate Change Mitigation Technologies under the Project "Global Technology Needs Assessment" in Viet Nam was developed in consultation with various national experts and personnels from relevant minsitries, sectors and institutions.

Throughout the course of the Project, we also received plenty of valuable comments and contributions from experts at the Asian Institute of Technology (AIT) in Thailand and the UNEP Risoe Center in Denmark in rectifying the Report and Plan.

Report on Technology Needs Assessment for Climate Change Mitigation, Technology Action Plan for Priority Climate Change Mitigation Technologies and the outcomes of the Project will contribute to the achievement of sustainable development goals, as well as efforts towards low-carbon economy and green growth in Viet Nam in the future. On this occasion, the Department of Meteorology, Hydrology and Climate Change would like thank the Ministry of Natural Resources and Environment for facilitating the administrative and legal procedures of the report and project development.

We hereby would like to express the sincerest thanks to GEF, which financed the Project, and to UNEP and the UNEP Risoe Centre which implement the project.

We owe a debt to experts at AIT and UNEP Risoe Center experts for their important technical assistance to the project implementation as well as their valuable comments throughout the course of the Project.

Finally, we would like to thank the active and efficient participation of all national stakeholders which drove the Project to success.

ABBREVIATIONS

AIT	Asean Institute of Technology
BRT	Bus rapid transit
CDM	Clean Development Mechanism
CNG	Compressed Natural Gas
CH_4	Methane
CHP	Combined heat and power
CLFs	Compact fluorescent lamp
CO_2	Carbon dioxide
COP	Conference of the Parties under the United Nations Framework Convention on Climate Change
DNA	Designated National Authority
DMHCC	Department of Meteorology Hydrology and Climate Change
DOF	Department of Forestry (Forestry Administration)
EST	Environmentally Sound Technology
EVN	Vietnam Electricity
FIPI	Forest Inventory and Planning Department
GHG	Green house gases
GoV	Government of Vietnam
IPCC	Intergovernmental Panel on Climate Change
IPR	Intellectual property right
LPGs	Liquefied petroleum gases
LULUCF	Land use, Land use change and Forestry
MARD	Ministry of Agriculture and Rural Development
MCDA	Multi Criteria Decision Assessment
MOET	Ministry of Education and Training
MONRE	Ministry of Natural Resources and Environment
MOF	Ministry of Finance
MOFA	Ministry of Foreign Affairs
MOIT	Ministry of Industry and Trade
MOST	Ministry of Science and Technology
MOT	Ministry of Transportation
MPI	Ministry of Planning and Investment
N_2O	Nitrous oxide

NTP	National Target Programme to Respond to Climate Change
PMU	Project Management Unit
RD&D	Research, development and demonstration
REDD	Reducing Emissions from Deforestation and Forest Degradation
SNC	Vietnam's Second National Communication to the United Nations Framework Convention on Climate Change
TAP	Technology Action Plan
TNA	Technology Needs Assessment
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNFCCC	United Nations Framework Convention on Climate Change
URC	UNEP Risoe Center
PCs	Municipal People's Committees
DOT	Department of Transportation

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EXECUTIVE SUMMARY

INTRODUCTION

According to the United Nations Environment Programme (UNEP), climate change is considered an "unconventional" security issue, and one of the biggest challenges to the "global environmental – development security." Climate change does cause impacts not only to nature, but also to human livelihood and social life, espcially developing countries such as Vietnam.

One of the major items on the agendas of the Conference of Parties to the United Nations Framework Convention on Climate Change (UNFCCC) is transfering climate change adaptation and greenhouse gas (GHG) mitigation technologies to developing countries. According to Article 4.5 of the UNFCCC, Technology Needs Assessment (TNA) project is one of the items of the Poznan Strategy on Technology Transfer, proposed by Global Environment Facility (GEF) to assist developing countries in developing and updating their technology needs.

Part I Report of the TNA project summarizes concerns and low emission technology priorities to reach the targets of sustainable development and GHG emission mitigation to reduce climate change impacts. One main outcome of the project is a list of priority technologies for climate change mitigation in each sector.

PROJECT INSTITUTIONAL ARRANGEMENTS AND ROLES OF STAKEHOLDERS

The Department of Meteorology, Hydrology and Climate Change (DMHCC) under the Ministry of Natural Resources and Environment (MONRE) was assigned to coordinate the project implementation. Throughout the course, the Project Management Unit, under DMHCC, and the National TNA team were supported by experts at the UNEP Risoe Center (URC) and the AIT, as well as other relevant institutions.

SECTOR PRIORITIZATION

The process and criteria to identify sectors for priority GHG mitigation technologies followed the guidances in the Handbook for Conducting Technology Needs Assessment for Climate Change, published jointly by the UNFCCC and United Nations Development Programme (UNDP) in November 2010. Sectors prioritized for GHG mitigation are of high GHG emissions, large potential for implementing feasible mitigation options, high potential for applying low-carbon technologies and in compliance with national development goals.

With the above directions, stakeholder consultations were held to prioritize sectors for GHG mitigation based on the following criteria: economic, social and environmental benefits, and GHG mitigation potential, on a rating scheme of 0-5. Most experts agreed that the priority sectors for technology needs assement for GHG mitigation were energy, agriculture, and land use change and forestry (LULUCF).

The TNA team also agreed on criteria to prioritize GHG mitigation technologies based on their costs and benefits. Costs include investment, operation and maintanance, and GHG mitigation costs. Benfits include: future mitigation potential; air, water and land pollution reduction; job creation, healthcare and knowledge generation; contribution to national economic development, energy saving and balance of payment.

GHG MITIGATION TECHNOLOGY NEEDS ASSESSMENT FOR PRIORITY SECTORS

TECHNOLOGY NEEDS ASSESSMENT FOR CLIMATE CHANGE MITIGATION IN ENERGY

To meet the demand for economic development and GDP growth, consumption of energy, such as natural gas, electricity or coal for production and household activities, has been increasing, especially demand for coal in electricity generation. Energy-related GHG emissions come from two sources: fuel combustion and fugitive from mining and handling. Emission estimates from fuel combustion for 2000 were 45.9 million tonnes of CO_2, 68.4 thousand tonnes of CH_4, and 1.27 thousand tonnes of N_2O. Emissions from fuel fugitive primarily came from extraction of coal, oil, gas and gas leakage. CH_4 emissions from coal mining (underground or surface) were 89.26 thousand tonnes while the amount of emissions from oil and gas extraction was 150.95 thousand tonnes. As a result, energy production and consumption is considered the main sources of emission in the following decades.

According to the UNDP TNA Handbook, the Multi Criteria Decision Analysis (MCDA) was used for assessing current technology needs for climate change mitigation. First, this method identifies and categorized technologies/options based on their mitigation potential. Next, technologies are given points and weighted. Finally, decisions are made on which technologies are of high priority.

Based on the MCDA method, high priority GHG mitigation technologies were identified for energy and transportation, including five technologies for energy production, two for energy consumption, one for coal-oil-gas

extration, and one for transportation. The results of the prioritization process are in compilance with Vietnam's development goals of industrialization, modernization and sustainable development in the coming years.

TECHNOLOGY NEEDS ASSESSMENT FOR CLIMATE CHANGE MITIGATION IN AGRICULLTURE

In the context of global climate change, ensuring food security is a curical matter for agricultural countries like Vietnam. The total land area for agriculture in 2000 was 9.3 million ha, accounting for 28.2% of the total national land area, of which 7.6 million ha was for rice cultivation. Main sources of GHG emissions in agriculture sector include rice cultivation, livestock, agricultural soils, burning of agricultural residues, etc. The total emssions from agriculture were 65,090.7 thousand tonnes of CO_2 equivalent (tCO_2e). Therefore, agriculture is a priority sector for GHG mitigation technologies.

Using the MCDA method, there are 11 GHG mitigation technologies assessed for agriculture, out of which three technologies were prioritized, including biogas, wet and dry irrigation and nutrition enhancement for dairy cattle.

TECHNOLOGY NEEDS ASSESSMENT FOR CLIMATE CHANGE MITIGATION IN LULUCF

In the Forestry Development Strategy for 2006-2020, total land area for forestry shall reach 16.24 million ha by 2020, equivalent for 49.3% of the national natural land area. This includes 5.6 million ha of protection forest, 2.2 million ha of forest for special use and 8.4 million ha of production plantation. Emissions/removals of GHGs in LULUCF mainly came from changes in forest and biomass stocks, land use and land use change, and emissions from soils. The total emssions form 2000 were 15,104 thousand tCO_2e. The LULUCF sector, on the other hand, is also a significant sink of GHGs.

Using the MCDA method, five GHG mitigation technologies were assessed for the LULUCF sector, out of which three technologies were prioritized, including sustainable forest management, aforestation and reforestation, and magrove rehabilitation.

Chapter 1. Introduction

Climate change, most prominently demonstrated by global warming and rising sea level, is one of the biggest challenges to mankind in the 21st century. Natural disasters and extreme weather events are on the rise in many parts of the world. The global average temperature and sea level have been increasing at a faster rate than ever; this poses a major threat to all nations, particularly those with a long, low-lying coastline like Vietnam. While social and economic consequences are inevitable for all countries, the developing and Least Developed Countries, particularly their poor population, are probably the most affected.

Vietnam is considered one of the countries most vulnerable to climate change, especially to sea-level rise. In fact, it is now facing many climate change impacts on livelihoods, natural resources, society, infrastructure and economic development. Climate change consequences for Vietnam can be serious and threaten to undermine the hunger eradication, poverty reduction, Millennium Development Goals accomplishment and sustainable development of the country. Today, climate change is no longer a mere environmental problem; it has become a social and economic issue. Responding to climate change is a vital imperative to Vietnam's development.

On the one hand, climate change will adversely influence the socio-economic development. On the other hand, it also represents opportunities for Vietnam to obtain, develop and deploy environmental-friendly technologies to address climate change and mitigate greenhouse gas (GHG) emission effectively and develop towards a low-carbon economy.

Recognizing the climate change risks at its early stages, the Government of Vietnam (GoV) signed and ratified the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. The GoV has issued a number of directives and decisions for the implementation of the UNFCCC, the Kyoto Protocol and promulgated the National Target Program to Respond to Climate Change (NTP). Vietnam's Second National Communication (SNC) to the UNFCCC was completed and submitted to the UNFCCC Secretariat in December 2010, with support from the Global Environment Facility (GEF), the United Nations Environment Program (UNEP), and the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP). The SNC contains the GHG inventory for the base year 2000 and estimations of GHG emissions for three main sectors: energy, agriculture and land use, land use change and forestry (LULUCF) for 2010, 2020 and 2030, and introduces a number of adaptation measures and GHG mitigation options and deployment of eco-friendly technologies in Vietnam.

Laws and legislation regarding the development and application of GHG emission mitigation technologies have been enacted in Vietnam, including:

National Assembly's laws:

- Law on Environmental Protection No. 52/2005/QH11 dated 29 November 2005 (replacing the 1993 Environmental Protection Law).
- Petroleum Law (1993) No. 10/2008/QH12 dated 6 July 1993 (amended twice on 9 June 2000 and 3 June 2008).
- Law on Minerals No. 2/1996/QH9 dated 1st September 1996 (amended on 27 June 2005).
- Law on Forest Protection and Development No. 29/2004/QH11 dated 3 December 2004 (replacing the 1991 Law on Forest Protection and Development).
- Electricity law No. 28/2004/QH11 dated 3rd December 2004.
- Law on Energy Efficiency No. 50/2010/QH12 dated 28 June 2010.

Government's legislation

2003: the *National Environment Protection Strategy by 2010 and orientation by 2020* was adopted by the Government to promote clean technologies, cleaner production processes and less polluting, environment-friendly fuels and materials.

2004: The Government passed *Vietnam Sustainable Development Orientation* (Vietnam's Agenda 21) for the national sustainable development on the basis of close coordination between balanced development of society and economy, and environmental protection. The Agenda 21 includes 5 main parts, which identify priorities in social and economic sectors, natural resource uses, environmental protection and pollution control for the sustainable development.

2006: The GoV established the *National Target Program on Energy Efficiency*, aiming to raise public awareness, promote research and development of science and technology, and enforce rules and regulations on energy conservation and efficiency. The Program sets a three to five percent conservation rate goal for national energy consumption for 2006-2010 and five to eight percent for 2011-2015.

2008: The GoV approved the *National Target Program to Respond to Climate Change* (NTP). The goal of the Program is to develop feasible action plans to effectively respond to climate change, in the short and long term, in order to ensure the country's sustainable development and make use of low-carbon economic growth opportunities. The Program sets out nine tasks and corresponding solutions, including development and implementation of a national science and technology program, and research of technologies that adapt to climate change and mitigate GHG emissions. To facilitate climate change science and technology research and development, the Ministry of Science and Technology, in cooperation with the MONRE, has introduced a *National Science and Technology Framework on Climate Change*, including several 2015 milestones: i) completing and updating the climate change database, ii) implementing the national science and technology program for climate change at the ministerial, sectoral and local levels, iii) updating and further studying sciences, development, scenarios and potential impacts to develop resilient capacity to climate change. This task is broken down into different following activities:

1. Facilitating research on climate change nature, sciences, uncertainties, and climate change social and economic impacts; analyzing the cost-benefit of climate change response activities
2. Integrating climate change issues into environmental protection, natural resources utilization, disaster management, and marine research programs
3. Intensifying scientific research to strengthen the climate and climate change monitoring system
4. Developing a database for climate change assessment
5. Conducting research on GHG emission mitigation and climate change adaptation technologies
6. Developing a coordination mechanism between research, capacity training and technology development institutes in related sectors
7. Strengthening international cooperation in science and technology activities; implementing and transferring eco-friendly and climate-friendly technologies in an effective manner.

Climate change adaptation and GHG mitigation technology transfer to developing countries is one of the predominant items on the agendas of the Conferences of Parties (COPs) to the UNFCCC. Through technology transfer, developing countries can carry out quantitative GHG emission reduction, enabling their sustainable development and contributing to the UNFCCC's common goal of stabilizing the GHG concentration in the atmosphere and preventing dangerous anthropogenic interference with the Earth's climate system.

Despite the fast economic growth rate, Viet Nam's industry is still underdeveloped due to outdated technologies. Therefore, assessing technology needs is a very important step to the transfer of climate change technologies needed for achieving the sustainable development goals. One of the main tasks set out in the NTP is "Development of a science and technology program on climate change", which aims to research and develop technologies to mitigate greenhouse gases emissions and adapt to climate change.

The Project "Global Technology Needs Assessment", coded 1215227-03, is supported by GEF, UNEP and Norwegian Government, and carried out by UNEP (in collaboration with RISOE of UNEP (URC) in Denmark) in 35-45 developing countries. In the initial phase of the project, Vietnam was chosen as one of the 15 participant countries within a timeframe of 18 months.

The technology needs assessment (TNA) project is an item of the Poznan Strategic Program on Technology Transfer, proposed by GEF, to help developing countries to develop and update their technology needs according to Article 4.5 of the UNFCCC.

The main goal of this TNA project is to assist participant developing countries identify and analyze priority technology needs, which can form the basis for a portfolio of environmentally sound technology (EST) projects and programs to facilitate the transfer of, and access to, the ESTs.

The project's specific goals include: (1) identifying and prioritizing adaptive and mitigation technologies, and contributing to the national sustainable development goals; (2) identifying barriers hindering the acquisition,

deployment, and diffusion of prioritized technologies; (3) developing technology action plans (TAPs) to overcome the barriers and facilitate the transfer, adoption, and diffusion of selected technologies in the participant countries.

Chapter 2. Institutional arrangement for the TNA and stakeholder involvement

2.1 Overview

The Ministry of Natural Resources and Environment (MONRE) is appointed as the national Focal Point to implement the UNFCCC and the Kyoto Protocol.

The Department of Meteorology, Hydrology and Climate Change (DMHCC), under the auspices MONRE, is responsible for: i) coordinating the implementation of the UNFCCC and the Kyoto Protocol, ii) hosting the Standing Office of the Steering Committee of the UNFCCC and Kyoto Protocol, and the UNFCCC Secretariat contact point, iii) coordinating with other agencies to monitor and evaluate climate change impacts and propose climate change response plans; and iv) acting as Designated National Agency (DNA) of the Clean Development Mechanism (CDM). DMHCC was the coordinating agency in the development of Vietnam Second National Communication to the UNFCCC.

The National Steering Committee for the UNFCCC and Kyoto Protocol constitutes 18 members from 13 ministries, including the Ministry of Natural Resources and Environment, Foreign Affairs, Industry and Trade, Culture, Sports and Tourism, Planning and Investment, Finance, Transportation, Science and Technology, Labor, War Invalids and Social Affairs, Construction, Agriculture and Rural Development, Education and Training, Justice, and the Vietnam Union of Science and Technology Associations. It is an inter-ministerial organization responsible for assisting the Minister of MONRE in instructing, managing and coordinating the UNFCCC and Kyoto Protocol implementation activities, and CDM projects in Vietnam.

2.2 Institutional arrangement of Vietnam TNA project

The implementation of the TNA project in Vietnam involved the participation of multiple government agencies, research institutions, and non-governmental organisations.

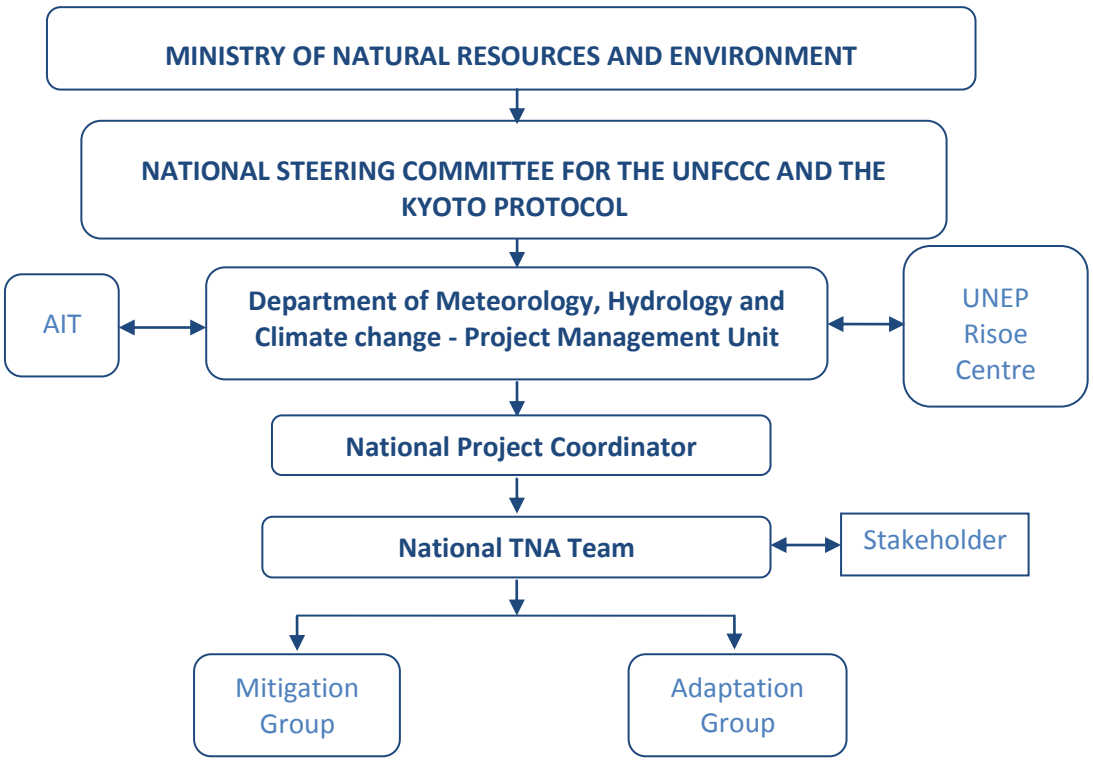

Figure 1 - Project Institutional Arrangment

As indicated in **Error! Reference source not found.**, the roles of different institutions are as follows:

Table 1 - The roles of institutions involved in the TNA project

Figure	*Hierarchy level*	*Job description/task/function*
MONRE	1	Line Agency
National Steering Committee for the UNFCCC and the Kyoto Protocol	2	Leads the TNA process
DMHCC	3	Coordinates the implementation of the Project
PMU	4	The PMU Director is a leader of the DMHCC. Directly coordinates and leads the project implementation
Project National Coordinator	5	An official from the DMHCC with outstanding project management skills and substantial technical knowledge
National TNA Team	6	Divided into 02 groups: adaptation and mitigation. Includes representatives from relevant institutions in the public and private sector (see Table 2.2).

The National Supervising Agency: Ministry of Natural Resources and Environment.

National Coordination Institution/Executing Agency: Department of Meteorology, Hydrology and Climate Change, Ministry of Natural Resources and Environment.

National Steering Committee for the UNFCCC and Kyoto Protocol: The TNA process was led by the National Steering Committee for UNFCCC and Kyoto Protocol.

Project Management Unit: The Project Management Unit (PMU) was formed via MONRE's Decision 259/QD-BTNMT dated 16 February 2011. The PMU composed one Project Director who is the Deputy Director-General of the DMHCC and one Project Accountant.

The PMU's mandate was to coordinate and implement the Project based on the Project Document and the TNA Handbook, and responsible for reporting to MONRE leaders and the National Steering Committee for UNFCCC and Kyoto Protocol for all activities of the Project.

2.2.1. National Project Coordinator, National TNA team and consultants

The Project Coordinator was Director of Climate Change Division of DMHCC who has a background in engineering and was able to demonstrate his facilitation and project management skills throughout the project. He functioned as a focal point for the work and management of the overall TNA process. He was capable of providing vision and leadership for the overall effort, facilitating the tasks of communication with the National TNA Team members, and managing outreach to stakeholders, formation of networks, information acquisition, and coordination and communication of all work products.

The National TNA Team comprised two groups of experts: mitigation and adaptation. The team included members familiar with national development objectives and sector policies, overall insights in climate change science, and potential climate change impacts for the country, adaptation needs and mitigation options of climate change. The experts should come from policy-making institutes and organizations (both governmental and non-governmental) with responsibility to undertake TNA activities such as research, analyses, and synthesis in support of the TNA exercise.

Specifically, the tasks of TNA team include:

- Identifying national development priorities on the basis national plans, National Communications, energy plans, previous TNAs; identifying and categorizing the country's sectors, and identifying potential technologies for mitigation and adaptation.
- Leading the process of technology needs assessment, identifying assessment criteria, and identifying and addressing the barriers.
- Preparing the TAP - a roadmap of policies that will be required for removing barriers; and
- Preparing the mid-term reports and final report (TNA and TAP).

During the course of the project, the TNA experts worked with various state agencies and referred to the climate techwiki website (http://climatetechwiki.org/) and the TNA project website (www.tech-action.org) for information and data.

For the list of agency/organization which experts work in, see Table 2 below.

Table 2 - List of agency/organization

P.o	Agency/Organization
1	Department of Science and Technology, Ministry of Natural Resources and Environment
2	Institute of Strategy and Policy for Natural Resources and Environment, Ministry of Natural Resources and Environment
3	Science Institute of Meteorology, Hydrology and Environment, Ministry of Natural Resources and Environment
4	Vietnam Administration of Forestry, Ministry of Agriculture and Rural Development
5	Institute of Energy, Ministry of Industry and Trade
6	Institute of Industrial and Chemical Safety Technology, Vietnam Union of Science and Technology Association
7	Vietnam Electricity
8	Centre for Ozone Protection, Department of Meteorology, Hydrology and Climate Change, Ministry of Natural Resources and Environment
9	Research Centre for Climate change and Sustainable Development

2.2.2 The cooperation of UNEP Risoe Center and AIT

During the implementation of technology needs assessment, Vietnam received the technical support from UNEP Risoe Center and AIT experts.

DMHCC had a meeting with representative of UNEP Risoe Center to discuss about main difficult issues in preparing the TNA report such as the application of MCDA model, criteria for technology prioritization, etc., any needs for support, plan for preparing the TAP report.

After the draft reports were sent to the UNEP Risoe Center and AIT for review comments. The national TNA team then revised the reports based on the comments received. This report has gone through several rounds of such reviews and revisions.

2.3 Stakeholder Engagement Process followed in TNA

Stakeholders are an indispensable part involved in the TNA Project implementation. The list of stakeholders includes policy-making governmental agencies, research institutes and centers, academies, and public and private sector organizations related to technology needs assessment for climate change adaptation and GHG emission mitigation.

The List of stakeholders is given in Annex IV of the report.

The PMU and the National Team as well as stakeholders cooperated in the assessment process:

- The PMU consulted experts to assess priority level of (sub) sectors and sent the results to all stakeholders. Based on the feedbacks, the Project Management Unit organized meetings with National Team and stakeholders to summarize comments and vote to identify/choose prioritized sectors.

- The PMU organized meeting with key experts and others on technologies for (sub) sectors. The outcome was a list of potential prioritized GHG mitigation technologies. Other important outcome was development of criteria for sector prioritization.

- In a meeting with participation of a wide range of stakeholders, comments and recommendations were made to identify/choose priority sectors and decide on assessment criteria for those sectors.

- The process of making a survey form for technologies of each sector have gained lots of comments from involved stakeholders to eliminate outdated technologies and prioritized modern technologies with GHG mitigation potential in short or long terms. As a result, the categorization and arrangement of technologies was more precise and clarified, which made it easier for the ensuing expert consultation on assessment criteria.

- During the process of Multi-Criteria Decision Analysis, the survey form was sent to independent experts chosen from all stakeholders in order to get the best objective opinions.

The linkage of all stakeholders in all prioritized sectors was an opportunity to carry out the research in an objective fashion when there were various points of view. At the same time, the National Team also had zealous support from all stakeholders to collect and clarify useful data to get the best results.

Chapter 3. Sector prioritization

3.1 An overview of sectors, and projected climate change and the GHG emission status and trends of the different sectors

3.1.1 An overview of sectors

3.1.1.1 Energy

Vietnam has a wide range of primary energy sources (oil, petroleum, gas, and hydropower). However, low capacity in extracting, processing and production, especially in electricity generation Vietnam's energy industries have yet to meet the growing demand of development and higher living standards.

Despite being a crude oil exporter, Vietnam is going to have to import oil until 2020 due to low refining capacity. Rising oil price will inevitably put pressure on Vietnam's social and economic development.

Coal production is growing at a average annual rate of 12.74% between 1990 and 2008. In 2008, coal production reached 39.8 million tonnes, of which 20.1 million tonnes was for domestic consumption, and about 19.7 million exported [*].

At the end of 2010, the total installed capacity of all power plants was 21,500 MW. Commercial electricity consumption per capita is estimated to be 1000 kWh/year per capita– considerably lower than the levels in many other countries in the region [*].

The *Rural electrification program* has been implemented over the past few years. According to reports by Vietnam Electricity (EVN), by the end of 2010, there had been 97.93% of communes and 94,67% of households having access to electricity from the national grid, higher than most countries with the same GDP in the region and the world [*].

Vietnam has a high potential for renewable energy (RE) resources, including small-scale hydropower, biomass energy, wind energy, solar energy, etc., which can be utilized to meet the energy demand, especially the need for electricity in areas far from the grid. However, due to limited budgets and lack of technology, the majority of population have to rely on biomass, a non-commercial energy. As a result, Vietnam has low commercial energy consumption per capita compared to other Asian countries.

Total primary energy consumption is increasing. Primary energy consumption, which totaled 32,235 KtOe in 2000, increased to 58370 KTOE in 2009. In terms of energy share, total final energy consumption rose from 26.28 million tOe in 2000 to 46.77 million TOE in 2009, with coal consumption rising from 12.3% to 19.2%, oil and petroleum from 26.3% to 33.9%, gas from 0.1% to 1.4 % and electricity from 7.3% to 14.1% [*].

The fast-paced economic development and GDP growth lead to high demand for natural gas, electricity and coal for the manufacturing industries and residential activities, especially coal. Thus, energy generation and consumption is going to be the main source of GHG emissions in the coming decades.

3.1.1.2 Agriculture

Agriculture has always been one of Vietnam's economic pillars. Twenty years since the reformation, Vietnam's rural lives have significantly altered. The rural economic structure is changing, with service industries growing and new industries and products forming.

Total agricultural area in 2000 was approximately 9.3 million hectares or 28.2% of the national land area, with 7.6 million hectares of rice fields.

Animal husbandry and crop are two fundamental sub-sectors of agriculture. However, the techniques and technologies used in agriculture have been outdated, although agricultural production still manages to meet domestic demand and export. Cultivation has been moving towards industrial farming scale and market economy to enhance product quality and value. Animal husbandry is changing into industrial livestock production, with aquaculture the fastest developed subsector.

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[*] Institute of Energy, 2011- Power Development Master Plan VII of Viet Nam, Period 2011-2020 with outlook to 2030.

Agriculture has helped to create jobs for thousands of people, and remains the major source of income for poor households.

With the globally changing climate, food security is one of the essential problems to countries with a large agricultural population like Vietnam.

3.1.1.3 Forestry

According to the 2006-2020 forestry development strategy, the total land area for forestry is 16.24 million hectares, equivalent to 49.3% of the total natural land area, including 5.6 million hectares of protection forest, 2.2 million hectares of the special forest, and 8.4 million hectares of production forest [*].

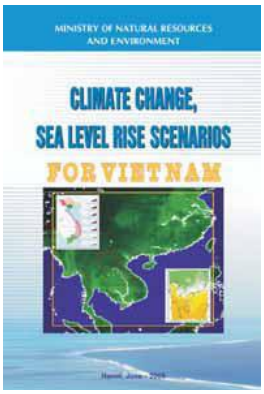
Forest coverage. The total forestland area was 13.258 million hectares by December 2009. Increased forest coverage is beneficial to the environmental protection as it helps to reduce impacts of storm, flood, drought and climate change. Scattered plants reach 200 million trees a year, contributing to the quantity of timber and burning wood in rural areas. The quality of plantation forest is increasing gradually; plantation productivity in many areas reaches 15-20 m3/ ha/year [**].

Better forest conservation. Project 661 (allocating forest to community for protection and management) has resulted in 2.6 million hectares/8 million hectares of protection forest and special forest planted during 2006-2010 - 172% more than the Government planned. 13.2 million hectares of forest have been protected, with a rate of 2.5 million hectares a year [**].

Production was 3.8 million m3 in 2009 and 4.95 million m3 in 2010, of which 90% was from plantation, reducing pressure on natural forest [**].

Forestry product value increases every year. Value of timber and non-timber forest products increased from VND 60,059 billion in 2005 to VND 116,685 billion in 2009 (inflation-adjusted prices) - a 194% rise. Export value increased from US$ 1.56 million in 2005 to US$ 2.8 billion in 2008 and reached US$ 3.45 billion in 2010 (average growth rates of 20% a year). Vietnam's woodwork has been exported to 100 countries and regions in the world, especially the US, the EU and Japan [**].

3.1.2 Climate change scenarios



Vietnam climate change scenarios were developed for seven climate zones in the 21st century, with elements including temperature, rainfall and sea-level rise. The coupled method (MAGICC/SCENGEN 5.3) and down-scaling method were used, based on greenhouse gas emission scenarios detailed in Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report: Climate Change 2007 (AR4). They are high emission scenario (A21), low emission scenario (B12), and medium emission scenario (B23).

Projected increases in temperature, rainfall and sea level in the three climate change scenarios compared to the 1980-1999 levels are presented in

Table .

[1] Scenario A2: A very heterogeneous world, self-reliance and preservation of nations; continuously increasing population in the 21st century, regionally-oriented economic development, technological change and more fragmented and slow per capita economic growth (high emission scenario).

[2] Scenario B1: Rapid economic growth but with rapid changes towards a service and information economy, global population reaches peak in 2050 and declines thereafter, reduction in material intensity and the introduction of clean and resources efficient technologies; emphasis on global solutions to economic, social and environmental sustainability (low emission scenario).

[3] Scenario B2: Continuously increasing population, but at a rate lower than A2, emphasis on local rather than global solutions to economic, social and environmental sustainability, intermediate levels of economic development, less rapid and more diverse technological change than in B1 family (medium emission scenario).

[*] Prime Minister, 2007. Decision No.18/2007/QD-TTg dated 05 Feb, 2007 on approving development strategy on Vietnam's forestry period 2008-2010

[**] Verification report No.74/BC-UBKHCNMT13 dated 24 Oct, 2011 of Committee of science and technology on planting 5 million hectares of forest project

Table 3- Projected increases in temperature, rainfall and sea level in the three climate change scenarios relative to 1980-1999

Element/ Climate zone	Year	2020			2050			2100		
Temperature (^{o}C)	**Scenario**	**B1**	**B2**	**A2**	**B1**	**B2**	**A2**	**B1**	**B2**	**A2**
	Northwest	0.5	0.5	0.5	1.2	1.3	1.3	1.7	2.6	3.3
	Northeast	0.5	0.5	0.5	1.2	1.2	1.3	1.7	2.5	3.2
	Red River Delta	0.5	0.5	0.5	1.2	1.2	1.3	1.6	2.4	3.1
	North Central Region	0.5	0.5	0.6	1.4	1.5	1.5	1.9	2.8	3.6
	North Central Region	0.4	0.4	0.4	0.9	0.9	1.0	1.2	1.9	2.4
	Central Highlands	0.3	0.3	0.3	0.8	0.8	0.8	1.1	1.6	2.1
	South	0.4	0.4	0.4	1.0	1.0	1.0	1.4	2.0	2.6
Rainfall (%)	Northwest	1.4	1.4	1.6	3.6	3.8	3.7	4.8	7.4	9.3
	Northeast	1.4	1.4	1.7	3.6	3.8	3.8	4.8	7.3	9.3
	Red River Delta	1.6	1.6	1.6	3.9	4.1	3.8	5.2	7.9	10.1
	North Central Region	1.5	1.5	1.8	3.8	4.0	3.7	5.0	7.7	9.7
	North Central Region	0.7	0.7	0.7	1.6	1.7	1.7	2.2	3.2	4.1
	Central Highlands	0.3	0.3	0.3	0.7	0.7	0.7	1.0	1.4	1.8
	South	0.3	0.3	0.3	0.7	0.8	0.7	1.0	1.5	1.9
	Scenario	**B1**	**B2**	**A1F1**	**B1**	**B2**	**A1F1**	**B1**	**B2**	**A1F1**
Sea-level rise (cm)	Nationwide	11	12	12	28	30	33	65	75	100

Source: (MONRE, 2009)

3.1.3 Result of GHG inventory for the year 2000 under Vietnam's SNC

The 2000 national GHG inventory, under the development of Vietnam SNC to the UNFCCC, was carried out in accordance with the Revised 1996 IPCC Guidelines for National GHG Inventories for principal GHG (carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) emissions from the energy, industrial processes, agriculture, LULUCF, and waste sectors.

a) Energy

In the energy sector, GHG was emitted from two major sources: fuel combustion and fugitive emissions due to extraction and transportation of fuels. Estimated fuel combustion emissions were 45.9 million tonnes of carbon dioxide, 68.4 thousand tonnes of methane and 1.27 thousand tonnes of nitrous oxide. Fugitive emission sources are mainly from coal, oil and gas extraction, and gas leakage. Amount of methane emitted from coal mining (surface and underground) was estimated at 89.26 thousand tonnes while emissions from oil and gas extraction stood at 150.95 thousand tones.

The year 2000 national GHG inventory results is presented in Figure 2 and Table .

Table 4 - Energy GHG emissions by sub-sector

Unit: thousand tonnes of CO_2 equivalent

Sector	2000	
	Emission	Percentage
Fuel combustion		
• Energy industries	11,205.20	21.2
• Manufacturing industries and construction	15,113.23	28.6
• Transportation	11,946.61	22.6
• Commercial/Institutional sector	2,971.48	5.6
• Residential sector	3,933.37	7.5
• Agriculture/Forestry/Aquaculture	1,384.53	2.6
• Others	1,174.63	2.2
Fugitive emissions		
• Solid fuels	1,874.46	3.6
• Gasoline and oil	3,169.95	6.1
Total	**52,773.46**	**100**

Source: (SNC, 2010)

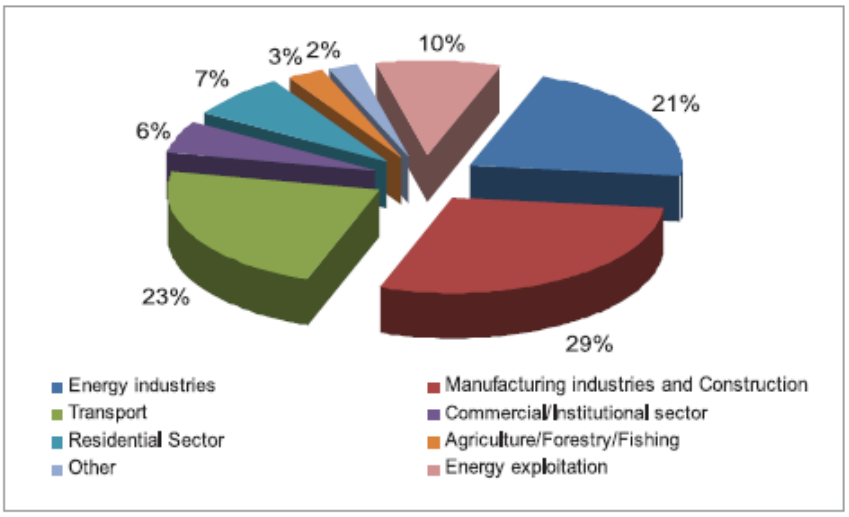


Figure 2 - Energy GHG emissions by sub-sector

b) Indutrial Processes

Carbon dioxide released from industrial process in 2000 were 10,006 thousand tonnes, mostly from cement and steel production with 6,629 and 2,536 thousand tonnes, respectively.

Inventory results for industrial processes are shown in Table and Figure 3.

Table 5 - GHG emissions from industrial processes

Unit: thousand tonnes of CO_2 equivalent

Production	2000	Percentage
Cement	6,629.05	66.3
Lime	821.99	8.2
Ammonia	10.40	0.1
Carbide	8.60	0.1
Steel	2,535.56	25.3
Total	**10,005.8**	**100**

Source: (SNC, 2010)

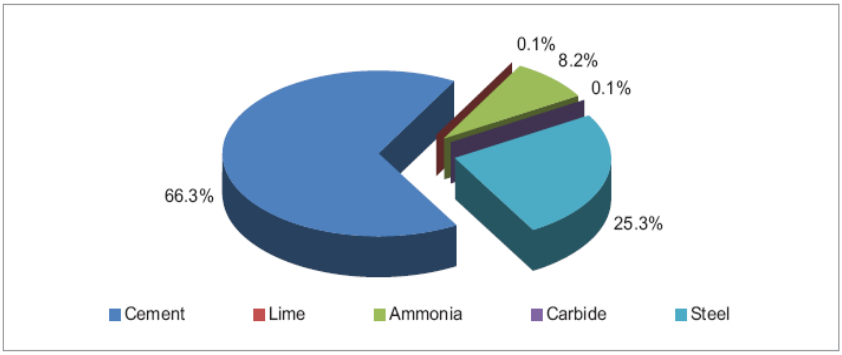


Figure 3 - Industrial processes GHG emissions by source, 2000

c) Agriculture

Emission sources in the agriculture sector are identified as rice cultivation, livestock raising, agricultural soils, and burning of agricultural residues. The total amount of emissions in agriculture stood at 65,090.7 thousand tonnes of CO_2 equivalent (tCO_2e).

Agricultural emission estimations are shown in Table and Figure 4

Table 6 - GHG emissions in agriculture

Unit: thousand tonnes

Sub-sector	CH_4	N_2O	CO	NO_x	CO_2e	Percentage
Enteric fermentation	368.12				7,730.52	11.9
Manure management	164.16				3,447.36	5.3
Rice cultivation	1,782.37				37,429.77	57.5
Agricultural soils		45.87			14,219.70	21.8
Savannah burning	9.97	1.23	261.71	4.46	590.67	0.9
Burning of agricultural residues	59.13	1.39	1.214.68	50.28	1,672.63	2.6

Total	**2,383.75**	**48.49**	**1,476.39**	**54.74**	**65,090.65**	**100**

Source: (SNC, 2010)

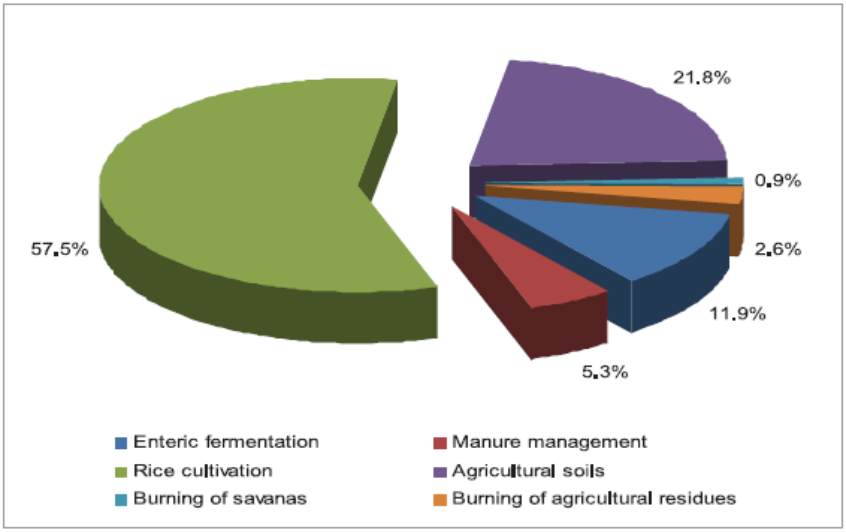


Figure 4 - Agricultural GHG emissions by source, 2000

d) Land use, land use change and forestry

Emission and removal of GHG in LULUCF were mostly resulted from changes in forest and biomass stocks, land use and land use change, and soil carbon emission. GHG emissions totaled 15.104 million of tCO_2e in 2000.

GHG emissions/removals in LULUCF is presented in Table and Figure 5.

Table 7 - LULUCF greenhouse gas emissions by source, 2000

Unit thousand tonnes

Sub-sector	CO_2 emission	CO_2 uptake	CH_4	N_2O	CO_2e
Changes in forest and other woody biomass stock	0	- 49,830.18			-49,830.18
Land use change	40,665.17		140.30	0.96	43,909.70
Abandonment of managed land	0	- 7,330.33			-7,330.33
CO_2 uptake/emission from soils	46,943.75	-18,588.22			28,355.53
Total	**87,608.92**	**-75,748.73**	**140.30**	**0.96**	**15,104.72**

Source: (SNC, 2010)

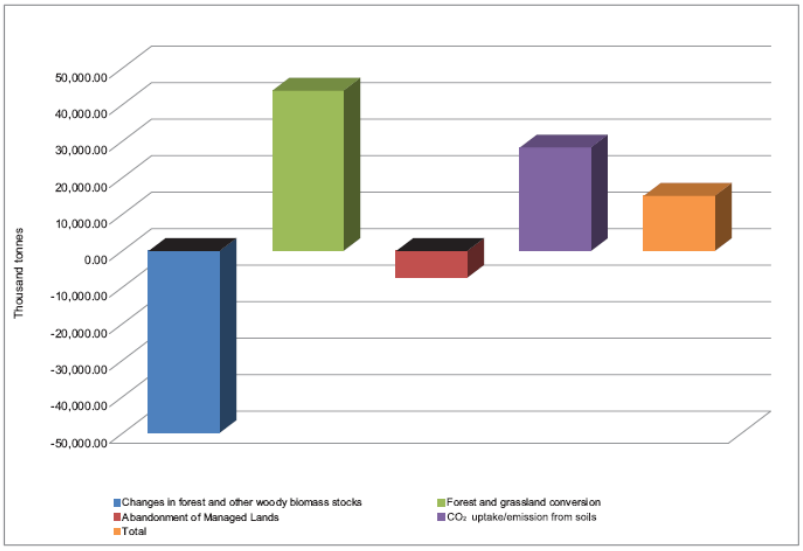


Figure 5 - LULUCF greenhouse gas emissions by source, 2000

e) Waste

Total GHG emission amount from the waste sector in 2000 was estimated at 331.48 thousand tonnes of CH_4 and 3.11 thousand tonnes of N_2O, equating 7,925.18 thousand tCO_2e

GHG emission from the waste sector is shown in Table and Figure 6.

Table 8 - Waste GHG emissions by source, 2000

Unit: thousand tonnes

Sub-sector	CH_4	N_2O	CO_2 equivalent	Percentage
Solid waste	266.52		5,596.92	70.6
Waste water	1.35		28.35	0.4
Industrial wastewater	63.61		1,335.81	16.8
Human waste		3.11	964.10	12.2
Total	**331.48**	**3.11**	**7,925.18**	**100**

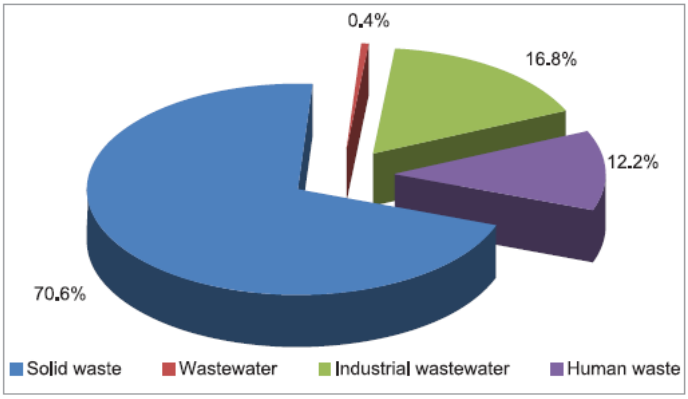


Figure 6 - Waste GHG emissions by source, 2000

In total, 2000 GHG emissions in Vietnam stood at 150.9 million tCO_2e., with the following sectoral shares: Agriculture: 65.1 million tCO_2e; Energy: 52.8 million tCO_2e; LULUCF: 15.1 million tCO_2e; Industrial processes: 10.0 million tCO_2e; and Waste: 7.9 million tCO_2e. (See Table and Figure 7)

Table 9 – The year 2000 National GHG Inventory results by sectors

Unit: thousand tonnes

Sectors	CO_2	CH_4	N_2O	CO_2 equivalent	Percentage
Energy	45,900.00	308.56	1.27	52,773.46	35.0
Industrial process	10,005.72	0	0	10,005.72	6.6
Agriculture	0	2,383.75	48.49	65,090.65	43.1
LULUCF	11,860.19	140.33	0.96	15,104.72	10.0
Waste	0	331.48	3.11	7,925.18	5.3
Total	**67,765.91**	**3,164.12**	**53.83**	**150,899.73**	**100**

Source: (SNC, 2010)

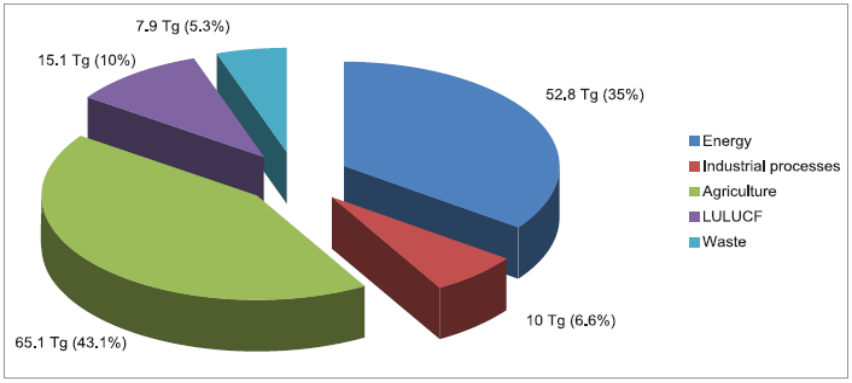


Figure 7 - GHG emissions by sector in 2000 in CO_2e

3.1.4 Projected emissions from main sector for 2020 and 2030

Aggregate GHG emissions from three sectors – energy, agriculture, and LULUCF – is projected to be 300.4 million tCO_2e by 2020, and 515.8 million tCO_2e by 2030, with energy being the biggest source, amounting to 91.3% of the 2030 total emissions. (See Table and Figure 8)

Table 10 - Projected GHG emissions by 2020 and 2030

Unit: million tonnes of CO_2 equivalent

Sector	2020	2030
Energy	251.0	470.8
Agriculture	69.5	72.9
LULUCF	-20.1	-27.9
Total	**300.4**	**515.8**

Source: (SNC, 2010)

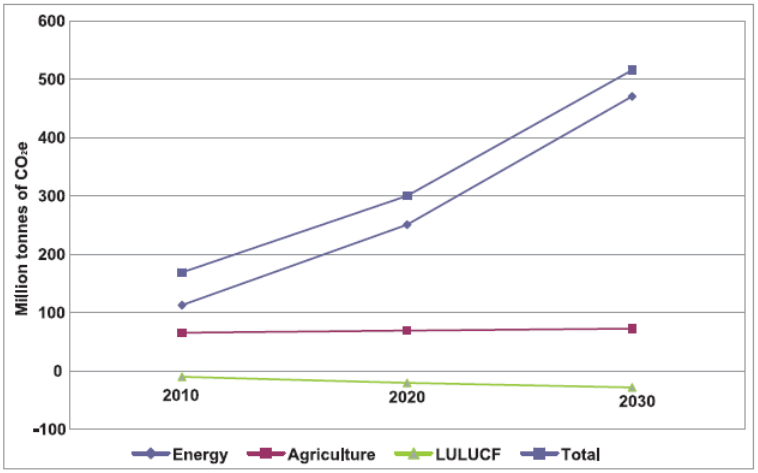


Figure 8 - Projected GHG emissions by 2020 and 2030

3.2 Process and criteria of prioritization

Sector prioritization process and criteria for subsequent assessment of mitigation and adaptation technology needs were carried out in accordance with the *Handbook on conducting technology needs assessment for climate change* by the UNFCCC and the United Nations Development Programme (UNDP), published in November 2010.

Sectors identified for mitigation are based on their shares in national GHG emissions, their potential for feasible GHG mitigation options, their capacity to employ low-carbon technologies, and their contribution to overall national development goals.

According to the 2000 National GHG Inventory (under the SNC), energy, agriculture and LULUCF are identified as the main emitting sources, having a higher share in the country's GHGs than other sectors and predicted to be future major sources/sinks of GHGs.

With all driven analyses above, the hosts held up conference to correspond experts to choose priority sectors to mitigate GHG emissions and agreed on 4 priority criteria, including:

+ Economic benefits: the level of contribution of sector into national economy, via ratio of sector over GDP, energy saving;
+ Social benefits: level of contribution of sector to employment, hunger eradication and poverty reduction, enhancing health and cultural living;
+ Environmental benefits: show significant of sector to development of land, air, water, ecology environments;
+ GHG emission mitigation potential: large reduction of GHG when technologies are applied.

The method of giving points to sectors was designed by experienced experts/stakeholders. The points based on characterization of how the deployed low emission technology (direct and indirect) could bring improvements to sectors. The improvements hereby means contributions to all criteria above and level of mark are:

0 – no benefit

1 – faintly desirable

2 – fairly desirable

3 – moderately desirable

4 – very desirable

5 – extremely desirable

After all reviews and opinions were collected from experts/stakeholders, the priority points were shown on

Table and were summed for each sector. Meanwhile, each point of each criterion, each sector was average approximate point from experts/stakeholders.

Table 11 - Performance matrix of prioritizing sectors for mitigation

Sectors	Economic priority	Social priority	Environmental priority	GHG reduction potential	Total benefit
Energy	5	4	5	5	19
Industrial processes	4	3	3	1	11
Agriculture	5	5	4	5	19
LULUCF	4	4	4	5	17
Waste	3	4	4	2	13

The total results were also shown in

Table proved that all experts/stakeholders agreed 3 high priority sectors were: energy, agriculture and LULUCF. The three sectors were foci in national development strategy.

3.3 Current status of technologies in the selected sectors

3.3.1 Energy

3.3.1.1 Coal mining

- Blast mining, manual loading and mechanical transportation in underground mining
- Mechanical technologies in coal processing and separation; dense medium separation contributing 30% of coal production.

3.3.1.2. Gas and oil

- Magnetic drilling and exploration
- Offshore drilling and exploration
- Oil refining: only one refinery is in operation since 2010, with annual capacity of 6.5 million tonnes.
- Medium-scale liquefaction
- Associated gas recovery and utilization: applied in one CDM project

3.3.1.3. Electricity generation

- Thermal power using coal-fired superheaters: widely used
- Thermal power using circulating fluidized bed combustion: used in two projects, with a capacity of 100 MW each
- Combined cycle power plant (CCPP): popular in the southern areas
- Multiyear regulation hydropower plants
- Small-capacity thermal power co-generation
- Electric power transmission technology: currently in use at different voltages.
- Information technologies employed in automation and communication

3.3.1.4. Energy use

- Small-capacity, low-pressure steam generator technology, fuelled primarily by coal or petrol
- Small-scale, low-efficiency furnaces or kilns still dominant in various industries including construction

- Outdated electrical machines
- Industrial air conditioning, cooling or freezing technologies mostly old and obsolete, though small part of these technologies are considered adequate
- Electricity-efficient technologies, such as high-efficiency engines or energy-saving compact light, starting to enter into use.

3.3.1.5. Renewable energy

- Small-capacity solar water heaters
- Small-scale hydropower: now very common
- Wind energy, with first plant in operation since 2010, with a capacity of 6 MW.
- Biogas for heating: fairly common
- Small-capacity solar battery: beginning to be used
- Biomass as fuels for small-scale combined heat-power cogeneration: in pilot stage

3.3.1.6. Transportation

- Road transportation: most vehicles (cars, trains) fueled by diesel
- Water transportation: conventional boats and small ships
- Motorbikes are the most common type of vehicles in urban areas.

CONCLUSIONS

Mechanization of coal mining and preparation have just begun in Vietnam. Automatic technologies are almost non-existent and efficiency in coal recovery is low. Overall, coal mining and preparation technologies are considered low.

Oil and gas exploration and refining technologies are imported into Vietnam through businesses with foreign partners and considered slightly satisfactory.

Electricity generation technologies can be deemed satisfactory with many new plants coming into operation and only a few old plants in use.

Energy use technologies are outdated, with old equipment and energy consumption 1.2 – 1.5 times higher than the regional standards.

Replacing low-efficiency technologies with new, low-carbon ones is inevitable. However, studies on appropriate criteria and roadmap must be performed to achieve this.

Transfer and application of advanced technologies are demanded to meet the of social and economic development needs in the future.

3.3.2 Agriculture

Agriculture has grown at a fast rate in recent years. From a country struggling with food insecurity and famine, Vietnam has risen to become the world's second rice exporter. Additionally, agricultural production (meat, fish, fruit and vegetables, etc.) increases at a high speed and has moved towards industrial farming, producing products in large quantity.

These results were achieved by the development and effective use of new agricultural technologies, such as:

1. Wet and dry irrigation during rice plants' growth stages as a irrigation management method
2. Changing from 2 crops (rice-rice) to 3 crops (rice-other grain-rice)
3. Using microorganism fertilizers
4. Supplementing fodder and balancing nutrition for cattle
5. Using biogas as fuels

6. Genetically modified cattle breeds
7. Using sulfate fertilizers instead of urea fertilizers
8. Increasing vegetation cover on cropped land to keep carbon soil
9. Managing agricultural residues/by-products

Among the 9 options above, options 1 and 4 have high potential for methane emission reduction; options 3 and 7 for nitrous emission reduction. The rest have medium potential to mitigate GHG emissions.

3.3.3 LULUCF

Today, technology is playing an increasingly important role in forestry and LULUCF. Major GHG reduction and adaptation technologies in this sector are:

- **Crop management and cultivation technologies** (irrigation and drainage management, fertilizer application, pest and disease control). For a long time, crop management and cultivation practices have been instrumental in raising agricultural productivity. In forestry, however, they have only been adopted for planting raw material trees. Crop management will have to face more difficulty in a changing climate.
- **Plant science and planting technology**. Planting is currently the biggest forestry activity in Vietnam. Efforts in implementation of national forest protection and development – the Reforesting barren lands and degraded forests policy, are demonstrated in the rapidly increased forest coverage. Nationwide, plants are grown to provide materials for production. Planting technologies include plant cutting techniques, tissue culture, land preparation (plowing, harrowing, etc,).
  - *Selecting species* that tolerate lower humidity and higher temperature. Many drought-tolerant species were selected and studied to restructure the distribution and patterns of plants.
  - *Relocating* major species from dry areas to a milder environment. Further research on application potential of this technology, however, needs to be conducted.
  - Applying *biotechnology* to selecting and creating new plant species; selecting drought-, flood-, and disease-resistant species that are highly adaptive to climate change. This technology has shown some results and started to be used in production.
  - *Intensive forest planting techniques* are applied in nationwide material plantations.
  - Most technologies are applied in land use for sustainable development (sustainable land management) in view of a changing climate and adaptation such as sub-surface irrigation, application of superabsorbent polymer AMS-1 to growing plants on arid lands, etc.
  - Other conventional technologies for sustainable forestry are still widely applied by communities, including cultivating on steep land, agroforestry, post-harvest silvicultural generation methods.
- **Forest management and conservation**. For the last ten years, sustainable forestry has become of great interest to authorities. Sciences and technologies for sustainable management of natural forests have been under intensive research. Major techniques in forest protection are using the following technical factors:
  - Silvicultural methods
  - Extraction management
  - Community-based natural forest management
  - Sustainable plantation management
  - Land-use management and wildfire control by the geographical positioning system (GPS) and remote sensing
- **Forestry development technologies:**
  - Forestry utilization technologies are rather outdated, mainly labored by man and working animals. Low-impact development (LID) has been brought into Vietnam during the past few years and piloted in several provinces. Nonetheless, a great deal of work needs to be done in terms of policy, procedures, standards, and technology diffusion and human training before this technology can be applied.
  - In wood processing, technologies employed are mainly for lumber production (drying, cutting, shaping, etc.) and forest product preservation. Vietnam's wood processing is rather out of date compared to the world's and regional standards due to lack of planning, technologies and concentration areas for raw materials.

Chapter 4. Technology prioritization for the energy sector

4.1 An overview of possible mitigation technology options in the energy sector and their mitigation benefits

An overview of possible mitigation technology options in the energy sector and their mitigation benefits are presented in the Table below.

Table 12 - An overview of possible mitigation technology options in the energy sector and their mitigation benefits

Technology Options	Description	Mitigation benefits	Potential
Combined cycle thermal power	High efficiency, low capital costs, reducing CO_2	35-40% of GHG emissions reduced compared to coal-fired thermal power, usually 420-430gr CO_2/kWh.	Used on medium scale, will be expanded to larger scale according to planning
Large-Scale Heat and Power (Cogeneration)	High efficiency, reducing CO_2	- Higher efficiency than conventional technology by 15-20%. - Reducing fuel loss and carbon dioxide emissions by 15%, equivalent to 100grCO_2/kWh, compared to conventional coal-fired thermal power.	Used on medium scale, will be expanded to larger scale according to planning
Wind power	Clean energy, reducing CO_2	- Approximately, each MW of wind power emits 2000 tonnes of CO_2 less than coal-fired thermal power. - Vietnam's wind energy potential is high, with a possible capacity up to 1000-2200 MW. Producing 1280 MW of wind energy can reduce 28.4 million tonnes of CO_2 compared to producing 400 MW of coal-fired thermal power.	Possible further development
Small-scale hydropower	Clean energy, reducing CO_2	Vietnam has the potential to produce about 2000 MW of electricity by small-scale hydropower instead of 1200 MW of coal-fired thermal power, therefore reducing 120 million tonnes of CO_2.	Possible further development
Pumped-storage hydroelectricity	Efficient use of water	Utilizing water and other renewable energies effectively, reducing the fossil fuel consumption and, in the end, GHG emissions.	Undergoing feasibility study, further development into large scale
Energy-saving compact fluorescent lamps	Clean energy, reducing CO_2	- Electric lighting is one of the major sources of carbon dioxide. According to the International Energy Agency (IEA), an CFL can help to reduce 0.5 tonnes of CO_2 during its lifespan (2006). - Vietnam's population is projected to be 104 million in 2030, equivalent to 23 million households. If each household uses four light bulbs, 90	Currently in use, further development

		million incandescent light bulbs can be replaced by CFLs in Vietnam by 2030, reducing 70 million tonnes of CO_2.	
Solar water heaters	Using a clean fuel, competitive to other sources	- Solar water heating can reduce fossil fuel consumption and subsequently GHG emissions. - If 50-65% of households, equivalent to 12 million households, use solar water heaters by 2030, the emission reduction potential can reach 100 million tonnes of CO_2.	Currently in use, further development
Underground coal gasification	Enhancing efficiency, safe	- Minimizing environmental impacts around mine areas. - Higher efficiency and lower CO_2 emissions than direct burning of fuels.	Further development
Compressed Natural Gas (CNG)	Reducing CO_2, cheaper than petrol	- CNG is a clean, low in NO_x and dust emission fuel, so it can enhance urban air quality. - Natural gas emits less CO_2 than other oil-based fuels. - Potential to use CNG in urban transportation is high. Vietnam is expected to have 193,000 buses by 2025, up from 79,000 buses in 2005. If one third, or 60,000, of the buses use CNG, it is estimated to reduce 4 million tonnes of CO_2.	Experimental, further development
Bus rapid transit (BRT)	Satisfying transportation demand, saving energy	- Vietnam has a high potential to develop BRT in big cities, especially in Hanoi and Ho Chi Minh City, where traffic jams occur regularly. BRT is already under consideration for implementation. - By 2030, if there are 30 BRT routes in operation, 3 million tonnes of CO_2 can be reduced (according to Mexico example).	Experimental, further development

4.2 Criteria and process of technology prioritization

4.2.1 Criteria of technology prioritization

According to UNEP guidelines on TNA, the Multi Criteria Decision Analysis (MCDA) were used to assess the needs of techonologies for mitigation GHG and adaption to climate change. The MCDA provided policy makers and consultants a framework of which they can form their ideas. Moreover, the method allowed links centered to one topic, therefore, different experiences and views could be applied to make an overall decision. Beside, the uncertainties from data lacking, different views or change in the future could be researched in MCDA in order to develop best solution.

When applying MCDA at first a set of criteria is needed. The contribution of each technology will affect assessment towards the objectives of adaption/mitigation which follows national climate change scenarios.

Criteria were based on current research that estimated potential effects of criteria on searching suitable technologies. Although there are plenty of criteria when choosing technologies, there was a necessity of discussion to clarify appropriate criteria and most needed designed at mitigation GHG emissions and climate change. The following activities will be done to create criteria:

• Discuss in each group of each sector about appropriate criteria to arrange technologies in prioritized order/estimated mitigation and adaption:

- To prioritize the resilience of sectors versus the effects of climate change and other sectors that may be affected indirectly.

- To minimize GHG emission.

- To maximize benefits of prioritized development related to environment, society, economy and minimize harmful effects.

• To decide and indentify criteria based on experts' views to solve compulsory questions when modifying technologies for coal mining:

- How can the technology contribute to national development?

- How can the technology help adaptation to climate change objectives?

- How can the technology be applied in fact?

- What is the financial feasibility of the technology?

The Management Board leaded meeting to unite all criteria for each sector based on activities of involved stakeholders. After the discussion, research, assessment, all criteria were presented in 4.2 below.

4.2.1.1 Energy (not including transportation)

The energy expert group agreed on a set of criteria for assessing priority mitigation technologies in energy, including:

- Cost: capital, operation and maintenance costs, and cost-benefit of the GHG mitigation.
- Benefit:
    - Amount of GHG emissions reduced by 2030;
    - Environmental: reducing air, land and water pollution;
    - Social: more work created, improved healthcare services and enhanced awareness and understanding

Economic: contribution to economic development, saving energy and balance of payments (BoP).

Table 13 - Criteria of technology prioritization in the energy sector (not including transportation)

P.o	Criterion	Specification
1	**Costs**	This is the most important group of criteria in deciding which technology will be invested and how they are going to be invested to receive the desired results. This criterion is demonstrated through two factors: costs and financial indicators.
1.1	Capital costs	Based on initial costs such as technology fees, facility building costs, transfer fees, etc. to attain the technology. Less capital-intensive technologies will be preferred, although this information is not available at the moment or the technology does not have a general representative value.
1.2	Operation and Maintenance costs (O&M)	Based on considerations of other costs such as annual maintenance costs, technology operation costs, etc. Lower costs will result in higher scores.
1.3	GHG emission	Based on cost estimation of the technology to reduce GHG emissions. Lower costs

P.o	Criterion	Specification
	reduction costs	will result in higher scores.
2.	**GHG emission reduction potential by 2030**	This is a very important and crucial criterion of technology assessment to predict the future trends of climate change response technologies. Technologies with higher potential of GHG emission reduction will have higher scores.
3.	**Environmental benefits**	This is the "last but not least" group of criteria in assessing technologies. To reduce the GHG emissions, adapt to climate change and improve environment, the technology must generate environmental benefits.
3.1	Air quality	This criterion assesses air quality through the reduced concentration of toxic gases and dust.
3.2	Land	This criterion is based on the soil pollution prevention potential through reducing release of solid waste to the environment.
3.3	Water	This criterion assesses the potential to enhance efficiency of water use in production, and reduce the amount of wastewater discharged into environment.
4.	**Social benefits**	Like economic benefits, social benefits need to be taken into account when assessing technologies. Good technologies which are beneficial in economic and social terms are considered technologies for the future. Social benefits are demonstrated through the four following factors:
4.1	Job opportunity	Benefits from a good technology to the society are shown in its potential to create work opportunities and reducing the jobless rate. Therefore, this criterion is used to assess the overall societal objective. Technologies that have higher potential for job or new sector creation will have higher scores.
4.2	Health	This criterion will assess the potential to reduce health risks such as diseases or labor accidents, or improve laborer's quality of life.
4.3	Awareness	A newly transferred and applied technology is an opportunity for access to modern sciences, which in turn will help raise awareness on new issues. In addition to economic benefits, technologies also help raise awareness on environmental protection issues.
5.	**Economic benefits**	Technology needs assessment must look at the economic aspect because the purpose of technology innovation is to create more economic benefits, or more specifically, more revenue. At the same time, development of a new technology should satisfy the overall objective, that is, to ensure development of all three aspects: economic, social and environmental. The economic benefit criteria group is specified through the three factors below:
5.1	Economic development	This criterion assesses the contribution of the technology to the economic stability and development through activities such as developing new industries, creating investment environment, building and maintaining infrastructure, reducing costs and opening more opportunities for business, etc.
5.2	Energy saving	Modern technologies use less and less energy to secure national energy security. On the other hand, using energies such as electricity and thermal power can emit GHGs. Therefore, the more efficient the technologies, the higher they are rated.

P.o	Criterion	Specification
5.3	Balance of Payment (BoP)	This criterion assesses the potential of the technology to contribute to reducing expenditures in foreign currencies, particularly through reducing material imports. This will contribute to the stable and sustainable economic development and reducing imports.

4.2.1.2 Transportation

The transportation expert group agreed on a set of criteria for assessing priority mitigation technologies in transportation, including:

- Cost: capital, operation and maintenance costs, and cost-benefit of the GHG mitigation.
- Benefit:
    - Amount of GHG emissions reduced by 2030;
    - Environmental: reducing air, land, water and noise pollution;
    - Social: decrease in the number of traffic accidents, more work created, improved healthcare services and enhanced awareness;
    - Economic: contribution to economic development, saving energy and BoP.

Table 14 - Criteria of technology prioritization in the transportation sector

P.o	Criterion	Specification
1	**Costs**	This is the most important group of criteria in deciding which technology will be invested and how they are going to be invested to receive the desired results. This criterion is demonstrated through two factors: costs and financial indicators.
1.1	Capital costs	Based on initial costs such as technology fees, facility building costs, transfer fees, etc. to attain the technology. Less capital-intensive technologies will be preferred, although this information is not available at the moment or the technology does not have a general representative value.
1.2	Operation and Maintenance costs (O&M)	Based on considerations of other costs such as annual maintenance costs, technology operation costs, etc. Lower costs will result in higher scores.
1.3	GHG emission reduction costs	Based on cost estimation of the technology to reduce GHG emissions. Lower costs will result in higher scores.
2.	**GHG emission reduction potential by 2030**	This is a very important and crucial criterion of technology assessment to predict the future trends of climate change response technologies. Technologies with higher potential of GHG emission reduction will have higher scores.
3.	**Environmental benefits**	This is the “last but not least” group of criteria in assessing technologies. To reduce the GHG emissions, adapt to climate change and improve environment, the technology must generate environmental benefits.
3.1	Air quality	This criterion assesses air quality through the reduced concentration of toxic gases and dust.
3.2	Land	This criterion is based on the soil pollution prevention potential through reducing release of solid waste to the environment.

P.o	Criterion	Specification
3.3	Water	This criterion assesses the potential to enhance efficiency of water use in production, and reduce the amount of wastewater discharged into environment.
3.4	Noise	Based on the potential to reduce noise pollution in the area where the technology is applied.
4.	**Social benefits**	Like economic benefits, social benefits need to be taken into account when assessing technologies. Good technologies which are beneficial in economic and social terms are considered technologies for the future. Social benefits are demonstrated through the four following factors:
4.1	Traffic accident prevention	Based on the potential to reduce the number of traffic accidents when applying the technology. Technologies with higher potential to meet this criterion will be scored higher.
4.2	Job opportunity	Benefits from a good technology to the society are shown in its potential to create work opportunities and reducing the jobless rate. Therefore, this criterion is used to assess the overall societal objective. Technologies that have higher potential for job or new sector creation will have higher scores.
4.3	Health	This criterion will assess the potential to reduce health risks such as diseases or labor accidents, or improve laborer's quality of life.
4.4	Awareness	A newly transferred and applied technology is an opportunity for access to modern sciences, which in turn will help raise awareness on new issues. In addition to economic benefits, technologies also help raise awareness on environmental protection issues.
5.	**Economic benefits**	Technology needs assessment must look at the economic aspect because the purpose of technology innovation is to create more economic benefits, or more specifically, more revenue. At the same time, development of a new technology should satisfy the overall objective, that is, to ensure development of all three aspects: economic, social and environmental. The economic benefit criteria group is specified through the three factors below:
5.1	Economic development	This criterion assesses the contribution of the technology to the economic stability and development through activities such as developing new industries, creating investment environment, building and maintaining infrastructure, reducing costs and opening more opportunities for business, etc.
5.2	Energy saving	Modern technologies use less and less energy to secure national energy security. On the other hand, using energies such as electricity and thermal power can emit GHGs. Therefore, the more efficient the technologies, the higher they are rated.
5.3	Balance of Payment (BoP)	This criterion assesses the potential of the technology to contribute to reducing expenditures in foreign currencies, particularly through reducing material imports. This will contribute to the stable and sustainable economic development and reducing imports.

4.2.2 Process of technology prioritization

In each sector, based on criteria above, technologies were given score and weighted for each criterion and arranged in priority order. The more the point was, the higher rank was.

Weight: reflects importance of each **criterion** in making decision. It considered differences between the upper and lower of the elevation of point and the level of group interest (namely 'changable weighted method'). Once all options had been weighted, the criteria became important. This is necessary to ensure independance when giving point to one criterion. For example, 100 points for environment is different from 100 point for society. The elevation of weighted point has the scale of 100. The effect of one criterion on decision is maximum and max at 100. Consequently, criteria affected in different decision making will be weighted on the scale.

The weighted point is converted as below:

$$w_{n,}(\%) = \frac{W_n * 100}{\sum W}$$

Where:

w_n : Convert weight of criterion n (%)

W_n : Query weight of criterion n

$\sum W$: Sum of overall query weight of all criteria

Giving point: in order to evaluate expected productivity of technology based on its contribution to the criteria. The productivity of technology is considered by categorized information in selecting technology, knowledge and reviews of experts.

The experts are asked to give point from 0-100 in TNA Table (0 means least preferable option not no productivity). The best and least options are identified first and issued in order from 100-0, then come other points of other options.

The process of giving point repeats for each group, each sector.

Given the counsels and information, points for each expert is calculated by the following formula:

$$S_i = w_1 s_{i1} + w_2 s_{i2} + \ldots + w_n s_{in} = \sum_{j=1}^{n} w_j s_{ij}$$

Where:

$\mathbf{S_i}$: overall points of experts on the technology "i"

w_n: converted weighted point for criterion "n"

s_{in}: weighted point of technology "i" according to criterion "n"

The benefits when used MCDA: The main option for MCDA was benefit-cost analysis and for each technology. Cost analysis was depended on each related elements such as NPV, IRR, operation, maintenance & adaptation costs, etc. However, benefit-cost analysis was complicated because it required all benefits in cash while some of them can not be estimated. Therefore, based on overall point from formula, benefit-cost analysis is calculated as $S_b = S_i - S_c$

Where:

S_b: benefit point of technology "i"

$\mathbf{S_i}$: overall point of expert for technology "i"

S_c: overall point of cost for technology "i"

The average benefit point: The points were given by experts as explained above by survey forms. The average benefit point was quotient of overall benefit point of all experts and numbers of experts. Therefore, the average benefit point (S_a) would serve as a basis for arrange technologies in priority order. S_a was calculated as:

$$S_a = \frac{\sum(S_i - S_c)}{\text{Number of experts}}$$

Number of experts involved in scoring and weighting were 10 persons per sectors.

4.3 Result of technology prioritization

4.3.1 Energy (not including transportation)

Based on the above-mentioned process of technology pripritization in item 4.2, survey forms were sent to energy experts to assess the technologies.

Results of mitigation technology prioritization in the energy sector are presented in the Table below.

Table 15 - Result of mitigation technology prioritization in the energy sector

Technology Option	Average MCDA score	Average benefit (S_a)
Combined cycle thermal power	48.73	34.43
Large-Scale Heat and Power (Cogeneration)	67.10	50.89
Wind power	71.06	54.51
Small-scale hydropower	66.80	50.14
Pumped-storage hydroelectricity	53.97	42.50
Energy-saving compact fluorescent lamps	74.16	50.97
Solar water heaters	68.88	50.96
Underground coal gasification	27.96	27.07

Sensitivity Analysis

MCDA used criteria, points and weights as basic subjective concepts of people to decide. Therefore, it was recognised as a matter of fact that there were no clear, coded decisions, objective and subjective alike, and close checking for uncertainties. The same process was applied unrepeatedly when assess the sensivity for prioritized technologies for sectors.

- To analysis sensivity based on the points given by experts

The overall point of each expert to each technology was different from overall average of that technology (Stb). However, the average of difference of chosen techonogies given by each expert was expected below 5% compared with overall point of Stb (detailed in

Table below)

Table 16 - Difference of chosen technologies given by each expert compared with overall average point of prioritized technologies in the energy sector

P.o	Technology	Difference of chosen techonogies given by each expert compared with Stb (%)									
	No. of expert	EP1	EP2	EP3	EP4	EP5	EP6	EP7	EP8	EP9	EP10
1	Energy-saving compact fluorescent	5.26	5.64	4.69	4.10	3.19	0.75	3.63	13.83	8.35	6.87

	lamps										
2	Wind power	3.82	5.50	0.42	12.15	1.32	0.19	2.79	3.95	24.78	2.85
3	Large-Scale Heat and Power (Cogeneration)	4.56	3.85	7.16	11.08	17.63	9.49	7.43	12.77	1.06	5.84

Based on consideration of sensivity analysis of assessment, the Management Board agreed with key expert group and stakeholders to decide list and assessment of prioritized in order of Table .

Table 17 - List and assessment of prioritized technology in the energy sector

Availability/Scale	Technology Options	Potential for mitigation in 20 year (mil. tCO_2)	Benefits out put from MCDA assessment	Estimated abatement cost relative with current price ($US/$tCO_2$)
Short-term	Wind power	28	54.51	16.2
Short-term; small scale	Energy-saving compact fluorescent lamps	70	50.97	-8.2
Short- and medium-term; medium scale	Heat and Power (Cogeneration)	12	50.89	12-23

4.3.2. Transportation

Based on the above-mentioned process of technology prioritization in item 4.2, survey forms were sent to tranportation energy experts to assess the technologies.

Results of mitigation technology prooritization in the energy sector are presented in the Table below.

Table 18 - Result of mitigation technology prioritization in the transportation sector

Technology Option	Average MCDA score	Average benefit (S_a)
Compressed Natural Gas (CNG)	49,2	41,4
Bus rapid transit	**65,7**	**54,0**

Sensitivity Analysis

- Conducting sensitivity analysis on expert technology assessment results

The score given to a technology by a single expert is different from the average overall score (Stb). Nonetheless, the variation of the expert scores from the average overall score is mostly less than 7% in Table .

Table 19 - Difference of chosen technologies given by each expert compared with overall average point of prioritized technologies in the transportation sector

P.o	Technology	Difference of chosen techonogies given by each expert compared with Stb (%)									
	No. of Expert	EP1	EP2	EP3	EP4	EP5	EP6	EP7	EP8	EP9	EP10
1	Bus rapid transit	6.86	21.79	13.98	1.28	14.52	12.88	2.02	7.11	4.13	21.51

The gap amongs assessments of experts was acceptable.

Based on the sensitivity analysis results, the Management Board and the core group, taking into account stakeholders' recommnedations, reached an agreement on deciding the list of and assessing prioritized technologies, which is shown in Table in preference order.

Table 20 - List and assessment of prioritized technology in the transportation sector

Availability/Scale	Technology Options	Potential for mitigation in 20 year (mil. tCO_2)	Benefits out put from MCDA assessment	Estimated abatement cost relative with current price ($US/$tCO_2$)
Medium and long-term; large scale	Bus rapid transit	3	54.0	2.6

Conclusions

Prioritized technologies for GHG mitigation in energy and transportation include five technologies in energy generation, two in energy use, one coal, gas and oil extraction technology and one in transportation. The results reflect Vietnam's development needs towards the industrialization, modernization and sustainable development in the coming periods because they:

- Are new, modern and have high GHG emission reduction potential
- Reflect the current trend in using renewable energies;
- Are on a wide range of scales and can be applied in short-, medium- and long-term.

Chapter 5. Technology prioritization for the agriculture sector

5.1 An overview of possible mitigation technology options in the agriculture sector and their mitigation benefits

GHG mitigation technologies applied to agriculture include cultivation, animal husbandry and fertilizer application technologies. An overview of possible mitigation technology options in the agricultire sector and their mitigation benefits are presented in the Table below.

Table 21 - An overview of possible mitigation technology options in the agriculture sector and their mitigation benefits

P.o	Technology Options	Description	Mitigation benefits	Potential
1	Controlled nitrogen fertilizer application	Creating a formula to calculate the required amount to avoid over-application; fertilizer is applied deep into the soil; winter crops are planted to absorb residual nitrogen from previous crops	Reducing amount of nitrogen applied; cutting material and labor costs in applying fertilizer; reducing nitrous oxygen emissions	Medium
2	Wet and dry irrigation in certain rice growth stages	Drain water from the field during two growing stages of rice: maximum tillering and ripening. Methane emission is reduced while productivity is increased	High methane emission mitigation potential. By 2030, wet and dry irrigation may be practiced on 1.1 million hectares of rice in the northern deltas, while in the formerly Nam Khu 4, Southern Central Region and the South, the practiced areas may be 592,000 ha, 497,000 ha, 3.269 million ha, respectively If this technology is practiced in all the areas above, the amount of GHG emissions reduced may amount to 19,3 million tonnes of CO_2e by 2020 and 61 million tonnes of CO_2e by 2030	Medium
3	Wet and dry irrigation on rice paddies	Manage irrigation on rice fields using the wet and dry cycle (which lasts about 20-25 days) after tilling. Increase productivity and reduce methane emissions.	Potential to increase rice yield, save water and reduce methane emissions	Medium
4	Changing from perennial crops to short-term crops	Cultivate short-lived (more or less than 100 days), high-yielding, disease- and pest- resistant rice varieties that can survive unfavorable conditions, instead of perennial ones (more than 140 days).	Highly productive, saving water, reducing methane emissions due to short rice growth periods	High/ Medium
5	Nutrition improvement through controlled fodder supplements	Use several fodder additives as feed for cattle under close control (MUB, urea, etc.)	- The number of dairy cows fed with MUB will rise from 73 thousand (2010) to 183 thousand (2020) and 292	High

			thousand (2030) - GHG emission reduction potential of the technology is 0.150 million tonnes of CO_2e (2010), 2.89 million tonnes of CO_2e (2020) and 7.90 million tonnes of CO_2e (2030).	
6	Growth hormones for cattle	Use growth hormones such as bovine sometotropin (BST) and anobolic steroid to increase meat and dairy productivity while decreasing methane emissions per product unit.	Increasing the digestion efficiency, enhancing meat and diary production, reducing methane emssions on a product unit	Medium
7	Anaerobic manure digestion to produce biogas fuels	Digest manure in anaerobic conditions to produce methane for fuels and by-products for fertilizers and cattle feed.	- A 7-cubic-meter contanstly used digester can reduce about 4,919 tonnes of CO_2e/year in the flat land and 2,205 tonnes of CO_2e/year in the mountains. - Therefore, the amount of GHG emissions reduced can reach 6.01 million tonnes of CO_2e by 2020 and 22.64 tonnes of CO_2e by 2030.	High
8	Crop rotating technologies to avoid SOC loss	Conservative farming to maintain soil humidity and prevent soil loss. Sow leguminous plants to increase soil nitrogen fixation. Appropriate crop rotating techniques to climate and soil conditions.	Appropriate crop rotation to specific soil and climate conditions will preserve soil, retain moisture, increase SOC and boost crop yields.	Medium
9	Covering steep lands with trees to prevent soil erosion and keep soil moisture	Plant various types of trees in contour rows to retain moisture. Use sediment traps on steep terrain to prevent soil erosion.	Preventing soil erosion in steep slopes, retaining soil moisture, increasing fertility, and maintaining SOC.	Medium
10	Nutrition improvement through mechanical and chemical fodder processing	Fodder is processed mechanically (grinding, milling, mixing, etc.) and chemically (fermentation, ensilage micronutrient enrichment, etc.) to accelerate cattle metabolic rates, and thus increase cattle weight per unit of fodder.	Increasing the digestion efficiency, enhancing meat and diary production, reducing methane emssions on a product unit	Medium
11	Cattle genetic modification	Genetic engineering techniques to create new breeds which grow faster, have better tolerance to diseases and higher feed efficiency	Increasing the digestion efficiency, enhancing meat and diary production, reducing methane emssions on a product unit	Low

5.2 Criteria and process of technology prioritization

5.2.1 Criteria technology prioritization

The agricultural expert group agreed on a set of criteria for assessing priority mitigation technologies, including:

- Cost: capital, operation and maintenance costs, and cost-benefit of the GHG mitigation.
- Benefit:
    - Amount of GHG emissions reduced by 2030;
    - Environmental: reducing air pollution, increasing biodiversity;
    - Social: creating more jobs and reducing poverty and hunger;
    - Economic: contribution to economic development and balance of payments (BoP).

Table 22 - Criteria of technology prioritization in the agriculture sector

P.o	Criteria	Specification
1	**Costs**	This is the most important group of criteria in deciding which technology will be invested and how they are going to be invested to receive the desired results. This criterion is demonstrated through two factors: costs and financial indicators.
1.1	Capital costs	Based on initial costs such as technology fees, facility building costs, transfer fees, etc. to attain the technology. Less capital-intensive technologies will be preferred, although this information is not available at the moment or the technology does not have a general representative value.
1.2	Operation and Maintenance costs (O&M)	Based on considerations of other costs such as annual maintenance costs, technology operation costs, etc. Lower costs will result in higher scores.
1.3	GHG emission reduction costs	Based on cost estimation of the technology to reduce GHG emissions. Lower costs will result in higher scores.
2.	**GHG emission reduction potential by 2030**	This is a very important and crucial criterion of technology assessment to predict the future trends of climate change response technologies. Technologies with higher potential of GHG emission reduction will have higher scores.
3.	**Environmental benefits**	This is the “last but not least” group of criteria in assessing technologies. To reduce the GHG emissions, adapt to climate change and improve environment, the technology must generate environmental benefits.
3.1	Air quality	This criterion assesses air quality through the reduced concentration of toxic gases and dust.
3.2	Biodiversity	Based on the potential to protect and manage biological resources such as fauna and flora, ensuring the natural balance and landscape in an ecosystem (such as river basins, forests, etc.)
4.	**Social benefits**	Like economic benefits, social benefits need to be taken into account when assessing technologies. Good technologies which are beneficial in economic and social terms are considered technologies for the future. Social benefits are demonstrated through the four following factors:
4.1	Job opportunity	Benefits from a good technology to the society are shown in its potential to create work opportunities and reducing the jobless rate. Therefore, this

P.o	Criteria	Specification
		criterion is used to assess the overall societal objective. Technologies that have higher potential for job or new sector creation will have higher scores.
4.2	Poverty alleviation	Based on the potential to meet the food demand and the goal of improving life quality and finances of people in rural and remote areas. Technologies with higher potential will have higher score.
5.	**Economic benefits**	Technology needs assessment must look at the economic aspect because the purpose of technology innovation is to create more economic benefits, or more specifically, more revenue. At the same time, development of a new technology should satisfy the overall objective, that is, to ensure development of all three aspects: economic, social and environmental. The economic benefit criteria group is specified through the three factors below:
5.1	Economic development	This criterion assesses the contribution of the technology to the economic stability and development through activities such as developing new industries, creating investment environment, building and maintaining infrastructure, reducing costs and opening more opportunities for business, etc.
5.3	Balance of Payment (BoP)	This criterion assesses the potential of the technology to contribute to reducing expenditures in foreign currencies, particularly through reducing material imports. This will contribute to the stable and sustainable economic development and reducing imports.

5.2.2 Process of technology prioritization

Process of technology prioritization in the Agriculture sector is similar with process in the enrgy sector which was mentioned in the item 4.2.3 above.

5.3 Result of technology prioritization

Based on the above-mentioned process of technology prioritization in item 4.2, survey forms were sent to agriculture experts to assess the technologies. Results of mitigation technology prooritization in the energy sector are presented in the Table below.

Table 23 - Result of mitigation technology prioritization in the agriculture sector

P.o	Technology Option	Average MCDA score	Average benefit (S_a)
1	Controlled nitrogen fertilizer application	46.28	26.49
2	Wet and dry irrigation in certain rice growth stages	77.78	51.83
3	Wet and dry irrigation on rice paddies	51.06	30.96
4	Changing from perennial crops to short-term crops	49.00	29.96
5	Nutrition improvement through controlled fodder supplements	79.42	53.00
6	Growth hormones for cattle	49.65	34.61
7	Anaerobic manure digestion to produce biogas fuels	84.08	55.40
8	Crop rotating technologies to avoid SOC loss	55.89	35.90

9	Covering steep lands with trees to prevent soil erosion and keep soil moisture	54.20	34.77
10	Nutrition improvement through mechanical and chemical fodder processing	53.13	36.98
11	Cattle genetic modification	36.81	31.20

Sensitivity Analysis

- Conducting sensitivity analysis on expert technology assessment results

The score given to a technology by a single expert is different from the average overall score (Stb). Nonetheless, the variation of the expert scores from the average overall score is mostly less than 8% (detailed in Table below).

Table 24 - Difference of chosen technologies given by each expert compared with overall average point of prioritized technologies in the agriculture sector

P.o	Technology	Difference of chosen techonogies given by each expert compared with Stb (%)									
	No. of Expert	EP1	EP2	EP3	EP4	EP5	EP6	EP7	EP8	EP9	EP10
1	Wet and dry irrigation in certain rice growth stages	0.87	13.04	11.33	2.17	4.39	14.44	10.64	4.84	1.92	8.68
2	Nutrition improvement through controlled fodder supplements	1.12	0.93	3.99	11.03	9.88	11.90	10.92	5.74	5.11	5.01
3	Anaerobic manure digestion to produce biogas fuels	2.41	10.59	7.41	8.21	12.04	7.62	10.84	5.52	3.65	19.89

The gap amongs assessments of experts was acceptable.

Based on the sensitivity analysis results, the Management Board and the core group, taking into account stakeholders' recommnedations, reached an agreement on deciding the list of and assessing prioritized technologies, which is shown in Table in preference order.

Table 25 - List and assessment of prioritized technology in the agriculture sector

Availability/Scale	Technology Options	Potential for mitigation in 20 year (mil. tCO_2)	Benefits out put from MCDA assessment	Estimated abatement cost relative with current price ($US/$tCO_2$)
Short-term/small and medium scale	Biogas technology	22.64	55.40	- Biogas replacing coal in plains: 4.1 - Biogas replacing firewood in highlands: 9.7
Short- and medium-term/small scale	Nutrition improvement through controlled	7.9	53.00	-10.9

	fodder supplements			
Short- and medium-term/medium scale	Wet and dry irrigation in certain rice growth stages	61.1	51.83	5.2

Conclusions

Among the possible eleven mitigation technologies identified for prioritization in agriculture, biogas technology, nutrition improvement through controlled fodder supplements and wet and dry irrigation in certain rice growth stages are prioritized.

Chapter 6. Technology prioritization for the LULUCF Sector

6.1 An overview of possible mitigation technology options in the LULUCF sector and their mitigation benefits

An overview of possible mitigation technology options in the LULUCF sector and their mitigation benefits are presented in the Table below.

Table 26 - An overview of possible mitigation technology options in the LULUCF sector and their mitigation benefits

P.o	Technology Options	Description	Mitigation benefits	Potential
1	Sustainable forest management	Silvicutural methods to prevent reduction of biomass and increase vegetation cover	- For production forest: 2 million hectares of timber forest can be protected in 40 years. GHG removal increase potential is 904 million tonnes of CO_2, at a abatement cost of US$ 1.36 /tonne of CO_2. - For protection forest: 2.5 million hectares of protection forest will be protected in 40 years. GHG removal increase potential is 1153 million tonnes of CO_2, at a abatement cost of US$ 0.77/tonne of CO_2.	Can be applied immediately
2	Afforestation and reforestation	Increasing forest coverage by 43% by 2020, increasing carbon sinks and protecting environment, water sources and run-off	GHG removal increase potential is 944.2 million tonnes of CO_2, at a abatement cost of US$ 0.76/tonne of CO_2.	Can be applied immediately
3	Rehabilitation of ma ngrove	Rehabilitating mangrove swamps lost to shrimp farming or mineral extraction, etc. to protect the coastline.	In 15 years, there will be 50,000 hectares of new mangrove forest, which will reduce 25 million tonnes of CO_2, at US$ 0.59/tonne of CO_2	Can be applied immediately
4	Planting of scattered land	By covering plants on unplanned lands, increasing carbon sinks.	With a goal of planting 2 billion scattered trees in 20 years, 28.7 million tonnes of CO_2 will be reduced at US$2.56/tonne of CO_2	Can be applied immediately
5	Reducing emissions from forest degradation and deforestation (REDD)	REDD is the global effort to respond to climate change through reducing emissions. REDD is highly potential for developing countries like Vietnam	In a long term, Sohngen and Sedjo's estimation shows that REDD can be implemented at the cost of US$27.2/tonne of CO_2. Emission reduction potential in 40 years is about 1200 million tonnes of CO_2.	This technology takes time to be applied

6.2 Criteria and process of technology prioritization

6.2.1 Criteria of technology prioritization

The forestry and land use change expert group agreed on a set of criteria for assessing priority mitigation technologies, including:

- Cost: capital and O&M costs, and cost-benefit of the GHG mitigation.
- Benefit:
    - Amount of GHG emissions reduced by 2030;
    - Environmental: improving and preventing soil degradation, conserving water resources and reducing runoff decrease, improving air quality and biodiversity;
    - Social: creating more work and enhancing rural living standard;,
    - Economic: improving livelihood, protecting infrastructure and helping to develop other industries.

Table 27 - Criteria of technology prioritization in the LULUCF sector

P.o	Criteria	Specification
1.	**Costs**	This is the most important group of criteria in deciding which technology will be invested and how they are going to be invested to receive the desired results. This criterion is demonstrated through two factors: costs and financial indicators.
1.1	Capital costs	Based on initial costs such as technology fees, facility building costs, transfer fees, etc. to attain the technology. Less capital-intensive technologies will be preferred, although this information is not available at the moment or the technology does not have a general representative value.
1.2	Operation and Maintenance costs (O&M)	Based on considerations of other costs such as annual maintenance costs, technology operation costs, etc. Lower costs will result in higher scores.
1.3	GHG emission reduction costs	Based on cost estimation of the technology to reduce GHG emissions. Lower costs will result in higher scores.
2.	**GHG emission reduction potential by 2030**	This is a very important and crucial criterion of technology assessment to predict the future trends of climate change response technologies. Technologies with higher potential of GHG emission reduction will have higher scores.
3.	**Environmental benefits**	This is the “last but not least” group of criteria in assessing technologies. To reduce the GHG emissions, adapt to climate change and improve environment, the technology must generate environmental benefits.
3.1	Improving and preventing soil degradation	This criterion is based on the soil pollution prevention potential through reducing release of solid waste to the environment and soil quality improvement.
3.2	Protecting water resources and reducing flow depletion	This criterion assesses the potential of water use efficiency enhancement in production, wastewater reduction, and contribution to the protection of surface and ground water resources.
3.3	Air quality improvement	Based on the potential to reduce air pollutants such as SOx, NOx, suspended particles, non-methane volatile organic compounds, dust, and odor.

P.o	Criteria	Specification
3.4	Biodiversity	Based on the potential to protect and manage biological resources such as fauna and flora, ensuring the natural balance and landscape in an ecosystem (such as river basins, forests, etc.)
4.	**Social benefits**	Like economic benefits, social benefits need to be taken into account when assessing technologies. Good technologies which are beneficial in economic and social terms are considered technologies for the future. Social benefits are demonstrated through the four following factors:
4.1	Job opportunity	Benefits from a good technology to the society are shown in its potential to create work opportunities and reducing the jobless rate. Therefore, this criterion is used to assess the overall societal objective. Technologies that have higher potential for job or new sector creation will have higher scores.
4.2	Rural development	
5.	**Economic benefits**	Technology needs assessment must look at the economic aspect because the purpose of technology innovation is to create more economic benefits, or more specifically, more revenue. At the same time, development of a new technology should satisfy the overall objective, that is, to ensure development of all three aspects: economic, social and environmental. The economic benefit criteria group is specified through the three factors below:
5.1	Livelihood improvement	This criteria assesses the contribution of the technology to the settlement and finances of people, particularly in rural and remote areas.
5.2	Infrastructure protection	Assesses the potential to contribute to infrastructure protection of the technology. Technologies with higher potential have higher scores.
5.3	Balance of Payment (BoP)	This criterion assesses the potential of the technology to contribute to reducing expenditures in foreign currencies, particularly through reducing material imports. This will contribute to the stable and sustainable economic development and reducing imports.

6.2.2 Process of technology prioritization

Process of technology prioritization in the LULUCF sector is similar with process in the energy sector which was mentioned in the item 4.2.3 above.

6.3 Results of technology prioritization

Based on the above-mentioned process of technology prioritization in item 4.2, survey forms were sent to LULUCF experts to assess the technologies.

Results of mitigation technology prooritization in the energy sector are presented in the Table below.

Table 28 - Result of mitigation technology prioritization in the LULUCF sector

P.o	Technology Option	Average MCDA score	Average benefit (S_a)
1	Sustainable forest management	84.42	60.19
2	Afforestation and reforestation	78.12	57.52
3	Rehabilitation of mangrove	75.26	49.08

4	Planting of scattered land	56.97	32.58
5	Reducing emissions from forest degradation and deforestation (REDD)	49.34	42.43

Sensitivity analysis

- Conducting sensitivity analysis on expert technology assessment results

The score given to a technology by a single expert is different from the average overall score (S_{tb}). Nonetheless, the variation of the expert scores from the average overall score is mostly less than 5% (detail in Table below).

Table 29 - Difference of chosen technologies given by each expert compared with overall average point of prioritized technologies in the LULUCF sector

P.o	Technology	Difference of chosen techonogies given by each expert compared with Stb (%)									
	No. Expert	EP1	EP2	EP3	EP4	EP5	EP6	EP7	EP8	EP9	EP10
1	Sustainable forest management	3.17	3.70	0.21	6.97	4.88	3.53	1.16	4.52	4.71	6.66
2	Afforestation and reforestation	0.79	2.02	3.87	0.54	4.71	2.97	2.28	2.15	1.56	1.43
3	Rehabilitation of mangrove	6.20	0.97	2.75	1.63	3.76	1.42	6.55	2.48	4.08	4.03

The gap amongs assessments of experts was acceptable.

Based on the sensitivity analysis results, the PMU and the core group, taking into account stakeholders' recommnedations, reached an agreement on deciding the list of and assessing prioritized technologies, which is shown in Table in preference order.

Table 30 - List and assessment of prioritized technology in the LULUCF sector

Availability/Scale	Technology Options	Potential for mitigation in 20 years (mil. tCO_2)	Benefits out put from MCDA assessment	Estimated abatement cost relative with current price ($US/$tCO_2$)
Short-teram/Large scale	Sustainable forest management	1413	60.19	0.77
Short-teram/Large scale	Afforestation and reforestation	750	57.52	0.56
Short-teram/Large scale	Rehabilitation of man grove	250	49.08	0.59

Chapter 7. Summary/Conclusions

In the framework of implementation of technology needs assessments for reducing the greenhouse gas emissions, 03 priority areas were selected to evaluate the technology priorities including energy, agriculture, LULUCF. The list of prioritized technologies of reducing greenhouse gas emissions are summarized in the table below:

Table 31 - List of prioritized technologies to reduce greenhouse gases emissions

P.o	Sector/Technology	Availability/Scale
1	***Energy Sector***	
	- Wind power technology	Short term/Medium
	- Energy-saving compact fluorescent lamps	Short term/Small and Medium
	- Large-Scale Heat and Power (Cogeneration)	Short and Medium term/Medium
	- Bus rapid transit	Medium and Long term/Large
2	***Agriculture sector***	
	- Biogas	Short term/Small and Medium
	- Nutrition improvement through controlled fodder supplements	Short and Medium term/Small
	- Wet and dry irrigation in certain rice growth stages	Short and Medium term/Medium
3	***LULUCF Sector***	
	- Sustainable forest management	Short term/Large
	- Afforestation and reforestation	Short term/Large
	- Rehabilitation of mangrove	Short term/Large

The prioritized technologies to reduce greenhouse gas emissions were selected in the group of high greenhouse gas emissions with different scopes and have the ability to perform in the short, medium and long terms; the mitigation options for reducing greenhouse gas emission that used prioritized technologies are feasible, highly potential to reduce greenhouse gas emissions and consistent with the goal of national sustainable development.

PART II
Technology Action Plans

Executive Summary

Based on the technology assessment needs in Part I, priority technologies were identified for each sector. However, the application of these technologies needs to comply with the nation-driven development plans and policies of the sector. Moreover, current mechanisms still, to some extent, barricade the diffusion of technologies. Therefore this report on technology action plan (TAP) provides brief information on barrier analysis and solution proposals for technologies, based on which an action plan was produced to apply the priority GHG mitigation technology.

For priority adaptation and mitigation technologies, the proposed analysis process is as follows:

Step 1: Clarifying priorities and establishing key milestones. This included two major sub-steps: reaffirming development and climate priorities in the National Target Program to Respond to Climate Change, sectoral development plans and generating milestones for the sectors/subsectors and the selected technologies.

Step 2: Identifying measures to develop capacities and enabling framework. In this step, the current systems were characterized, such as policies, driving forces, market conditions, policy frameworks and stakeholder networks. Then, an analysis was conducted to identify bottlenecks and barriers in terms of economic, insitutional, technological capacities as well as market potential of the technology, and to propose measures. These measures were grouped to create an enabling framework for the development and diffusion of the technologies.

Finally, a national strategy and action plan was built upon the enabling framework by the following activities: aggregrating and rationalizing measures to develop national capacities for acceleration the development and transfer of the technologies; prioritizing and characterizing technology acceleration measures for the national strategy/action plan; incorporating technology investment costs and benefits; and finalizing the national strategy/action plan.

TECHNOLOGY ACTION PLAN FOR ENERGY

PRELIMINARY TARGETS AND BARRIERS

In Vietnam's National Energy Development Strategy by 2020, vision towards 2050, the Government emphasized on "increasing the share of new and renewable energies to 5% and 11% of the total primary commercial energies by 2020 and 2050, respectively." According to the business-as-usual scenario, the National Target Program on Energy Conservation and Efficiency aims at saving 5-8% of the total energy consumption for 2011-2015.

Based on the above general targets, specific targets for wind power, compact flourescent light bulbs, bus rapid transit and combined heat and power (CHP) generation were identified.

However, there were a number of barriers to the energy technologies, including lack of investment, high investment costs, inadequate capacities for technology transfer and application, and various environmental impacts.

ACTION PLANS FOR THE TECHNOLOGIES

Wind power technology action plans

Policy measures will be focused on to promote the use of alternative energies instead of electricity (particularly new and renewable energies). New incentives and support policies will be created to encourage investment on renewable energies, especially subsidization policies. Wind mapping as well as site planning for investment on wind power will be completed as soon as possible, in parralel to infrastructure upgrade, reparing and maintanance and stakeholder networking for information sharing. In addition, a technical team will be formed and international experience sharing will be done to enhance the operating and maintanance capacities.

Compact Flourescent light (CFL) technology action plan

CFL requires support policies for production, awareness raising on its economic, social and environmental benefits, detailed regulations and management on labelling to ensure product quality, development of an information network on product manufacturers and retailers.

Relevant agencies will develop regulations on lighting quality and quality examination, study and exchange experience with major labels to enhance product quality.

Bus Rapid Transit (BRT) technology action plan

BRT action plan focuses on the following measures: facilitating financially and technically BRT development; managing reasonable ticket fares; constraining individual vehicles; synchronizing the BRT system with other transportation systems.

Combined heat and power (CHP) generation technology action plan

Based on the distint charateristics of the CHP technology, the action plan aims for short-term (five years) and medium-term (10 years) CHP technologies, including: extraction-condensing turbines/back pressure steam turbines; steam turbines with a heat recovery steam generator; diesel engines and riversible internal combustion engines with a heat recovery steam generator.

In addition, the action plan also introduces long-term (15 years) CHP technologies, including: ultra micro gas turbine; fuel cell; sterling internal combustion engines.

TECHNOLOGY ACTION PLAN FOR AGRICULTURE

PRELIMINARY TARGETS AND BARRIERS

There are four preliminary targets in agriculture: developing a healthy, diverse and sustainable commodity agriculture; transfer and application of advanced technology to production; developing a market for science and technogy in rural areas; linking and coordinating with the National Target Programs, and other socio-economic programs in selecting and diffusing suitable technologies; enhancing technical capacity for local people and staff.

Based on the above general targets, specific targets for biogas technology, wet and dry irrigation, nutrition improvement for diary cattle were identified.

Some major barriers to the development and transfer of technologies were aslo indentifed including: lack of understanding of technology benefits, inertia of old traditional practices and inadequate capacity for technology application.

ACTION PLANS FOR THE TECHNOLOGIES

GHG mitigation technologies are still very new concepts to Vietnamese farmers. However, due to their benefits to people's income and living standards, the following technologies need to be diffused:

Biogas technology: Managing cattle manure by storing them in digesters to produce methance that will be used as a fuel instead of normal burning materials.

Wet and dry irrigation: Controlling irrigation on rice field by alternatively irrigating and draining the field in each stage to improve productivity and reduce methance emssions from the field.

Feed nutrition improvement for diary cattle: Improving nutrition for diary cattle by feeding them with MUB, which helps shorten digesting time of cattle and reduce methane emissions from cattle digestion.

TECHNOLOGY ACTION PLAN FOR LULUCF

PRELIMINARY TARGETS AND BARRIERS

Sustainable forest management is considered the basis for forestry development with the target of increasing the national forest coverage to 45% in 2020. Therefore, the following tasks need to be considered: completing bordering and planning for the three types of national forest; sustainable management, planning and use of protection forest and special use forest; planning for afforestation and reforestation.

Based on the above general targets, specific targets for sustainable forestr management, afforestation and reforestation, and mangrove rehabilitation were identified.

Some barriers to the technology transfer and diffusion in this sector are lack of budget and investment for forest technologies, lack of information on complex forest ecosystems, insufficient land planning for forest development and lack of capacity for technology development and diffusion.

ACTION PLANS FOR THE TECHNOLOGIES

Sustainable forest management

To move forward sustainable management of natural forest resources requires research in the following areas: finetuning reduced impact logging techniques; sustainable use of natural resources; changing concepts on forest jobs;

forming a scientific basis and best practices for sustainable forest management; completing the set of criteria on sustainable management and forest certification.

In addition, enabling policies will be made to engage the entire society in forest management, giving autonomy to forest owners while still keeping a close watch, developing and protecting forest based on strict and scientific rules.

Afforestation and reforestation

Afforestation and reforestation is a major program with national strategic targets. In order to fultil them, a policy system for forest development and sivilculture technology will be developed.

Mangrove rehabilitation

The "Coastal mangrove rehabilitation and development for 2008-2015" was developed on the basis of an investigation and review of planning carried out by relevant ministries in accordance with Directive 38/2005/CT-TTg of the Prime Minister.

Mangrove rehabilitation needs to be emphasized as a national priority in its efforts to reducing GHG emission, meeting the urgent demand of national defense and disaster preparedness and recovery.

Chapter 1. Energy Sector

In Part A, the technology capable of mitigation to reduce greenhouse gas in energy has been taken into account, scoring and evaluation to select the most preferred technology. As a result, these technologies are arranged in order of priority and summarized in the table below

Table 32 - List and assessment of prioritized technology in the energy sector

Availability/Scale	Technology Options	Potential for mitigation in 20 year (mil. tCO_2)	Benefits out put from MCDA assessment	Estimated abatement cost relative with current price ($US/$tCO_2$)
Short-term	Wind power	28	54.51	16.2
Short-term; small scale	Energy-saving compact fluorescent lamps	70	50.97	-8.2
Short- and medium-term; medium scale	Heat and Power (Cogeneration)	12	50.89	12-23

Table 33 - List and assessment of prioritized technology in the transportation sector

Availability/Scale	Technology Options	Potential for mitigation in 20 year (mil. tCO_2)	Benefits out put from MCDA assessment	Estimated abatement cost relative with current price ($US/$tCO_2$)
Medium and long-term; large scale	Bus rapid transit	3	54.0	2.6

1.1. Preliminary targets for technology transfer and diffusion

The overall goal to develop technologies in the energy sector is determined based on the strategy, planning, national program for energy sector in general or the approved primary energy sector in particular by Prime Minister.

The planning, strategy and national program mentioned above also indicate the specific objectives for each sub-field and the specific objectives are also taken as a basis for developing objectives and milestones for development technology of the sub-domains.

1.1.1. Reaffirmation of targets for technology transfer and diffusion

a) General targets

Vietnam's energy development strategy by 2020, with vision towards 2050, emphasizes that efforts will be put into increasing the share of new and renewable energies to 5% and 11% of the total primary commercial energies by 2020 and 2050, respectively.

The National Target Program on Energy Saving and Efficiency sets targets of saving from 5% to 8% of the total energy consumption during 2011-2015, based on the current predictions of future energy and socio-economic development in the business-as-usual scenario [*].

By 2020, the public transport will be the main transportation means in urban areas [**].

b) Specific targets

For wind power technology

Targets of development and diffusion of renewable energies (REs) are specified in the Vietnam Electricity Power Development Plan for 2011-2020 that was approved by the Govenment, with visions towards 2030 as follows:

- By 2020: Installation capacity of wind power reaches 1,000 MW;
- By 2030: Installation capacity of wind power reaches 6,200 MW [***].

For compact fluorescent lamp (CFL) technology

- For the period of 2011-2015, continue the implementation of the program of replacing incandescent light bulbs with CFLs in households.
- Create incentives to gradually reduce the use of normal household light bulbs; implement the roadmap for replacing 40 million incandescent lights with energy-saving CFLs by 2020.

For bus rapid transit (BRT) technology

Priority is given to modes of public transportation, particularly those with high capacity.

- By 2020, the transportation system basically meets varied social demand for transportation. By 2050, the modernization of the nationwide transportation network and external traffic is to be completed.
- Low emission fuels are used for traffic vehicles: 20% and 80% of buses or taxis run on compressed natural gases (CNGs) or liquefied petroleum gases (LPGs) by 2020 and 2050, respectively.

For combined heat and power (CHP) technology

Implement integrated energy use strategy to increase electricity generation efficiency, in which CHP technology is prioritized for industrial zones that consume both heat and electricity.

1.1.2. Establishing milestones to accomplish technology development targets

a) Milestones in the energy sector

- By 2015, the total domestic and import electricity reach 194-210 TWh
- By 2020, the total domestic and import electricity reach 330-362 TWh
- By 2030, the total domestic and import electricity reach 695-834 TWh

b) Milestones for prioritized technologies in the energy sector

- Focus on developing REs and increasing the RE contribution to the total electricity production from 3.5% in 2010 to 4.5% in 2020 and 6.0% in 2030.

- By 2020, replace 40 million incandescent light bulbs by energy-saving CFLs.

- By 2020, secure the goal that 50% to 60% of traffic in large municipalities is public transportation.

- 2019 – 2020, maintain the ratio of coal-fired electricity to total source capacity below 60%

1.2. Barrier analysis

A proposed method for technology innovators to find barriers and problems is mapping market.

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[*] The National Target Program on Energy Saving and Efficiency.

[**] Decision No. 206/2004/QD-TTg on December 10th, 2004 on Approval of the Development Strategy of transport in Vietnam until 2020.

[***] Decision No. 1208/QD-TTg on July 21th, 2011 on Approval of Power Development Master Plan VII of Viet Nam, Period 2011-2020 with outlook to 2030.

- By this method, the group of experts discussed and exchanged information to build up a comprehensive map of the entire existing market elements related to the technologies and the lingkages between them. The main factors considered included:
- Enabling environment that allows the introduction of new technologies (such as legal, institutional, organizational, ...)
- The market players (such as manufacturers, wholesalers, retail dealers, consumers, households producers ...)
- Supporting services (such as finance, quality management, performance, standards, etc ...).

Based on this map, the Steering Committee and other stakeholders to identify existing problems in the system, from which barriers would be found out for each technology and common barriers to all technologies in the same field of sector. Next, by simple voting groups, implementation groups (they are experts who works in acencies/organizations are mention in Table) have pointed out the barriers that need to be addressed prior to deciding which measures short-term, medium term and long term for each field.

The market mapping is only applied for technologies which are classified by consumer and capital goods. The detail of market maps for these technologies categories of mitigation techonologies are presented in the Annex 2. Following that, maps of analysing framework condition for them are shown parallel as well in this Annex 2.

1.2.1. Barrier identification and analysis for the transfer and diffusion of wind power technology

The identification and analysis of the common barriers across most technologies are presented in item 1.2.4

This part, however, only focuses on the barriers specific to each of the technologies

a) Economic barriers

The cost of wind electricity is higher than the price of on grid electricity due to inappropriate mechanisms to encourage investment, support the purchase price of wind electricity when connecting to grid.

b) Technical barriers

Business organizations that can provide wind power installation equipment and post-installation services do not exist in Vietnam. Therefore, wind power technology has to be imported, with no post-installation maintenance or repairing services.

Seasonal variations in wind velocity and low capacity factor lead to high investment costs.

c) Environmental barrier

The wind electricity project requires a relatively large area for installation, which take up land for other purposes (such as farmland, livestock ….)

The installation of the wind motors on the wide coastal area can affect the natural landscape and travelling services.

1.2.2. Barrier identification and analysis for the transfer and diffusion of compact fluorescent lamp (CFL) technology

The following are some of the key obstructions to the development and diffusion of CFL technology:

a) Economic barriers

CFL technology remains high costs compared with traditional technology, which leads to unattractive high-cost production.

b) Technical barriers

Capacity and level of production are limited, which leads to insufficient lightening quality and low life expectancy of the product compared to expectations and requirements of the users.

c) Environmental barrier:

The after-used products become waste that were difficult to treat and required expensive high technology to handle.

1.2.3. Barrier identification and analysis for the transfer and diffusion of Bus rapid transit (BRT) technology

The following are some of the main reasons which hinder the development and deployment of the BRT technology:

a. Economic barriers

Requiring high capital costs to build new traffic infrastructure.

b. Technical barriers

This technology has to be imported because national capacity does not allow local development.

c. Environmental barrier: Unidentified.

1.2.4. Barrier identification and analysis for the transfer and diffusion of CHP technology

a. Economic barrier

A small-scale and fragmented industry is the reason that technology investment costs are still high.

b. Technical barrier

This technology should be integrated into industrial zone planning.

Only applicable to facilities that demand both heat and electricity for energy.

c. Environmental barrier

This technology generates gas and solid waste.

1.2.5. Linkages of the barriers identified

During the analysis process, it has been found that many barriers and other obstacles of the system is common to all technologies and just a few of which will become a specific for a certain technology and field as described. The aggregation and summary of the common barriers of technology in the field is to minimize duplication as well as ensure coherence and is presented in Table below.

Table 34 - Common barriers and inefficiencies identified for technologies

Economic barriers	
	Lack of investment incentive mechanisms and subsidization schemes
	Difficulties in accessing financial resources from commercial banks due to low rate of return
	Low electricity prices compared to the international standard, therefore investors find it not financially attractive to invest in electricity generation projects or promoting energy-saving products
Market linkage	
	High capital costs, partly due to the fact that the technology has to be imported
	Lack of a binding mechanism
Support actions	

	Insufficient technology information and technical assistance, lack of a network of equipment suppliers
	Limited technical, design, installation and operation and maintenance (O&M) capacity
	Limitations in infrastructure and support post-services

1.3. Enabling framework for overcoming the barriers

From the analysis and identification of general and specific barriers above, those barriers will be classified according to six general groups of the core element (core group barriers) and measures address barriers also sorted, classified according to the same core group of factors, including the group of the following measures:

- **Creating a network of experts:** is an important medium that allows ideas and information exchange to ensure popular, innovative and successful implementation of measures to promote strategies include compulsory information campaign message and raise awareness.

- **Policies and measures:** is to promote possible exist technology transfer in the country but need to be resolved through implementing as well as enforcement new purpose, rationalized measures and policies to encourage current or new directions.

- **Change organization / behavior:** is usually outside the market system but nevertheless important in improving market and non-market functions. These obstacles caused by the actual state of the current operation or organizations may request a change in management approach.

- **Market, support systems and other financial services:** are to ensure accountability, their functions, and providing key services to achieve efficiency. That is why there are so many relevant systems in one place. They are related to many financial services, quality insurance system, consultancy and information services.

- **Skills, education and training:** are the key to development. Planning and investment in this area will need to make in parallel with other measures to bring the skills needed and ensure appropriated needs of education and training.

- **International Cooperation and IPR issues:** The national network may not be sufficient for promoting technology so international link may be required by international activities. International trade and IPR system may need to be edited as well as other tasks under international agreements also can influence.

Based on expert knowledge of the stakeholders and the picture of an enabling environment for technology, experts have discussed measures to make it possible to overcome barriers for each group of factors in each core technologies. Also through this discussion that the recommendations proposed solution to the energy sector.

Framework to overcome barriers in energy sector is presented in detail below.

1.3.1. Possible solutions to address the barriers for the transfer and diffusion of wind power technology

1.3.1.1. Measures to support the creation of a stakeholder network for the development and transfer of the technology

Measure 1: Form a communication system to provide sufficient, update information to stakeholders.

1.3.1.2. Actions to improve policies and creating measures for technology development and transfer

Measure 1: Create investment incentives and schemes to subsidize the purchase of wind-produced electricity.

Measure 2: Establish a market-driven electricity pricing system.

1.3.1.3. Measures to strengthen functioning of organizations and institutions

Unidentified

1.3.1.4. Measures to strengthen market, system support and financial services through quality assurance, availability of consultancy, market information, financial services, etc.

Measure 1: Build wind maps to locate appropriate sites for wind power plants.

Measure 2: Make financial support mechanisms and incentives for local production of wind power, in order increase national wind power production.

Measure 3: Formulate a legally binding mechanism to oblige local electric utilities to purchase wind-produced electricity.

Measure 4: Establish a system of infrastructure of maintenance services.

1.3.1.5. Measures to support skills training and education for technology development and transfer

Measure 1: Facilitate training and education on the technology, form groups of technicians and share experience with international experts.

1.3.1.6. Measures to facilitate international cooperation and deal with intellectual property rights (IPR), particularly for a more cooperative model for research, development and demonstration (RD&D)

Unidentified

1.3.2. Possible solutions to address the barriers for the transfer and diffusion of compact fluorescent lamp (CFL) technology

1.3.2.1. Measures to support the creation of a stakeholder network for the development and transfer of the technology

Measure 1: Raise public awareness on the technology.

1.3.2.2. Actions/Measures to improve policies and creating measures for technology development and transfer

Measure 1: Create and provide tax or loan incentives for importing technology of or investments on producing CFLs.

Measure 2: Make regulatory requirements for for lighting quality and the quality verification procedures.

Measure 3: Establish a market-driven pricing system.

1.3.2.3. Measures to strengthen market, system support and financial services through quality assurance, availability of consultancy, market information, financial services, etc.

Measure 1: Raise public awareness on the social, economic and environmental benefits of CFL technology.

Measure 2: Provide financial support to research, innovation or development of production technologies of CFLs.

Measure 3: Formulate detailed regulations for and control over the product labeling.

1.3.2.4. Measures to facilitate international cooperation and deal with intellectual property rights (IPR), particularly for a more cooperative model for RD&D

Measure 1: Collaborate with foreign major manufactures to improve the quality of local products.

1.3.3. Possible solutions to address the barriers for the transfer and diffusion of BRTs

1.3.3.1. Measures to support the creation of a stakeholder network for the development and transfer of the technology

Measure 1: Form an efficient information system on bus rapid transit routes for commuters.

1.3.3.2. Actions to improve policies and creating measures for technology development and transfer

Action 1: Reduce private means of transport; prioritize BRT infrastructure (road, etc.) development.

Action 2: Create financing mechanisms and loan incentives.

1.3.3.3. Measures to strengthen market, system support and financial services through quality assurance, availability of consultancy, market information, financial services, etc.

Measure 1: Develop infrastructure for relevant forms of public transits to facilitate commuting by BRTs.

Measure 2: Raise awareness on the benefits of BRTs.

Measure 3: Reasonable ticket fares.

1.3.4. Possible solutions to address the barriers for the transfer and diffusion of combined heat and power (CHP)

1.3.4.1. Measures to support the creation of a stakeholder network for the development and transfer of the technology

Measure 1: Facilitate existing networks of stakeholders.
Measure 2: Establish a coordination mechanism between stakeholders.

1.3.4.2. Actions to improve policies and creating measures for technology development and transfer

Measure 1: Provide incentives in addition to legal regulations to engage stakeholders in the technology deployment.
Measure 2: Publish materials on new technologies for application to industries that consume both heat and power.

1.3.4.3. Measures to strengthen functioning of organizations and institutions

Measure1: Review and develop planning.

Measure 2: Provide CHP training for staff.
Measure 3: Develop technical management capacity and raise community awareness on the benefits of this technology.

1.3.4.4. Measures to support skills training and education for technology development and transfer
Measure 1: Work with international experts and send staff members to training courses.

Measure 2: Make budget for training and education.

1.3.4.5. Measures to facilitate international cooperation and deal with intellectual property rights (IPR), particularly for a more cooperative model for RD&D

Measure 1: Join forces with the global community in development and transfer of CHP technology.

1.3.5. Recommended solutions for energy

a) Recommended solutions for electricity generation

- Incentivize the investment on renewable energy (RE) production through policies and financing mechanisms. Establish post-installation maintenance services and networks of information on new technologies.

- Develop a legal framework for the acceleration, encouragement and obligation of the diffusion of CHP technology in potential areas; for instance: *Add obligatory regulations to facilitate the deployment of CHP technology in potential areas (such as industrial zones, processing utilities, new residential areas, etc., that consume electricity and heat) to the Law on Energy Efficiency*.

b) Recommended solutions for energy consumption

- Enhance energy efficiency through measures such as: Developing and promoting tax incentives for importing production technologies and concessional loans for national businesses to invest on, innovate or deploy new production technologies.

- Build a system of information on new technologies, equipment suppliers, and raise awareness on the social, economic and environmental benefits on energy-saving technologies. Support businesses to expand their cooperation with international partners in terms of research and sharing experience of how to enhance product quality.

1.4. Technology action plan, project ideas, and other issues in energy

1.4.1. Wind power technology

1.4.1.1. Technology action plan for wind power technology

a) Aggregation and rationalization of measures identified for technology acceleration

The list of measures identified for formulation of a national strategy to accelerate the development and transfer of technologies can be seen in Table below.

Table 35 - Aggregation for strategy formulation

Strategic measure	Accelerating innovation RD&D	Accelerating deployment	Accelerating diffusion
Creation of Network			
Build a communication system to provide information to stakeholders	X	X	X
Policies and Measures			
Develop investment incentive and subsidization schemes	X	X	X
Establish a market-driven pricing system	X	X	X
Organizational/behavioral change			
Strengthen the coordination between organizations	X	X	X
Market support actions			
Build wind maps to locate appropriate sites for wind power plants	X	XX	XX
Provide financial support mechanisms and incentives for local production of wind power	X	X	X
Make legal obligations for local electric utilities to purchase wind electricity	X	X	X
Develop infrastructure and maintenance services	X	XX	XX
Training and education			
Facilitate training and education on the technology, form groups of technicians and share experience with international experts	XX	X	XX

* Note: This table illustrates for a strategy of acceleration measures according to letters of each square, using the timescale for completion of an action, where:

- Letter “X” refers to measures which need to be started in the short term and carried out within the next five years;

- Letter “XX” refers to measures which can be completed in up to 10 years;

- Letter “XXX” refers to measures longer-term measures which can be planned for completion within 15 years from the current date and also will be used for other technologies below.

b) Prioritization and characterization of technology acceleration measures for a national plan

The list of measures identified for the acceleration of technologies and the innovation stage structured under the core elements of a national strategy are identified and aggregated in Table below.

Table 36 - Prioritization and characterization of technology acceleration measures

Sector: Energy							
Specific Technology and category: Wind power technology/Medium-scale, short term							
Innovation stage: Deployment – Diffusion							
Measure (grouped under core elements)	**Prio-rity**	**Why is it important?**	**Who should do it?**	**How should they do it?**	**Time-scale**	**Monitoring, reporting and verification for measure**	**Estimated costs (1,000 USD)**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Creation of networks							
Build a communication system to provide information to stakeholders	2	It helps stakeholders to make easier decisions on which technology they are going to invest on	MOST	Study information needs, review the existing information channels and develop a suitable information system	2012-2020	MOIT	20
Policies and measures							
Develop investment incentive and subsidization schemes	1	Wind power production has not been able to exploit its full potential and there is a lack of investment incentives or subsidization schemes to accelerate the purchase of wind electricity	MOIT, MOF	Develop investment incentives and subsidization schemes for wind power	2012-2015	MOIT	100
Establish a market-driven pricing system	1	This helps the sector to develop towards a competitive and equitable electricity market	MOIT, MOF	Set an appropriate roadmap taking into consideration negative impacts of electricity price increase on production and household activities	2012-2015	MOIT	50

Market support actions							
Build wind maps to locate appropriate sites for wind power plants	1	It enhances capacity factor and reduces investment costs to appeal to investors	MOIT and EVN	Carry out wind observation in potential sites; Build wind maps	2012-2020	MOIT	1,000
Provide financial support mechanisms and incentives for local production of wind power	1	It helps to reduce investment costs, lower the price and increase competitiveness of technology	MOIT, MOF	Review the existing legislation to form the basis for making financing incentives for wind power projects; develop new support policies for local wind power equipment manufacturing	2012-2015	MOIT	100
Make legal obligations for local electric utilities to purchase wind electricity	1	It helps to develop and facilitate national wind power market	MOIT and EVN	Review the existing legislation to formulate a legally binding framework of wind electricity purchase	2012-2015	MOIT	100
Develop infrastructure and maintenance services	2	It helps to maintain the operation of wind power stations	MOIT and EVN	Investigate and assess the demand for equipment replacement in order to develop infrastructure and maintenance services	2012-2020	MOIT	5,000
Skills training and education							
Facilitate training and education on the technology, form groups of technicians and share experience with international experts	1	To build designing, operating and maintenance capacity of technicians, designers, installation and O&M staff	MOIT, EVN	Assess capacities and training needs, make plans for training and experience sharing with foreign partners	2012-2020	MOIT	1,500

*** Note:**

(1) Measures were grouped under the core elements for a technology acceleration action plan. Using a simple process, expert groups (they work in angencies and organizations which was mentioned in Table and they came from national steering committee for the UNFCCC and the Kyoto Protocol) were requested to categorize each measure into level 1, 2 or 3 according to their view on the importance of the measure to the action plan. The priority levels reveal the importance of the measure, divided into 3 levels from 1 to 3 with the following specifications:

- 1: very important, should be carried out in the short term.
- 2: important, can be carried out in new future (the next 5-10 years) or when possible.
- 3: fairly important, should be carried out but in a longer term, no need to be done in the short time.

c) Finalizing national strategy

Based on priority technology action plans in the subsectors, a national strategy and action plan for the wind power development targets are presented in Table .

Table 37 - National Strategy (technology transfer and development for mitigation)

	0-5 years	5-10 years	10-15 years
Commercially available technologies (short-term)			
Wind power technology			
Build a communication system to provide information to stakeholders	X		
Develop investment incentive and subsidization schemes	X		
Establish a market-driven pricing system	X		
Build wind maps to locate appropriate sites for wind power plants	X	X	
Provide financial support mechanisms and incentives for local production of wind power, increasing the national wind power production	X		
Make legal obligations for local electric utilities to purchase wind electricity	X		
Develop infrastructure and maintenance services	X	X	
Facilitate training and education on the technology, form groups of technicians and share experience with international experts	X	X	

1.4.1.2. Brief summary of project ideas for international support (details in Annex 4)

1.4.2. Compact fluorescent lamps

1.4.2.1. Technology action plan for compact fluorescent lamps (CFLs)

a) Aggregation and rationalization of measures identified for technology acceleration

Similar to the section above, the list of measures identified for formulation of a national strategy to accelerate the development and transfer of technologies can be seen in Table .

Table 38 - Aggregation for strategy formulation

Strategic measure	Accelerating innovation RD&D	Accelerating deployment	Accelerating diffusion
Creation of Networks			
Raise awareness on technology	X	XX	XX
Policies and Measures			
Provide import tax or loan incentives for CFL production	X	X	X
Make regulatory requirements for lighting quality and the	X	XX	XX

quality verification procedures			
Establish a market-driven pricing system	X	X	X
Market support action			
Raise public awareness on the social, economic and environmental benefits of CFLs	X	X	X
Provide financial support to research, innovation or investment on production techniques	X	X	X
Formulate detailed regulations for and control over the labeling of the product	X	XXX	XXX
International cooperation and IPR			
Collaborate with foreign major manufactures to improve the quality of local products	X	XXX	XXX

* Note: see Note in Table .

b) Prioritization and characterization of technology acceleration measures

Similar to above, the measures were prioritized and characterized through a detailed process for an action plan, as seen in Table below.

Table 39 - Prioritization and characterization of technology acceleration measures

Sector: Energy							
Specific Technology and category: Compact fluorescent lamps/Small scale, short-term							
Innovation stage: Deployment – Diffusion							
Measure (grouped under core elements)	**Prio-rity**	**Why is it important?**	**Who should do it?**	**How should they do it?**	**Time-scale**	**Monitoring, reporting and verification for measure**	**Estimated costs (1,000 USD)**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Creation of networks							
Raise awareness on technology	1	Consumers will be informed and able to make decisions on their product choice.	MOIT and EVN	Study information needs, review the existing information channels and develop a suitable information system	2012-2015	MOIT	20
Policies and measures							
Provide import tax or loan incentives for CFL production	1	Helps to encourage large-scale application of CFLs and reduce investment costs and product price	MOIT, MOF	Review the existing legislation Develop and enforce CFL development policies	2012-2015	MOIT	50
Make regulatory requirements for lighting quality and the quality verification procedures	1	Because lighting quality of domestic CFLs do not meet the requirements of consumers	MOST	Review current lighting quality regulations and standards Consult international regulations and standards to form a basis for Vietnam	2012-2015	MOST	100
Establish a market-driven pricing	1	Helps to develop the sector towards a competitive and equitable	MOIT, MOF	Set an appropriate roadmap, taking into consideration negative impacts of	2012-	MOIT	100

system		electricity market	and EVN	increase in electricity costs on production and people's lives	2015		
Market support actions							
Raise public awareness on the social, economic and environmental benefits of CFLs	1	Helps to facilitate replacement of incandescent lights by CFLs to save energy	MOIT	Plan and budget awareness raising activities Develop support mechanisms for awareness raising campaigns	2012-2015	MOIT	500
Provide financial support to research, innovation or investment on production technologies	1	Helps to enhance product quality to meet consumers' demand	MOIT, MOF	Review current incentive mechanisms to make appropriate amendments	2012-2015	MOIT	500
Formulate detailed regulations for and control over the labeling of the product	1	Helps to enhance product quality to appeal to consumers	MOIT	Review current incentive mechanisms to make appropriate amendments	2012-2015	MOIT	100
International cooperation and IPR							
Collaborate with foreign major manufactures to improve the quality of local products	1	Helps to reduce the cost and improve CFL quality	MOIT	Assess current capacities and production technologies, find partners and facilitate cooperation	2012-2020	MOIT	1,000

*** Note:**

(1) See Note in Table .

c) Finalizing national strategy

Based on priority technology action plans in the subsectors, a national strategy and action plan for the CFL technology development targets are presented in Table .

Table 40 - National Strategy (technology transfer and development for mitigation)

	0-5 years	5-10 years	10-15 years
Commercially available technologies (short-term)			
Compact fluorescent lamps			
Raise awareness on technology	X		
Provide import tax or loan incentives for CFL production	X		
Make regulatory requirements for lighting quality and the quality verification procedures	X		
Establish a market-driven pricing system	X		
Raise public awareness on the social, economic and environmental benefits of CFLs	X		
Provide financial support to research, innovation or investment on production technologies	X		
Formulate detailed regulations for and control over the labeling of the product	X		
Collaborate with foreign major manufactures to improve the quality of local products	X	X	

1.4.2.2. Brief summary of project ideas for international support (details in Annex 4)

1.4.3. Bus rapid transit

1.4.3.1. Technology action plan for bus rapid transit

a) Aggregation and rationalization of measures identified for technology acceleration

Similar to the above section, the list of measures identified for formulation of a national strategy to accelerate the development and transfer of technologies can be seen in Table .

Table 41 - Aggregation for strategy formulation

Strategic measure	Accelerating innovation RD&D	Accelerating deployment	Accelerating diffusion
Creation of Network			
Create BRT information systems for commuters	X	X	X
Policies and Measures			
Reduce private vehicles; develop BRT infrastructure	X	XX	XX

Create financing mechanisms and loan incentives	X	X	X
Market support actions			
Develop infrastructure for relevant forms of public transits to facilitate commuting by BRTs	X	XXX	XXX
Raise awareness on the benefits of BRTs	X	X	X
Reasonable ticket fares	X	X	X

* Note: see Note under Table .

b) Prioritization and characterization of technology acceleration measures

Similar to above, the measures were prioritized and characterized through a detailed process for an action plan, as seen in Table .

Table 42 - Prioritization and characterization of technology acceleration measures

Sector: Energy							
Specific Technology and category: Bus rapid transit/ Large and small scale, short, medium and long-term							
Innovation stage: Deployment – Diffusion							
Measure (grouped under core elements)	**Prio -rity**	**Why is it important?**	**Who should do it?**	**How should they do it?**	**Time-scale**	**Monitoring, reporting and verification for measure**	**Estimated costs (1,000 USD)**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Creation of networks							
Create BRT information systems on for commuters	2	Helps passengers to easily use BRTs.	PCs, DOT	Provide information through appropriate channels Set up a system of appropriate sign posts.	2012-2015	MOT	50
Policies and measures							
Reduce discourage private vehicles, and support BRT development	1	Facilitates the development of public transportation and reduces traffic congestion in cities	MOT, MOF, PCs	Review current policies to make appropriate amendments	2012-2020	MOT	200
Create financing mechanisms and loan incentives	1	Building BRT routes requires large investment costs, while cities are in need of budget for upgrading the transportation system; thus, there is a need for financing mechanisms and loan incentives	MOT, MOF, PCs	Develop financing mechanisms for BRTs through the tax system for other private vehicles to encourage people to use public transportation, including BRTs.	2012-2015	MOST	100

		for BRTs					
Market support actions							
Develop infrastructure for relevant forms of public transits to facilitate commuting by BRTs	1	Create a synchronized network of transportation to encourage passengers to use BRTs	MPI, MOT, MOF	Prioritize, supervise the synchronized transportation development,	2012-2030	MOT	10,000
Raise awareness on the benefits of BRTs	1	To enhance public awareness on the socio-economic and environmental benefits of BRTs	MOT, MOF, PCs	Plan and budget awareness raising activities Create facilitating mechanisms for awareness raising programs	2012-2015	MOT	1,000
Reasonable ticket fares	2	To encourage people to use public transportation	PCs, DOT	Study the ticket fare standard and ticketing system in developed countries to draw lessons and choose an appropriate model for Vietnam	2012-2015	MOT	500

*** Note:**

(1) Priority levels are similar to Table .

*c) **Finalizing national strategy***

Based on priority technology action plans in the subsectors, a national strategy and action plan for the bus rapid transit technology development targets are presented in Table .

Table 43 - National Strategy (technology transfer and development for mitigation)

	0-5 years	5-10 years	10-15 years
Long-term technologies			
Bus rapid transits			
Create BRT information systems on for commuters	X		
Reduce private vehicles; develop BRT infrastructure	X	X	
Create financing mechanisms and loan incentives	X		
Develop infrastructure for relevant forms of public transits to facilitate commuting by BRTs	X	X	X
Raise awareness on the benefits of BRTs	X		
Reasonable ticket fares	X		

1.4.4. Combined heat and power (CHP) or heat and power cogeneration

1.4.4.1. Technology action plan for CHP

a) Aggregation and rationalization of measures identified for technology acceleration

Similar to the above section, the list of measures identified for formulation of a national strategy to accelerate the development and transfer of technologies can be seen in Table .

Table 44 - Aggregation for strategy formulation

Strategic measure	Accelerating innovation RD&D	Accelerating deployment	Accelerating diffusion
Creation of Network			
Facilitate existing network of stakeholders	XXX	XXX	
Create a coordination mechanism between stakeholders	XXX	XXX	
Policies and Measures			
Formulate incentive policies and binding legal obligations for technology deployment	X	XX	X
Publish technical materials on new technologies for manufacturing industries employing CHP	X	XX	X
Organizational/behavioral change			
Review and plan	X	X	XX

Staff training on the CHP technology	X	X	XX
Strengthen technology management capacity and raise community awareness on technology benefits	X	X	XX
Skills training and education			
International experts, have staff members trained	XX	X	XX
Create funds for training and education	XX	X	XX
International cooperation and IPR			
International cooperation in CHP technology development and transfer		X	

* Note: see Note under Table .

b) Prioritization and characterization of technology acceleration measures

Similar to above, the measures were prioritized and characterized through a detailed process for an action plan, as seen in Table .

Table 45 - Prioritization and characterization of technology acceleration measures

Sector: Energy							
Specific Technology and category: Heat and power cogeneration/Large and small scale, short, medium and long-term							
Innovation stage: Deployment – Diffusion							
Measure (grouped under core elements)	**Prio-rity**	**Why is it important?**	**Who should do it?**	**How should they do it?**	**Time-scale**	**Monitoring, reporting and verification for measure**	**Estimated costs (1,000 USD)**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Creation of networks							
Facilitate existing network of stakeholders	1	Forms a basis for integrating CHP in the General Development Planning of the sector	MOIT	Create networks Build coordination mechanisms Formulate regulations and sanctions for implementation	In 5 years	MOIT	25
Create a coordination mechanism between stakeholders	2	Facilitates the cooperation and information sharing between experts of different principles in the application of CHP	MOIT	Create networks Build coordination mechanisms Formulate regulations and sanctions for implementation	In 5 years	MOIT	15
Policies and measures							
Formulate incentive policies and binding legal obligations for technology deployment	1	Encourages businesses to deploy this technology	MOIT, MPI	Create networks Build coordination mechanisms Formulate regulations and sanctions for implementation	In 5 years	MOIT	17.5

Publish technical materials on new technologies for manufacturing industries employing CHP	2	Facilitates desk research in the R&D of CHP for the deployment of this technology in high potential sectors.	MOIT, MPI	Create networks Build coordination mechanisms Formulate regulations and sanctions for implementation	In 5 years	MOIT	17.5
Organizational/behavioral change							
Review and plan	1	So far, CHP has not been included in industrial zone planning. This measure will form the basis for integration of CHP in planning industrial zone	MOIT, MPI	Review industrial zone planning Amend and finalize the planning	In 5 years	MOIT	35
Staff training on the CHP technology	2	This measure will help address the lack of CHP experts and facilitate the CHP diffusion	MOIT, MOET	Identify demand for information and training needs to plan and implement the training roadmap	In 5 years	MOIT	25
Strengthen technical management capacity and raise community awareness on the benefits of this technology	2	This measure will address insufficient management capacity and limited understanding of CHP	MOIT	Organize training courses and awareness raising campaigns	In 5 years	MOIT	15
Skills training and education							
International experts, have staff members trained	1	Capacity and experience of national experts are limited	MOIT, MOET	Review and develop a training plan, open training courses in colleges and vocational schools	In 5 years	MOIT	125
Create funds for training and education	2	Because of limited financial resources for research and education	MOIT, MOF	Identify needs, plan and establish funds	In 5 years	MOIT	10
International cooperation and IPR							
International cooperation in CHP	1	This measure will help to build	MOIT	Identify needs, and develop transfer	In 5	MOIT	250

technology development and transfer		capacity, develop human resources and facilitate technology transfer to CHP deployment		plan	years		

*** Note:**

(1) Priority levels are similar to Table .

*c) **Finalizing national strategy***

Based on priority technology action plans in the subsectors, a national strategy and action plan for the CHP development targets are presented in Table .

Table 46 - National Strategy (technology transfer and development for mitigation)

	0-5 years	5-10 years	10-15 years
Commercially available technologies (short-term)			
Combined heat and power			
Facilitate existing network of stakeholders	X		
Create a coordination mechanism between stakeholders	X	X	
Formulate incentive policies and binding legal obligations for technology deployment	X	X	
Publish technical materials on new technologies for manufacturing industries employing CHP	X		
Review and plan	X		
Staff training on the CHP technology	X	X	
Strengthen technical management capacity and raise community awareness on the benefits of this technology	X		
International experts, have staff members trained	X	X	
Create funds for training and education	X		
International cooperation in CHP technology development and transfer	X		

1.4.4.2. Brief summary of project ideas for international support (details in Annex 4)

1.5. Summary

a) Wind power action plan

Present to 2015: Focus on implementing policies for promotion of new energies (particularly REs) to reduce electricity consumption, develop investment incentives and financing mechanisms for RE development, invest on RE projects, build financial support mechanisms, including tax incentives for importing equipment, business tax, concessional loans, and particularly subsidization schemes for purchase of REs.

Up to 2020: Build wind maps to locate appropriate sites to maximize efficiency of investment projects, develop infrastructure and maintenance services, and create a system of information for stakeholders. In addition, form technical expert groups and increase international cooperation to enhance operation and maintenance capacity.

b) CFL action plan

Present to 2015: Develop and apply tax incentives for importing production equipment and concessional loan policy for national businesses to invest, upgrade and employ new production technologies. Gradually erase the coal subsidization for electricity generation, develop a market-based pricing system. Provide financial support to awareness raising on social, economic and environmental benefits of CFLs. Regulate requirements for lighting

quality and control over labeling procedure to ensure quality claimed on label. Strengthen the information network, provide sufficient information on manufacturers and retailing agencies to consumers.

Up to 2020: Regulate lighting quality and quality verification procedures. Strengthen international cooperation for improving the quality of local products.

c) BRT action plan:

Present to 2015: Create financing mechanisms and loan incentives to reduce investment costs for BRT route construction. Support awareness raising on BRT benefits. Develop a reasonable fee system for passengers. Create an adequate information system on bus rapid transit routes for commuters.

Up to 2020: Develop policies to reduce private means of transport and focus on building of BRT infrastructure.

Up to 2025: Focus on synchronizing the public transportation system to make BRT easier to use for passengers.

d) CHP action plan:

Vietnam's general electricity, coal, gas and oil development plan, with a short (five years), medium (5-10 years) and long (10-15 years) term visions, claims to associate the development of industrial zones with investment projects in heat- and electricity-consuming sectors, such as pulp, sugar, food industry, oil refining industry, construction materials, etc.

Because of the technology's characteristics, the action plan for CHP diffusion emphasizes on the following short and medium term technologies:

+ extraction-condensing/back pressure steam turbines

+ gas turbine with heat recovery boiler (with or without bottoming steam turbine)

+ diesel and reciprocating engines with heat recovery boiler

Besides, long-term action plans also mention long term (15 years) technologies for future reference:

+ Micro-turbines

+ Fuel cells

+ Stirling engines

The action plan proposes support policies for technology transfer, analyses barriers and develop solutions to overcome the barriers, aggregate solutions for the formulation of a national strategy that meet the characteristics of CHP.

Chapter 2. Agriculture Sector

In Part A, the technology capable of mitigation to reduce greenhouse gas in agriculture has been taken into account, scoring and evaluation to select the most preferred technology. As a result, these technologies are arranged in order of priority and summarized in the table below

Table 47 - List and assessment of prioritized technology in the agriculture sector

Availability/Scale	Technology Options	Potential for mitigation in 20 year (mil. tCO_2)	Benefits out put from MCDA assessment	Estimated abatement cost relative with current price ($US/$tCO_2$)
Short-term/small and medium scale	Biogas technology	22.64	55.40	- Biogas replacing coal in plains: 4.1 - Biogas replacing firewood in highlands: 9.7
Short- and medium-term/small scale	Nutrition improvement through controlled fodder supplements	7.9	53.00	-10.9
Short- and medium-term/medium scale	Wet and dry irrigation in certain rice growth stages	61.1	51.83	5.2

2.1. Preliminary targets for technology transfer and diffusion

Identifying the preliminary targets and milestones for the agriculture sector is similar with the process in Chapter 1 (item 1.1).

2.1.1. Reaffirmation of targets for technology transfer and diffusion

a) General targets [*].

- Develop sustained, diverse, robust commodity agriculture, with access to and effective application of global new sciences and high technologies, and high national and international competitiveness.

- Transfer and deploy new technologies and sciences to production, preservation and processing industries to increase productivity, quality, efficiency and competitiveness of agricultural products within and outside the national market. Promote sciences and technologies in rural areas to help alleviate poverty and hunger. Create jobs and increase income to improve rural living standards through scientific and technological measures.

- Link to and cooperate with national target programs, socio-economic programs. Choose appropriate technologies to implement and draw lessons from the implementation to form the basis for the diffusion of the technologies.

- Enhance capacity for farmers and local officials to actively find, decide on and apply advanced technologies that meet the demand of the local socio-economic development.

b) Specific targets [**].

- Biogas digesters: 560 thousand by 2030.

- Wet and dry irrigation certain rice growth stages: area of irrigated rice farm reach 5.4 million hectares by 2030.

- Nutrition enhancement for dairy cattle: by 2030, population of MUB-fed cattle reaches 292,000 heads.

2.1.2. Establishing milestones to accomplish technology development targets

a) National milestones [**].

- Biogas digesters: 560 thousand by 2030.

- Wet and dry irrigation certain rice growth stages: area of irrigated rice farm reach 5.4 million hectares by 2030.

- Nutrition enhancement in dairy cattle: by 2030, population of MUB-fed cattle reaches 292,000 heads.

b) Prioritized subsector milestones [**].

- It is expected that biogas digesters in northern deltas, former Nam Khu 4, south central Vietnam and southern deltas, etc. will reach 280 thousand by 2020 and 560 thousand by 2030.

- Irrigated area through the wet and dry method will be about 3 million hectares by 2020 and 5.4 million hectares by 2030.

- By 2020, 183,000 heads of cattle will be provided MUB feed; this number is expected to increase to 292,000 in 2030.

2.2. Barrier analysis

Identifying the barriers is similar the process in Chapter 1 (item 1.2). The barrier analyis for the agriculture sector was presented below.

2.2.1. Barrier identification and analysis for the transfer and diffusion of biogas digester construction

a) Economic barrier

High investment and O&M costs for farmers lead to low competitiveness of the technology.

b) Technical barrier

- Biogas digester designs still vary and are in the process of completing.

- Lack of a full assessment of digester efficiency.

- Input materials have poor quantity and quality; most of biogas digesters are using cattle waste and have managed to utilize plant organic materials, such as hay, grass, algae, etc.

2.2.2. Barrier identification and analysis for the transfer and diffusion of wet and dry irrigation

a) Economic barrier

- High investment and O&M costs for an irrigation and drainage system.

b) Technical barrier

- Wet rice cultivation tradition is the key obstruction to the technology diffusion.

- Procedure for wet and dry irrigation in different areas and different rice varieties is not completed.

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[*] Decision No.150/2005/QD-TTg on 20 June, 2005 on Planning to covert argriculture, forestry and fishery structure of production up to in 2010 and towards 2020 and decision No.1831/QD-TTg on 01 Oct, 2010 of the Prime Minister on Approval of application program to support and transfer scientific technology for developing socio-economy in rural and mountainous areas in 2011-2015.

[**] Studying of Research Centre for Climate change and Sustainable Development.

- Lack of a full assessment of digester efficiency.

c) Environmental barrier

- Field channels have not been strengthened in certain areas, leading to large water leakages.

2.2.3. Barrier identification and analysis for the transfer and diffusion of Nutrition enhancement for dairy cattle

a) Economic barrier

- High investment and O&M costs for farmers, leading to low competitiveness of the technology.

b) Technical barrier

- Insufficient analysis of MUB feed ingredients.

- MUB fee preservation technology is not common among users of this technology.

2.2.4. Linkages of the barriers identified

Similar to Chapter 1, the linking and aggregation of the common barriers across the technologies of the sector helped to minimize overlaps and ensure that the process would flow smoothly, as shown in Table .

Table 48 - Common barriers and inefficiencies identified for technologies

Missing/insufficiencies in Market linkage	
	Lack of a technology transfer network
	Lack of information on stakeholders and special linkages to major projects and to foreign manufacturers
	High establishment costs. In addition, if technology changes are needed, users usually ignore externalities such as environmental and social elements.
	Lack of demonstration for unfamiliar technologies and adjustment of technologies to local conditions
	Lack of competitiveness assessment
Enabling environment	
	Facilitating policies are not uniform or strong enough
	Lack of regulations, standards and implementation
	Complicated, slow and sometimes inappropriate approval and authorization procedures
	Adjustments in importing procedure to simplify the procedure and accelerate the diffusion of the technology do not keep up with the demand
	Poor infrastructure
Support actions	
	Few R&D supports
	Lack of market information
	Poor O&M capacity

	Limited local capacity building activities to address technical barriers
	Limited or no loan or financing mechanisms for new or small-scale technologies

2.3. Enabling framework for overcoming the barriers

The development of the enabling framework for overcoming the barriers for the agriculture sector is similar with process in the Energy Chapter (item 1.3). The enabling framework for overcoming barriers for each technologies in the agriculture sector is presented as follows:

2.3.1. Possible solutions to address the barriers for the transfer and diffusion of biogas technology

2.3.1.1. Measures to support the creation of a stakeholder network for the development and transfer of the technology

Measure 1. Review, restructure and strengthen existing agricultural incentive structures.

Measure 2. Assign technology focal points.

2.3.1.2. Actions to improve policies and creating measures for technology development and transfer

Measure 1. Develop mechanisms to support R&D of biogas technology and implement pilot projects.

Measure 2. Create loan and tax incentives.

Measure 3. Review and assess existing policies.

2.3.1.3. Measures to strengthen functioning of organizations and institutions

Measure 1. Enhance management capacity of agricultural facilitating authorities and develop operating procedures and measures.

Measure 2. Provide financial support and build capacity for technology experts.

Measure 3. Formulate coordination mechanisms between agricultural authorities, farmers and research institutions.

2.3.1.4. Measures to strengthen market, system support and financial services through quality assurance, availability of consultancy, market information, financial services, etc.

Measure 1. Organize technology introduction workshops and study tours to find information on technology, equipment, products and market potential of technology.

Measure 2. Develop concessional loan mechanisms for farmers to build biogas digesters.

2.3.1.5. Measures to support skills training and education for technology development and transfer
Measure 1. Create funds for training and education.

2.3.1.6. Measures to facilitate international cooperation and deal with intellectual property rights (IPR), particularly for a more cooperative model for RD&D
Measure 1: Join forces with the global community in development and transfer of the technology.

2.3.2. Possible solutions to address the barriers for the transfer and diffusion of Wet and dry irrigation

2.3.2.1. Measures to support the creation of a stakeholder network for the development and transfer of the technology
Measure 1: Strengthening existing agricultural incentives for technology transfer.

Measure 2. Assign technology focal points.

2.3.2.2. Actions to improve policies and creating measures for technology development and transfer
Measure 1. Develop support policies, demonstrate and implement pilot projects.

Measure 2. Make policies to support construction of field drainage structures.

Measure 3. Review and assess existing policies.

2.3.2.3. Measures to strengthen functioning of organizations and institutions.

Measure 1. Enhance management capacity of agricultural authorities.

Measure 2. Provide financial support and build capacity for technology experts.

Measure 3. Formulate coordination mechanisms between agricultural authorities, farmers and research institutions.

2.3.2.4. Measures to strengthen market, system support and financial services through quality assurance, availability of consultancy, market information, financial services, etc.

Measure 1. Develop concessional loan mechanisms for local people.

2.3.2.5. Measures to support skills training and education for technology development and transfer
Measure 1. Create funds for training and education.

2.3.2.6. Measures to facilitate international cooperation and deal with intellectual property rights (IPR), particularly for a more cooperative model for RD&D
Measure 1. Join forces with the global community in development and transfer of the technology.

2.3.3. Possible solutions to address the barriers for the transfer and diffusion of Nutrition enhancement in dairy cattle

2.3.3.1. Measures to support the creation of a stakeholder network for the development and transfer of the technology.
Measure 1. Strengthen the existing agricultural incentives for technology transfer.

Measure 2. Assign technology focal points.

2.3.3.2. Actions to improve policies and creating measures for technology development and transfer

Measure 1. Enhance management capacity of agricultural authorities.

Measure 2. Provide financial support and build capacity for technology experts.

Measure 3. Formulate coordination mechanisms between agricultural authorities, farmers and research institutions.

2.3.3.3. Measures to strengthen functioning of organizations and institutions.

Measure 1. Enhance management capacity of agricultural authorities;

Measure 2. Build capacity for technology experts.

2.3.3.4. Measures to strengthen market, system support and financial services through quality assurance, availability of consultancy, market information, financial services, etc.

Measure 1. Develop concessional loan mechanisms for local people.

2.3.3.5. Measures to support skills training and education for technology development and transfer
Measure 1. Create funds for training and education.

2.3.3.6. Measures to facilitate international cooperation and deal with intellectual property rights (IPR), particularly for a more cooperative model for RD&D
Measure 1. Join forces with the global community in development and transfer of the technology.

2.3.4. Recommended solutions for energy

Raise awareness on climate change, including GHG mitigation in agriculture.

Develop models of applying mitigation technologies in cultivation (e.g.: wet and dry irrigation technologies) and livestock production (e.g.: MUB feed), draw implementation lessons and duplicate them.

Organize and develop the system of agricultural facilitating agencies to engage in mitigating GHGs in agriculture.

2.4. Technology action plan, project ideas, and other issues in agriculture

2.4.1. Biogas

2.4.1.1. Technology action plan for biogas

a) Aggregation and rationalization of measures identified for technology acceleration

Similar to the above section, the list of measures identified for formulation of a national strategy to accelerate the development and transfer of technologies can be seen in Table .

Table 49 - Aggregation for strategy formulation

Strategic measure	Accelerating innovation RD&D	Accelerating deployment	Accelerating diffusion
Creation of Network			
Review, restructure and strengthen existing agricultural incentive structure	X	X	X
Assign technology focal points	X	X	X
Policies and Measures			
Develop mechanisms to support R&D of biogas technology and implement pilot projects	X	X	X
Create loan and tax incentives	X	X	X
Review and assess existing policies	X	XX	XX
Organizational/behavioral change			
Enhance management capacity of agricultural facilitating authorities	X	X	X
Build capacity for technology experts	X	X	XX
Formulate coordination mechanisms between stakeholders	X	XX	XX
Market support actions			
Develop concessional loan mechanisms for farmers to build biogas digesters	X	XX	XX
Skills training and education			
Create funds for training and education	X	XX	XX
International cooperation and IPR			
International cooperation in development and transfer of the technology	X	XX	XX

* Note: see Note in Table .

b) Prioritization and characterization of technology acceleration measures for a national plan

Similar to the above sections, the list of measures identified for the acceleration of technologies and the innovation stage structured under the core elements of a national strategy are identified and aggregated in Table below.

Table 50 - Prioritization and characterization of technology acceleration measures

Sector: Agriculture							
Specific Technology and category: Biogas/Short-term, small and medium scale							
Innovation stage: Deployment – Diffusion							
Measure (grouped under core elements)	**Prio-rity**	**Why is it important?**	**Who should do it?**	**How should they do it?**	**Time-scale**	**Monitoring, reporting and verification for measure**	**Estimated costs (1,000 USD)**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Creation of networks							
Review, restructure and strengthen existing agricultural incentives	1	Helps to rationalize and promote the role and activities of organizations which have been or can be engaged in the network	MARD	Restructure towards deep-root structure, identify advantages and barriers to form a basis for strengthening the existing system.	2 years	MARD	25
Assign technology focal points	2	Helps to direct and uniformly instruct the technology innovation	MARD	Establish a central committee and a network of local representatives	2 years	MARD	25
Policies and Measures							
Develop mechanisms to support R&D of biogas technology and implement pilot projects	1	Helps to create tools to encourage organizations and individuals to research, develop and apply technologies	MARD	Formulate support policies to meet the demand for new technologies, create technology development budget	3 years	MARD, MOST	15
Create loan and tax incentives	2	Helps to find solutions to overcome financial barriers to encourage stakeholders to apply technologies in production activities.	MARD	Develop and enforce tax incentives to accelerate technology diffusion	2 years	MOF	5

Review and assess policies	3	Helps to increase effectiveness of existing policies and align them to current conditions	MARD	Review and assess effectiveness and disadvantages of existing policies	5 years	MARD	15
Organizational/behavioral change							
Enhance management capacity of agricultural facilitating authorities	1	Maximize the potential of organizations and minimize the disadvantage of limitations in management	MARD in coordination with related agencies	Organize management skills training courses, draw lessons, create operating procedures and measures	2 years	MARD	50
Build capacity for technology experts	1	To encourage the involvement of technical experts and ensure work efficiency	Institutes, departments and organizations	Identify information and training needs, develop plans and organize training course4s for technicians.	1 years	MARD	25
Formulate coordination mechanisms between stakeholders	3	There is a need for close coordination between managers, scientists and farmers	MARD	Consult with stakeholders to formulate a feasible mechanism	5 years	MARD	2.5
Market support actions							
Develop concessional loan mechanisms for farmers	2	To make budget and facilitate technology development and diffusion	State Bank, MARD	Develop loan policies through Agricultural Bank (AgriBank)	2 years	MOF	250
Market support actions							
Create funds for training and education	3	To make a fixed and constant budget for research and human resources development	MARD	Mobilize resources from international partners	5 years	MARD, MOST	5
International cooperation and IPR							

International cooperation in development and transfer of the technology	3	To learn and enhance understanding and knowledge of the technology	MARD	Organize study tours or research groups Exchange materials and information on technology	5 years	MARD	25

*** Note:**

(1) See note in Table .

*c) **Finalizing national strategy***

Based on priority technology action plans in the subsectors, a national strategy and action plan for the biogas development targets are presented in Table .

Table 51 - National Strategy

(technology transfer and development for mitigation)

	0-5 years	5-10 years	10-15 years
Commercially available technologies (short-term)			
Biogas			
Review, restructure and strengthen existing agricultural incentives	X		
Assign technology focal points	X		
Develop mechanisms to support R&D of biogas technology and implement pilot projects	X		
Create loan and tax incentives	X		
Review and assess policies	X	X	
Enhance management capacity of agricultural facilitating authorities	X	X	
Build capacity for technology experts	X		
Formulate coordination mechanisms between stakeholders	X	X	
Develop concessional loan mechanisms for farmers	X	X	X
Create funds for training and education	X	X	
International cooperation in development and transfer of biogas technology	X	X	X

2.4.1.2. Brief summary of project ideas for international support (details in Annex 4)

2.4.2. Wet and dry irrigation in certain rice growth stages

2.4.2.1. Technology action plan

a) Aggregation and rationalization of measures identified for technology acceleration

Similar to the above section, the list of measures identified for formulation of a national strategy to accelerate the development and transfer of technologies can be seen in

Table .

Table 52 - Aggregation for strategy formulation

Strategic measure	Accelerating innovation RD&D	Accelerating deployment	Accelerating diffusion
Creation of Network			

Strengthen existing agricultural incentives for technology transfer	X	X	X
Assign technology focal points	X	X	X
Policies and measures			
Develop support policies, demonstrate and implement pilot projects	X	X	X
Make policies to support construction of field drainage structures	X	X	X
Review and assess existing policies	X	XX	XX
Organization/behavioral change			
Enhance management capacity of agricultural authorities	X	X	X
Provide financial support and build capacity for technology experts	X	X	XX
Formulate coordination mechanisms between agricultural authorities, farmers and research institutions	X	XX	XX
Market support actions			
Develop concessional loan mechanisms for local people	X	XX	XX
Skills training and education			
Create funds for training and education	X	XX	XX
International cooperation and IPR			
International cooperation in development and transfer of the technology	X	XX	XX

*Note: see Note under Table .

b) Prioritization and characterization of technology acceleration measures for a national plan

Similar to the above sections, the list of measures identified for the acceleration of technologies and the innovation stage structured under the core elements of a national strategy are identified and aggregated in Table below.

Table 53 - Prioritization and characterization of technology acceleration measures for a national plan

Sector: Agriculture							
Specific Technology and category: Wet and dry irrigation/Short- and medium-term, medium scale							
Innovation stage: Deployment – Diffusion							
Measure (grouped under core elements)	**Prio-rity**	**Why is it important?**	**Who should do it?**	**How should they do it?**	**Time-scale**	**Monitoring, reporting and verification for measure**	**Estimated costs (1,000 USD)**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Creation of networks							
Review, restructure and strengthen existing agricultural incentives	1	Helps to rationalize and promote the role and activities of organizations which have been or can be engaged in the network	MARD	Restructure towards deep-root structure, identify advantages and barriers to form a basis for strengthening the existing system.	2 years	MARD	25
Assign technology focal points	2	Helps to direct and uniformly instruct the technology innovation	MARD	Establish a central committee and a network of local representatives	2 years	MARD	25
Policies and Measures							
Develop mechanisms to support R&D of the technology and implement pilot projects	1	Helps to create tools to encourage organizations and individuals to research, develop and apply technologies	MARD	Formulate support policies to meet the demand for new technologies, create technology development budget	3 years	MARD, MOST	15
Create loan and tax incentives	2	Helps to find solutions to overcome financial barriers to encourage stakeholders to apply technologies	MARD	Develop and enforce tax incentives to accelerate technology diffusion	2 years	MOF	5

		in production activities.					
Review and assess policies	3	Helps to increase effectiveness of existing policies and align them to current conditions	MARD	Review and assess effectiveness and disadvantages of existing policies	5 years	MARD	15
Organizational/behavioral change							
Enhance management capacity of agricultural facilitating authorities	1	Maximize the potential of organizations and minimize the disadvantage of limitations in management	MARD in coordination with related agencies	Organize management skills training courses, draw lessons, create operating procedures and measures	2 years	MARD	50
Build capacity for technology experts	1	To encourage the involvement of technical experts and ensure work efficiency	Institutes, departments and organizations	Identify information and training needs, develop plans and organize training course4s for technicians.	1 years	MARD	25
Formulate coordination mechanisms between stakeholders	3	There is a need for close coordination between managers, scientists and farmers	MARD	Consult with stakeholders to formulate a feasible mechanism	5 years	MARD	2.5
Market support actions							
Develop concessional loan mechanisms for farmers	2	To make budget and facilitate technology development and diffusion	State Bank, MARD	Develop loan policies through Agricultural Bank (AgriBank)	2 years	MOF	250
Market support actions							
Create funds for training and education	3	To make a fixed and constant budget for research and human resources development	MARD	Mobilize resources from international partners	5 years	MARD, MOST	5

International cooperation and IPR							
International cooperation in development and transfer of the technology	3	To learn and enhance understanding and knowledge of the technology	MARD	Organize study tours or research groups Exchange materials and information on technology	5 years	MARD	5

* Note:
(1): See Note under Table .

c) Finalizing national strategy

Based on priority technology action plans in the subsectors, a national strategy and action plan for the technology development targets are presented in Table .

Table 54 - National Strategy

(technology transfer and development for mitigation)

	0-5 years	5-10 years	10-15 years
Commercially available technologies (short-term)			
Wet and dry irrigation in certain growth stages			
Review, restructure and strengthen existing agricultural incentives	X		
Assign technology focal points	X		
Develop mechanisms to support R&D of the technology and implement pilot projects	X		
Create loan and tax incentives	X		
Review and assess policies	X	X	
Enhance management capacity of agricultural facilitating authorities	X	X	
Build capacity for technology experts	X		
Formulate coordination mechanisms between stakeholders	X	X	
Develop concessional loan mechanisms for farmers	X	X	X
Create funds for training and education	X	X	
International cooperation in development and transfer of the technology	X	X	X

2.4.2.2. Brief summary of project ideas for international support (details in Annex 4)

2.4.3. Nutrition enhancement in dairy cattle

2.4.3.1. Technology action plan

a) Aggregation and rationalization of measures identified for technology acceleration

Similar to the above section, the list of measures identified for formulation of a national strategy to accelerate the development and transfer of technologies can be seen in

Table .

Table 55 - Aggregation for strategy formulation

Strategic measure	Accelerating innovation RD&D	Accelerating deployment	Accelerating diffusion
Creation of Network			

Strengthen the existing agricultural incentives for technology transfer	X	X	X
Assign technology focal points	X	X	X
Policies and Measures			
Develop mechanisms to support R&D of the technology and implement pilot projects	X	X	X
Create loan and tax incentives	X	X	X
Review and assess policies	X	XX	XX
Organizational/behavioral change			
Enhance management capacity of agricultural facilitating authorities	X	X	X
Build capacity for technology experts	X	X	XX
Market support actions			
Develop concessional loan mechanisms for farmers	X	XX	XX
Skills training and education			
Create funds for training and education	X	XX	XX
International cooperation and IPR			
International cooperation in development and transfer of the technology	X	XX	XX

* Note: see Note under Table .

b) Prioritization and characterization of technology acceleration measures for a national plan

Similar to sections above, the list of measures identified for the acceleration of technologies and the innovation stage structured under the core elements of a national strategy are identified and aggregated in Table below.

Table 56 - Prioritization and characterization of technology acceleration measures

Sector: Agriculture							
Specific Technology and category: Nutrition enhancement/Short- and medium-term, small scale							
Innovation stage: Deployment – Diffusion							
Measure (grouped under core elements)	**Prio-rity**	**Why is it important?**	**Who should do it?**	**How should they do it?**	**Time-scale**	**Monitoring, reporting and verification for measure**	**Estimated costs (1,000 USD)**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Creation of networks							
Review, restructure and strengthen existing agricultural incentives	1	To rationalize and promote the role and activities of organizations which have been or can be engaged in the network	MARD	Restructure towards deep-root structure, identify advantages and barriers to form a basis for strengthening the existing system.	2 years	MARD	25
Assign technology focal points	2	To direct and uniformly instruct the technology innovation	MARD	Establish a central committee and a network of local representatives	2 years	MARD	25
Policies and Measures							
Develop mechanisms to support R&D of the technology and implement pilot projects	1	Create tools to encourage organizations and individuals to research, develop and apply technologies	MARD	Formulate support policies to meet the demand for new technologies, create technology development budget	3 years	MARD, MOST	15
Create loan and tax incentives	2	Find solutions to overcome financial barriers to encourage stakeholders to apply technologies	MARD	Develop and enforce tax incentives to accelerate technology diffusion	2 years	MOF	5

		in production activities.					
Review and assess policies	3	To increase effectiveness of existing policies and align them to current conditions	MARD	Review and assess effectiveness and disadvantages of existing policies	5 years	MARD	15
Organizational/behavioral change							
Enhance management capacity of agricultural facilitating authorities	1	Maximize the potential of organizations and minimize the disadvantage of limitations in management	MARD in coordination with related agencies	Organize management skills training courses, draw lessons, create operating procedures and measures	2 years	MARD	50
Build capacity for technology experts	1	To encourage the involvement of technical experts and ensure work efficiency	Institutes, departments and organizations	Identify information and training needs, develop plans and organize training course4s for technicians.	1 years	MARD	25
Market support actions							
Develop concessional loan mechanisms for farmers	2	To make budget and facilitate technology development and diffusion	State Bank, MARD	Develop loan policies through Agricultural Bank (AgriBank)	2 years	MOF	250
Skills training and education							
Create funds for training and education	3	To make a fixed and constant budget for research and human resources development	MARD	Mobilize resources from international partners	5 years	MARD, MOST	5
International cooperation and IPR							
International cooperation in development and transfer of the technology	3	To learn and enhance understanding and knowledge of the technology	MARD	Organize study tours or research groups Exchange materials and information on technology	5 years	MARD	5

* Note (1): See note under Table

c) Finalizing national strategy

Based on priority technology action plans in the subsectors, a national strategy and action plan for the nutrition enhancement development targets are presented in Table .

Table 57 - National Strategy

(technology transfer and development for mitigation)

	0-5 years	5-10 years	10-15 years
Commercially available technologies (short-term)			
Nutrition enhancement for dairy cattle			
Review, restructure and strengthen existing agricultural incentives	X		
Assign technology focal points	X		
Develop mechanisms to support R&D of the technology and implement pilot projects	X		
Create loan and tax incentives	X		
Review and assess policies	X	X	
Enhance management capacity of agricultural facilitating authorities	X	X	
Build capacity for technology experts	X		
Develop concessional loan mechanisms for farmers	X	X	X
Create funds for training and education	X	X	
International cooperation in development and transfer of the technology	X	X	X

2.5. Summary

Agricultural production has a key role in Vietnam's economy; agricultural production will help to sustain social security and rapid economic development.

In the agricultural development, focusing on GHG mitigation measures while accelerating production will be beneficial to farmers and environment.

GHG mitigation technologies in agriculture are applied mostly in cultivation and livestock production. These technologies involve:

- Manure management by storing in closed basement to produce methane use4d as fuel instead of fossil fuels.

- Wet and dry irrigation in certain growth stages of rice for higher yield and methane reduction.

- Improve nutrition and cattle feed in raising livestock, through supplying MUB feed to diary cattle, which reduces the digestion time and methane emissions from digestion activities.

These technologies are new to farmers; however, their benefits for production and lives of people are very prominent so it is expected that they will be applied in the future.

Chapter 3. Land use, land-use change and forestry

In Part A, the technology capable of mitigation to reduced greenhouse gas in LULUCF has been taken into account, scoring and evaluation to select the most preferred technology. As a result, these technologies are arranged in order of priority and summarized in the table below

Table 58 - List and assessment of prioritized technology in the LULUCF sector

Availability/Scale	Technology Options	Potential for mitigation in 20 years (mil. tCO2)	Benefits out put from MCDA assessment	Estimated abatement cost relative with current price ($US/tCO2)
Short-term/Large scale	Sustainable forest management	1413	60.19	0.77
Short-term/Large scale	Afforestation and reforestation	750	57.52	0.56
Short-term/Large scale	Rehabilitation of mangrove	250	49.08	0.59

3.1. Basic objectives for technology transfer and demonstration

Identifying the preliminary targets and milestones for the agriculture sector is similar with the process in Chapter 1 (item 1.1).

3.1.1. Reconfirming objectives for the development and demonstration of technologies

a) General objectives:

Development of Sustainable Forestry, Sustainable Forest Management will serve as the basis for forestry development. There are needs in clear planning policy and consistent development of forests such as production forests, protection forests and special use forests with forest quality is improved;

State investment with policy synchronization to manage and develop normal forests and special use forests as well as encourage organizations and individuals of all economic sectors to invest in production forests;

Combining forest with material from the processing industry in project planning and investment income from the forest to obtain forest development and forest enrichment.

b) Specific objectives

Management and sustainable use of 16.24 million ha of forest land; 8.4 million hectares of production forests; 5.68 million hectares of forests and 2.16 million ha of special use forests [*].

Accelerate and deepen the social process of forestry, forestry sector development overall. Ensure that the contracted care and protection of forests have stable local lives.

3.1.2. Establishing milestones for prioritized technologies of LULUCF

a) Construction of field markers for forestry and land-use change sectors

- By 2015: Completion of demarcation and to plan three national forests;

- By 2020:

+ Reasonable planning, management and effective use of protective forest system about 5.68 million ha and 2.16 million ha of special use forests before 2020 [*].

+ Zoning for 0.8 million ha of regeneration forest

+ Increase national coverage rate to 45% [*].

b) Develop milestones for the technology priorities of the forestry and land-use change sectors

Technology for Sustainable Forest Management

- By 2020:Sustainable management and efficient production of 8.5 million hectares of production forest; in which 30% has forest certification. Management and efficient use of 5.5 million ha protection forest system and 2.2 million ha of special use forest [*].

Technology Afforestation and reforestation:

- Reforestation of large timber treesnwith 100 000 ha of natural reproduction, in which:

+ From 2001 to 2010, 5,000 ha of forest will be planted each year;

+ From 2011 to 2020 is 3,000 hectares will be planted each year;

+ From 2021 to 2030 is 1,500 hectares will be planted each year;

+ From 2031 to 2040 is 500 hectares of forest will be planted each year [**];

- Planting large wooden long period at a rate of 400,000 ha:

+ From 2001 to 2010 is 14,500 ha / year;

+ From 2011 to 2020 is 14 200 ha / year;

+ From 2021 to 2030 and from 2031 to 2040 is 4800 ha / year [**];

- Planting material forests in shorter cycle: During 15 years, 1.2 million hectares of forest raw materials has developed rapidly, with speeds from 180 000 ha / year in the first 5 years, 66,550 ha / year in the next 3 years and 27 500 ha / year in the last 5 years [**];

- Planting 200,000 ha of NTFPs at a rate do10.000 ha / year in the first 10 years, 8,000 ha / year for 10 years and 2,000 ha / year for last 10 years [**];

Rehabilitation technology and development of mangrove

- By 2012, restoring and planting 18,858 hectares of mangrove forests within 500 m from the sea base. Bringing the total area of coastal mangrove forest is the country from 209,741 ha to 307,295 ha in 2015 [***];

3.2. Analysis the barriers

Identifying the barriers is similar the process in Energy Chapter (item 1.2). The barrier analyis for the LULUCF sector was presented below.

3.2.1. Indentifying and analyzing the barriers respected to transfer and demonstration of sustainable forest management technologies

a)Economic barriers

+ Lack of capital investment, implementation and supervising plan of sustainable forest management;

+ The particular capital for activities has not been identified;

+ There is few policies to guarantee the participants of stakeholders in managing forest resources;

+ The market conditions and needs for production have not been clear.

[*] Prime Minister (2007), Decision No.18/2007/QD-TTg dated 05 Feb, 2007 on approving development strategy on Vietnam's forestry period 2008-2010

[**] Vietnam's second national communication to the UN-FCCC (MONRE)

[***] Ministry of Agriculture and Rural Development (2008), Recovering and developing mangrove forest project period 2008-2015

b)Environmental barriers

Vietnam is located in tropical climates, complicated terrain with steep slopes so forest is at the risk of fluctuations due to natural disasters often as storms, floods, droughts, forest fires ... Maintaining the protection of forest resources are often faced with many challenges.

For sustainable forest management people should develop an effective system of uniform standards. However, Vietnam's forest environment is very diverse and complex so it becomes a huge barrier for building standards system.

c)Technology barriers

+ Lack of national system to sustainable forest management;

+ The FSC standards for granting credits are difficult to reach.

3.2.2. Indentifying and analyzing the barriers respected to transfer and demonstration of afforestation and reafforestation

a) Economic barriers

Lack of government budget for afforestation.

b)Environmental barriers

- Most of the forest land that is plain has become degraded, poor, arid and difficult to improve;

- The area of unplanned forest land has difficulty in being developed into big artificial forest in large scope.

c)Technology barriers

The scientific results from cross-breeding, choosing new breed and implementing technologies for afforestation, improvement and recovery are limited.

3.2.3. Indentifying and analyzing the barriers respected to transfer and demonstration of recovery mangrove forest

a) Economic barriers

- Lack of government budget;

- The competitive ability of recovery mangrove forest is low.

b)Environmental barriers

- Land and water pollution, erosion coastline are increasingly occurring;

- The deforestation of mangrove forest is being popular at the moment.

c)Technology barriers

- The technologies to plant and recover mangrove forest have not been invested for further research;

- The map and data system designed to manage mangrove forest are few and disorder.

3.2.4. The connection between identified barriers

The connection and compilation general barriers of technologies to minimize overlapping and guarantee the coherent are shown in

Table below:

Table 59 - The barries of identified technologies

Market chain	
	Lack of awareness about the importance of forest in environment protection

	Land planning is unclear and unstable
	The competitive abilty of forestry to other sectors is low
	Forest located in big area
	Require big investment cost
	Lack of pilot model to show off models that adapt to socio-economical and local conditions.
The available environment	
	The investment policies in forestry are not strong enough
	Climate change degrades environment
	Low socio-economic conditions
	Poor infrastructure
The supporting services	
	Limited R&D support
	Lack of standard system, data
	Lack of market information
	Lack of investment capital to support agro-forestry market
	Lack of technologies

3.3. Enabling framework to overcome barriers

The development of the enabling framework for overcoming the barriers for the LULUCF sector is similar with process in the Energy Chapter (item 1.3). The enabling framework for overcoming barriers for each technology in the LULUCF sector is presented as follows:

3.3.1. Measures designed to overcome barriers in sustainable forest management technologies

3.3.1.1. Identifying measures to support creating specialist network to develop and transfer technologies

Measure 1: To establish National Working Group of sustainable forest management

3.3.1.2. Identifying actions to improve policies and implementation measures for development and transfer technology

Measure 1: To develop the legal framework;

Measure 2: To develop a national system standard on sustainable forest management.

3.3.1.3. Identifying measures to reinforce the operation of institutions and organizations.

Measure 1: To balance among economic, environmental and social objectives.

3.3.1.4. Identifying measures to boost the market, system of support and other financial services through quality insurance, the availability of consulting services, market information and financial services

Measure 1: Preferential loans for the forestry businessmen

3.3.1.5. Identifying measures to support training skills and education for the development and transfer of technology

Measure 1: To enhance the training for staffs

3.3.1.6. Identifying measures to create favorable conditions for international cooperation and agreements on intellectual property rights (IPR), especially when there is more than one cooperation model for RD & D.

Measure 1: International cooperation in research and technology transfer

3.3.2. Identified measures for overcoming the technological barriers for Afforestation technology

3.3.2.1. Identifying measures that support network establishment for experts related to development and transfer technology

Measure 1. Establishment of associations of forestry businessmen;

Measures 2. Building and developing a network of research institutes and research centers.

3.3.2.2. Identifying actions to improve policies and measures for development and transfer technology

Measure 1. To finish processes, technical rules of planting, enrichment planting, forest exploitation and use;

Measures 2. To test, evaluate, assess and innovate policy;

3.3.2.3. Identifying measures to reinforce the operation of institutions and institutional arrangements.

Measure 1. To improve management capacity;

3.3.2.4. Identifying measures to boost the market, system of support and other financial services through quality insurance, the availability of consulting services, market information and financial services

Measure 1. To promote the demonstrate forest model that has FSC certified

Measures 2. To increase budget investment, innovation methods appropriate investment;

3.3.2.5. Identifying measures to support education and skills training for the development and transfer technology

Measure 1. Cooperation with partner countries to implement programs in forestry research.

3.3.2.6. Identifying measures to create favorable conditions for international cooperation and agreements on intellectual property rights, especially when there is more than one cooperation model for RD & D.

Measure 1. International Cooperation for mutual understanding and enlist the support of the international community.

3.3.3. The solution may be to overcome the barriers to technology Restore mangroves forest

3.3.3.1. Identifying measures that support network establishment for experts related to development and transfer technology

Measure 1: To develop information systems to the relevant object;

3.3.3.2. Identifying actions to improve policies and implementation measures for development and transfer technology

Measure 1: To formulate the regulation characteristics of management, rehabilitation and development system of coastal mangroves;

Measure 2: To socialize exploitation of the right to use mangrove forests

3.3.3.3. Identifying measures to reinforce the operation of institutions and institutional arrangements.

Measure 1: To demonstrate of successful models of mangroves forest

Measure 2: To develop a plan of system of mangroves forest nationwide

3.3.3.4. Identifying measures to boost the market, system of support and other financial services through quality insurance, the availability of consulting services, market information and financial services

Measure 1: To develop financial policies and preferential credits in the application of technology

3.3.3.5. Identifying measures to support training skills and education for the development and transfer of technology

Measure 1: To build scientific and technological capacity

3.3.2.6. Identifying measures to create favorable conditions for international cooperation and agreements on intellectual property rights, especially when there is more than one cooperation model for RD & D

Measure 1. International Cooperation for mutual understanding and enlist the support of the international community.

3.3.4. Recommendations for measures in LULUCF sector

1. To continue to strengthen propaganda and education work to raise awareness of the people, especially in the forest planning area and about the protection and forest development;

2. To quickly complete the planning and development of forest protection to serve as a basis for the construction of investment projects in order to protect and develop forests for later;

3. To modify the land allocation policy and mechanisms suitable to attract the investors in the forestry sector to ensure the interests of participants in planting and protecting forests;

4. To research and apply of scientific and technical progress in the stage of forest seeds, forest tending to contribute to improving productivity, quality and efficiency of forest trees;

5. To build a model of production such as effectively agro-fishery, agro-forestry model for the people to learn and demonstrate;

6. To develop special policies on investment in production of forestry towards sustainable production;

7. To increase investment budget for reforestation, forest management and forestry research;

8. To renew the national afforestation yards and rearrange activities of state entities which do the business;

9. To strengthen the legal work in the forestry sector, and strictly handle of the violation;

10. To enhance international integration and seriously implement international commitments on the environment.

3.4. Technology Action Plan, the project ideas and other issues in the field of forestry and land-use change

3.4.1. Sustainable forest management technology

3.4.1.1 Action plan for sustainable forest management technology

The list of measures to promote the development and transfer technology have been compiled into the overall Table .

a) Synthesis and rationalization measures have determined to promote technology

Table 60 - Gathering measures for building Strategy

Strategic measures	Innovation	Deployment	Demonstration
Network establishment of experts			
To set up a National Working Group (NWG) on sustainable forest	X	X	X

management			
Policies and measures			
To develop the legal framework	X	X	X
Develop national standards system on sustainable forest management	X	X	X
Change behavior / organization			
Balancing among economic, environmental and social objectives	X	X	X
Actions to support markets			
Preferential loans for forestry businessmen	X	X	X
Training skills and education			
To enhance the training for staffs	X	XX	XX
International cooperation and intellectual property			
International cooperation in research and transfer technology	X	XX	XX

* Note: The indicated symbols are similar to Table .

b) Prioritizing and characterization of the measures to promote technology

Prioritized measures are described in Table below.

Table 61 - Preferences and the characteristics of the measures to promote sustainable forest management technology

Sector: LULUCF							
Specific Technology and category: Sustainable forest management/Short-term, large scale							
Innovation stage: Deployment – Diffusion							
Measure (grouped under core elements)	**Prio-rity**	**Why is it important?**	**Who should do it?**	**How should they do it?**	**Time-scale**	**Monitoring, reporting and verification for measure**	**Estimated costs (1,000 USD)**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Network establishment of experts							
To set up a National Working Group (NWG) on sustainable forest management	1	- Raising awareness for the state, forest owners and communities about sustainable forest management and forest certification - Support forest owners and communities to implement sustainable forest management and forest certification	DOF	- To establish a national network of Vietnam, Association of Science and Technology in Forestry following FSC model through demo tests of subject by forest owners	1 year	MARD	30
Policies and measures							
To develop the legal framework	1	- To serve as basis for national forest setting and set up landmarks - To serve as basis for construction of sustainable forest management model	MARD	- To review, the current legal documents; - To construct and issue regulations that are still lack.	5 years	DOF	225

Develop national standards system on sustainable forest management	1	To serve as basis for verification of sustainable forest management	MARD	- Research, reference to international experience; - Workshop consultation with stakeholders; - Develop and promulgate a system of national standards.	5 years	DOF	75
Change behavior / organization							
Balancing among economic, environmental and social objectives		To ensure management and sustainable use of forest	MONRE, MARD	To determine the value of forest to the social's components, for integration into the planning development and management.	Annu-ally	MARD	110
Actions to support markets							
Preferential loans for forestry businessmen	2	Create capital, to encourage the development and application of technology.	Central bank, MARD	Develop policies through Agribank.	2 years	MOF	10
Training skills and education							
To enhance the training for staffs	1	Prepare the necessary human resources to receive technology transfer	MARD	-Survey, planning and training. -Open training and retraining.	5 years	MOET	150
International cooperation and intellectual property							
International cooperation in research and transfer technology	1	Facilitate capacity building, human resource training, and improving technology transfer.	MARD, MOFA	Survey the needs, then making a plan for technology transfer.	10 years	MARD, MONRE	25

*** Note: (1)** The level of priority is similar to Table .

c) Completion the National Strategy

From the results obtained from the action plans for each prioritized technology in each sub-sector, the description of National Strategy and Action Plan towards development objectives related to Sustainable Forest Management in the periods are described in Table .

Table 62 - National Strategy

(For the transferring and development of technologies aimed at mitigation)

	0 - 5 year	5 - 10 year	10 -15 year
The long-term technology			
Technology for Sustainable Forest Management			
To set up a National Working Group (NWG) on Sustainable Forest Management	X		
To develop the legal framework	X	X	
Develop national standards system on sustainable forest management	X	X	
Balancing among economic, environmental and social objectives	X	X	
Preferential loans for the forestry businessmen	X	X	
To enhance the training for staffs	X	X	
International cooperation in research and transfer technology	X	X	

3.4.1.2. Action Plan for Afforestation technology

a) Synthesizing and rationalization identified measures to promote technology

The list of measures to promote the development and transfer technology have been compiled in Table .

Table 63 - Gathering measures for building Strategy

Strategic measures	Innovation	Deployment	Demonstration
Network establishment			
Establishment of associations of forestry businessmen	X	X	X
Building and developing a network of research institutes and research centers	X	X	X
Policies and measures			
Finishing processes, technical rules of planting, enrichment planting, forest exploitation	X	X	X
Testing, evaluating, assessing and renewing policies	X	X	X
Change behavior / organization			

Improving management capacity	X	X	X
Actions to support market			
Promote the demonstration of reforestation models that have FSC certificate	X	X	X
Increasing budget investment, innovation of appropriate methods	X	X	X
Training skills and education			
Cooperation with partner countries to implement programs in forestry research	X	XX	XX
International cooperation and intellectual property			
International cooperation for mutual understanding and enlist the support of international community	X	XX	XX

* Note: The indicated symbols are similar to Table .

b) Prioritizing and characterization of the measures to promote afforestation technology

Prioritized measures are described in Table below.

Table 64 - Preferences and the characteristics of the measures to promote Afforestation Technology

Sector: LULUCF							
Specific Technology and category: Afforestation and reforestation/Short-term, large scale							
Innovation stage: Deployment – Diffusion							
Measure (grouped under core elements)	**Prio-rity**	**Why is it important?**	**Who should do it?**	**How should they do it?**	**Time-scale**	**Monitoring, reporting and verification for measure**	**Estimated costs (1,000 USD)**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Network establishment of experts							
Establishment of associations of forestry businessmen	2	To promote the role and effects of institutions and units aimed at supporting mutual cooperation in order to develop technology	MARD, MONRE, localities	-To promulgate legal documents for the establishment of societies, associations; -Develop operational regulations.	5 years	MARD	25
Building and developing a network of research institutes and research centers	2	To assist technique for forestry production entities;	MARD	To invest in infrastructure construction, new equipment and additional research facilities, laboratory	5 years	MARD	3,125
Policies and measures							
Finishing processes, technical rules of planting, enrichment planting, forest exploitation	1	To improve quality and economical efficiency of forest	DOF	-To review and assessment, workshops on the issued regulations -To amend and supplement the regulatory process	5 years	DOF	30
Testing, evaluating, assessing	1	-To solve the limitation or arising	DOF	-To organize investigation and seminars	5	DOF	60

and renewing policies		issues / new obstacles -To facilitate technology development		to gain experiences. -Additional editing and improving policies	years		
Change behavior / organization							
Improving management capacity	1	To maximize the potential development of the units and reduce the limitations due to the lack of executive ability.	MARD	-To organize training skills management workshops to exchange management experience and gain experiences. - To develop processes and operational measures;	Annually	MARD	1,100
Actions to support market							
Promote the demonstration of reforestation models that have FSC certificate	2	- To promote the achievements; -To socialize the application of technology.	MARD	To provide training and workshops; technical and legal assistance for people to participate in FSC plantation programs.	Annually	Government	3,750
Increasing budget investment, innovation of appropriate methods		To facilitate and encourage the application of technology.	MPI, MOF, MARD	-Survey the needs and develop a plan; -To amend the existing regulations related to investment.	Annually	Government	180
Training skills and education							
Cooperation with partner countries to implement programs in forestry research	1	- To promote the experience and good results which have been made -To prepare the necessary human resources and strengthen the coordination among the units involved	MARD, DOF, MOT	- To review of experiences - To construction plans for cooperation - To conduct collaborative research programs	5 years	MOET	250

International cooperation and intellectual property							
International cooperation for mutual understanding and enlist the support of international community	2	-To acquire the experience, new planting techniques; -To mobilize international resources to support reforestation.	MARD, MONRE, MOFA	- To organize the survey team, learning experience; -To mobilize international aid for afforestation programs.	5 years	MARD, MONRE	1,000

*** Note: (1)** The level of priority is similar to Table

c) Completion of a national strategy

From the results obtained from the action plans for each prioritized technology in each sub-sector, the description of National Strategy and Action Plan towards development objectives in the periods are described in Table .

Table 65 - National Strategy

(For the transfer and development of technologies aimed at mitigation)

	0-5 years	5-10 years	10-15 years
The long-term technologies			
Afforestation Technology			
Establishment of associations of forestry businessmen	X		
Building and developing a network of research institutes and research centers	X		
Finishing processes, technical rules of planting, enrichment planting, forest exploitation	X	X	
Testing, evaluating, assessing and renewing policies	X	X	
Improving management capacity	X	X	
Promote the demonstration of reforestation models that have FSC certificate.	X	X	
Increasing budget investment, innovation of appropriate methods	X	X	
Cooperation with partner countries to implement programs in forestry research	X	X	
International cooperation for mutual understanding and enlist the support of international community	X	X	

* Note: The indicated symbols are similar to Table .

3.4.2. Mangrove forest recovery technologies

3.4.2.1. Action plan for mangrove forest recovery technologies

The list of all solutions for transfer and demonstration technologies in order to compile National Strategy are summarized in Table .

Table 66 - Compilation technologies for National Strategy

Strategic measures	Innovation	Deployment	Demonstration
Network establishment			
Development of information system related to the objects	X	X	X
Policies and measures			
Building regulations on specific management, rehabilitation and	X	X	X

development system of coastal mangroves forest			
Socializing the right to use and exploitation of mangroves forest	X	X	X
Change behavior / organization			
Demonstration of successful models of mangroves forest	X	X	X
Development of a plan of system of mangroves forest nationwide	X	X	X
Actions to support markets			
Development of financial policies and preferential credits in the application of technology	X	X	X
Training skills and education			
Enhancing scientific and technical capacities	XX	XXX	XXX
International cooperation and intellectual property			
International cooperation for mutual understanding and enlist the support of the international community; implement the international treaties	X	XX	XX

* Note: The indicated symbols are similar to Table .

b) Prioritizing and describing the characteristics of technological measures to promote recovery of mangroves

Prioritized measures for Action Plan is summarized in Table below.

Table 67 - Preferences and the characteristics of the measures to promote technology Restore Technology mangroves

Sector: LULUCF							
Specific Technology and category: Rehabilitation of angrove/Short-term, large scale							
Innovation stage: Deployment – Diffusion							
Measure (grouped under core elements)	**Prio-rity**	**Why is it important?**	**Who should do it?**	**How should they do it?**	**Time-scale**	**Monitoring, reporting and verification for measure**	**Estimated costs (1,000 USD)**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Network creation							
Development of information system related to the objects	2	Information technology is not currently popular and widely disseminated	MARD and locality	To investigate and survey the existing channels of information and building suitable systems	3 years	MARD	150
The policies and measures							
Building regulations on specific management, rehabilitation and development system of coastal mangroves forest	1	There should be separate regulations, suitable to manage and restore mangroves forest	MARD	Survey actual needs; Compiling and promulgating regulations	5 years	DOF	25
Socializing the right to use and exploitation of mangroves forest	1	Increasing economical efficiency of mangroves forest; Strengthening the responsibility of people to protect mangroves forest.	MARD	Preference to develop land allocation to households, determine to withdraw improper uses of land.	3 years	DOF	250

Change behavior / organization							
Demonstration of successful models of mangroves forest	2	Promoting the achievement; Socializing application of technology.	MARD	-To provide training and workshops; - Technical and legal assistance for people to participate in FSC plantation programs.			200
Development of a plan of system of mangroves forest nationwide	1	For management and development of mangroves forest	FIPI	- To investigate and survey in order to create database; -To develop master plans and detailed plans for each area.	Annu ally	MARD	75
Actions to support markets							
Develop financial policies and preferential credits for application of technology	1	To encourage all economic sectors to participate in recovery mangrove forest; Increasing economic efficiency of mangrove forest	MARD, MOF	-To review existing related legal documents. -To construct and apply development of policies for mangrove forest.	Annu-ally	Government	15
Training skills and education							
Enhancing scientific and technical capacities	1	Scientific and technical skills and knowledge to recover mangroves forest of people are limited.	MARD	To organize training on rehabilitation techniques for mangroves forest	5 years	MOET	75
International cooperation and intellectual property							
International cooperation for mutual understanding and enlist the support of the international community	2	-To acquire the experience, new planting techniques; -To mobilize international resources to support reforestation.	MARD MONRE MOFA	-To organize the survey team to gain experience; -To mobilize international support for afforestation programs.	5 years	MARD MONRE	100

*** Note: (1)** The level of priority is similar to Table .

c) Completing national strategy

From the results of planning action plan for each prioritized technologies and (sub) sector, the National Strategy and Action Plan to reach development goals in each period involved with mangrove forest recovery technologies are shown in Table

Table 68 - National strategy

(for transferring and developing mitigation technologies)

	0-5 year	5-10 year	10-15 year
Long term technologies			
Mangrove forest recovery technologies			
Building up the information system to all stakeholders	X		
Building up particular Regulation on management, recovery and development mangrove forest	X	X	
Socializing the right to exploit mangrove forest	X	X	
Scaling up successful models of mangrove forest	X	X	
Building up nationwide mangrove forest system	X	X	
Building up special financial and credit policies on applying technologies	X	X	
Enhancing scientific ability	X	X	
International cooperation to mutual understanding and taking advatange of international communities;	X	X	

3.4.2.2. Briefly report of projects that have international support (Annex 4)

3.5. Summary

Technology for sustainable forest management

Aiming at sustainable management of natural forest resources in Vietnam, research should follow main directions as:

- ✓ Researches on how to complete low impact technologies of exploitation; technologies of sustainable use of resources towards promoting timber products, non-material services and non-material products;
- ✓ Changing conception of forestry subjects;
- ✓ Completion of scientific basis and technical system for sustainable forest management;
- ✓ Improvement of criteria system for sustainable forest management and forest certification;
- ✓ Develop an environmental management policy to support the social management capacity, to maximizing the initiative of forest owners as well as monitoring the development of protection forest based on closely regulations.

Afforestation technology:

Afforestation and reforestation are great goals as strategic objectives states. Firstly is the environmental effect: To increase the forest coverage to 45% in order to contribute to strengthen environmental safety by mitigation disasters and conservation of genetic resources and biodiversity; Secondly is the social effect: to create

jobs for workers which helps poverty reduction, stabilizing society and politic, national defense and security; Thirdly is economical effect: to supply raw materials for production, to meet the needs of fuel wood and other forest products, to make forestry become an economic sector. The first objective focuses on improving the system of policy on forest development and improving silviculture.

Technologies on mangrove forest recovery

The basis of Action Plan for Restoration of mangroves is the project "Restoration and development of coastal mangrove forests in the period 2008 -2015" which is depends on survey results, review control plan under Directive 38/2005/CT-TTg of the Prime Minister and research on the situation status management, protection of mangrove forests by MARD, MONRE and local coastal departments to make sure it is scientific and practical. It also has been updated with other forestry development policies from the Government, ministries, branches and localities.

Restoration of mangroves forest is also one of the nation's priorities with an effort to minimize the greenhouse gas, to meet urgent requirements for protection and disaster prevention as confirmed in the "Second National Communication of Vietnam" for UNFCCC.

PART III
Cross-cutting issues for the National TNA and TAPs

Part II, Action plans for mitigation technologies, lists measures to overcome barriers to the deployment and diffusion of adaptation technologies. Some measures are common across several technologies. For example, a measure not only supports the development of these technologies but also helps to overcome barriers to other technologies. Such measures bear similarities and advantages for the development of the technologies.

In contrast, the implementation of this measure could prevent the implementation of others. For example, an action to implement a technology development may not be necessarily important to that technology itself, but is essential to other technologies. Similarly, a number of actions to address barriers can have negative implications for the transfer and deployment of other technologies. This should be taken into consideration for review and recommendations in order to prevent the negative impacts of such actions.

The Steering Committee held discussions with core experts and stakeholders in order to point out measures that are similar, common across different technologies or have the potential to barricade other measures.

Analysis of similarity and the possible conflicts between measures are shown below.

3.1. Common measures to overcome barriers in sectors

3.1.1. Energy

Analysis of measures to overcome barriers of energy technologies has shown that there are no measures commonly used across the technologies. Each technology uses different measures to overcome their barriers.

These measures can be considered in terms of possible conflict between them and are looked at in part II.

3.1.2. Agriculture

Analyzing measures to overcome barriers to agriculture technologies show that most of them are similar/common and can be applied to all technologies, as shown in Table .

Table 69 - Common/similar measures to overcome barriers to the development of agricultural technological

Group of measures	Measures to overcome barriers for each technology			Common measures to overcome barriers
	Biogas digester construction	Wet and dry irrigation	Nutrition enhancement for dairy cattle	
Creation of a network		Strengthen the existing agricultural extension network for technology transfer	Strengthen the existing agricultural extension network for technology transfer	Strengthen the existing agricultural extension network for technology transfer
	Review, restructure and provide support for the existing networks			
	Assign a focal point for technology innovation	Assign a focal point for technology innovation	Assign a focal point for technology innovation	Assign a focal point for technology innovation
Policies and Measures	Formulate support policies for research and deployment of the technology	Formulate support policies for research and deployment of the technology	Formulate support policies for research and deployment of the technology	Formulate support policies for research and deployment of the technology

Group of measures	Measures to overcome barriers for each technology			Common measures to overcome barriers
	Biogas digester construction	**Wet and dry irrigation**	**Nutrition enhancement for dairy cattle**	
	Formulate loan incentives and tax waivers		Formulate loan incentives and tax waivers that are suitable to encourage stakeholders to apply the technology	Formulate loan incentives and tax waivers
		Develop support policies for irrigation and drainage works on the field		
	Review and assess existing policies	Review and assess existing policies	Review and assess existing policies	Review and assess existing policies
Organizational/ behavioral change	Build management and operation capacity of agricultural extension agencies	Build management and operation capacity of agricultural extension agencies	Build management and operation capacity of agricultural extension agencies	Build management and operation capacity of agricultural extension agencies
	Provide support for technical experts	Provide financial support for and build capacity of technology experts		Build capacity for technology experts
	Establish rules and regulations for coordination between stakeholders	Establish rules and regulations for coordination between stakeholders	Build capacity for technical experts	Establish rules and regulations for coordination between stakeholders
Market support actions	Provide loan incentives for farmers	Provide loan incentives for farmers	Provide loan incentives for farmers	Provide loan incentives for farmers
Skills training and education	Create funds for research and education	Create funds for research and education	Create funds for research and education	Create funds for research and education
International cooperation and IPR	International cooperation in sharing experience of biogas	International cooperation in sharing experience of rice irrigation	International cooperation through experience cattle feeding sharing	International cooperation in experience sharing

3.1.3. LULUCF

Analysis of measures to overcome barriers of LULUCF technologies has shown that there are no measures commonly applied across the technologies. Measures for technology development can only address barriers to a particular technology.

These measures were considered in terms of possible conflict between them and are looked at in part II.

3.2. Measures that have potential to barricade other measures/ technologies

As analyzed above, most measures in agriculture can help to overcome barriers to all technologies in the sector, thus there are no conflicts between measures. Therefore, measures which may obstruct the implementation of other technologies only exist in two sectors: energy and LULUCF.

3.2.1. Measures that can become barriers to other measures/technologies

3.2.1.1 Energy

Measures to develop energy technologies are summarized in the Table :

Table 70 - Measures to overcome barriers to energy technologies

Group of measure	Measures to overcome barriers to energy technologies			
	Wind power	**Compact fluorescent lamp**	**Bus rapid transit (BRT)**	**Combined heat and power (CHP)**
Creation of network	Create an information network to stakeholders	Increase information sharing on technology application	Create an information network on BRT routes for commuters	Support existing networks of experts; create a uniform coordination mechanism between experts
Policies and Measures	Provide incentives to encourage investment and purchase of wind power Create a market-based pricing system	Provide tax incentives for imports and loan incentives for compact lamp production technologies Formulate standards on lighting quality and lighting testing procedures Create a market-based pricing system	Formulate policies to restrain individual vehicles, provide incentives for investment on building BRT routes Formulate mechanism to mobilize investments and tax incentives.	Create mechanisms to encourage and enforce the application of CHP. Publish technical materials on CHP production
Organizational/behavioral change				Review and create planning Train CHP experts Build management capacity and raise awareness on the benefits of CHP
Market support actions	Make wind maps and locate the appropriate sites Develop financial and production support policies, gradually increase the share of national production of wind power	Raise awareness on economic, social and environmental benefits of compact lamps Provide financial supports for research, innovation and upgrade of lamp production technologies	Develop a public transport system to encourage commuters to use BRTs. Raise awareness on the benefits of BRTs. Create an appropriate fare system	

Group of measure	Measures to overcome barriers to energy technologies			
	Wind power	**Compact fluorescent lamp**	**Bus rapid transit (BRT)**	**Combined heat and power (CHP)**
	Develop legally binding mechanism for local electricity utilities to purchase wind power Develop infrastructure and maitainance services	Develop regulations and control over product labeling		
Skills training and education	Encourage training and education, form a technical team and international experience sharing			International experts/overseas staff training
International cooperation and IPR		Cooperate with major labels to increase quality of national products		International cooperation in research and transfer of CHP

Table demonstrates what measures are potential to obstruct other measures/technologies, as shown in the following table.

Table 71 - Measures and actions can become barriers to other energy technologies

Technology	Measure	Action
Wind power	Formulate financial support policies and incentives for national production, gradually increase the share of national production of wind power	Review current legal documents to form a basis for support mechanisms for wind power projects, create new policies to support the national production of wind power
Compact flourescent lamps	Provide financial support for research, improvement, investment into production technologies	Review current incetives; propose appropriate amendments to exisiting legal documents
BRT	Raise awareness on the benefits of BRTs	Plan and make budget for awareness raising activities Create support mechanisms for awareness raising campaigns
CHP	Create funds for research and training	Assess needs, make plans and budget

Based on measures to overcome barriers to energy technologies in the table above, and based on actions to undertake these measures, it can be seen that the deployment of each technology requires financial support from relevant stakeholders, however:

Developing support policies and incentives for national production and increasing the national production of wind power requires financial support for wind projects and new support policies for national production of wind power equipment. At the same time, measures such as financial support for research, innovation and upgrade of compact fluorescent lamps, raising awareness on the benefits of BRTs and creating funds for research and training for CHP also require financial support. As a result, this may cause difficulties in investment and development of technologies at the same time, leading to delay in the plan of technology development and transfer.

3.2.1.2. LULUCF

Measures to develop technologies in LULUCF are summarized in the Table :

Table 72 - Measures to overcome barriers to LULUCF technologies

Group of measures	Measures to overcome barriers to LULUCF technologies		
	Sustainable forest management	**Aforestation and reforestation**	**Mangrove rehabilitation**
Creation of network	Form a national working group (NWG) for sustainable forest management	Form associations of forest production and trade organizations Create and develop networks of research institutes and centers	Develop an information system for stakeholders
Policies and measures	Develop a legal framework Build national standard systems for sustainable management of forest	Strengthen technical procedures and regulations on development, enrichment and use of forest Review, assess and renew	Develop regulations on management, rehabilitation and development of the coastal mangrove system Enhance community egagement

Group of measures	Measures to overcome barriers to LULUCF technologies		
	Sustainable forest management	Aforestation and reforestation	Mangrove rehabilitation
		policies	n using the technology
Organizational/ behavioral change	Maintain a balance between economic, environmental and social goals	Raise management capacity	Duplicate succes stories on mangrove rehabilitation Make nation-wide mangrove rehabilitation planning
Market support actions	Develop loan incentives for forest developers and traders	Increase the application of FSC-certified forestation models Increase budget and invesment, apply suitable invesment methods	Develop finanaical policies and credit incentives in application of technologies
Skills training and education	Increase capacity building for staff	Cooperation with national partners in forestry research programs	Build scienctific and technological capacity
International cooperation and IPR	International cooperation in technology transfer	International cooperation for experience sharing and utilize international support	International cooperation for experience sharing and utilize international support

Based on the table for measures to overcome barriers to each technology and actions to carry out these measures, it can be seen that measures of each technology of LULUCF do not have any conflict which may lead to prevention of development and transfer of other technologies.

3.2.2. Measures to reduce negative impacts on other measures/technologies

According to the analysis above, the measures to develop this technology negatively affect the development of other technologies that only involves financial matters. To carry out all the technologies at the same time requires large finance, while the state budget is limited. It is difficult to meet the financial needs for all other sectors in general and technological development respond to climate change in particular.

Thus, the requirement is to provide measures to support policy development based on the priority level for each measure of each technology in each sector.

Those measures that have the level 1 priority will be first implementation than those have priority level 2 and 3.

Table 73 - Table shows level of priority of the measures has the potential financial conflict in energy

Sectors	Technology	Measure	Level of priority	Implementation time	Implementation phase
	Wind power	Formulate financial support policies and incentives for domestic production, gradually increase the national production	1	2012-2015	0-5 years

Sectors	Technology	Measure	Level of priority	Implementation time	Implementation phase
Energy	Compact fluorescent lamps	Provide financial support for research, innovation and investments to upgrade production technologies	1	2012-2015	0-5 years
	BRT	Raise awareness on benefits of BRTs	1	2012-2015	0-5 years
	CHP	Create funds to support research and training	2	In 5 years	0-5 years

According to Table , measures that have potential for financial conflicts of wind power, compact fluorescent lamps and BRTs all have level 1 priority and will be carried out from 2012-2015, while measures that have potential for financial conflicts of CHP have level 2 priority and will be carried out in 5 years. Thus, measures for development of wind power, compact fluorescent lamps and BRTs will be prioritized over those of CHP.

However, wind power, compact fluorescent lamps and BRTs will be carried out at the same time, over a period of time at the same level of priority, which will create difficulties in developing them. In this case, mobilizing financial resources will be very important, as it will supplement the finance to the deficit in state budget when developing these three technologies at the same time.

In addition, according to technology needs assessment by experts in part I: "Technology Needs Assessment for Mitigation Report", the order of priority for energy technologies is as follows:

1. Wind power
2. Compact fluorescent lamps
3. Bus rapid transit
4. Combined heat and power

If there is not enough budget for technology investment despite mobilizing all financial resources, technologies with higher priority level must be prioritized.

Besides considering the above-mentioned priorities there is need to make a number of measures to reconcile the budget such as:

- To estimate total capital investment;

- To prepare detailed investment plans for each sector and each technology;

- To balance investments in order not to affect the investment fund for technology in each area and in the fields together;

- To call for financial resources from outside. /.

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ANNEXES

Annex I. Technology Factsheets

I. Prioritized sector: Energy

I.1 Combined cycle thermal power

Technology status

Vietnam: in operation
World: widely used, transferable

Socio-economic benefits

- High-efficiency, fuel saving, and reducing costs.
- Highly automatic, labor saving.

Environmental benefits:

35-40% of GHG emissions reduced compared to coal-fired thermal power, usually 420-430gr CO2/kWh.

Application potential

Vietnam's high natural gas reserves make this technology viable and capable of increasing power plant efficiency by 50-60%.

Barriers

Gas resources must be shared with other sectors.

I.2 Large-Scale Heat and Power (Cogeneration)

Technology status

Vietnam: already operated on a small scale; capacity: 1-10MW; frequently used in sugar and paper production; highly efficient.
World: used on a large scale in many countries; capacity of up to several hundred MW; commercially viable; stable operation; transferable.

Scio-economic benefits

- Not more capital-intensive than conventional thermal power.
- Efficiency: 60-65%, reducing electricity and heat prices.

Environmental benefits

- Higher efficiency than conventional technology by 15-20%.
- Reducing fuel loss and carbon dioxide emissions by 15%, equivalent to 100grCO2/kWh, compared to conventional coal-fired thermal power.

Application potential

According to planning, Vietnam will be applying this technology to large-scale manufacturing facilities.

Barriers

- Robust industrial planning required

Higher awareness and understanding on centralized production and integrated energy use concepts

I.3 Wind energy

Technology status

The first Vietnam's wind power plant, which has a total capacity of 120 MW, is under construction in Tuy Phong (Binh Thuan province). This project is invested by Vietnam Renewable Energy JSC (REVN). Phase 1 of the project was completed with twenty 1.5 MW wind turbines installed, which are now in operation and contributing electricity to the national grids. In Phase 2, the two remaining 90 MW turbines will be installed by 2012.

Additionally, about 20 wind energy projects, with capacities ranging from 6 MW to 150 MW, are undergoing feasibility study, investment preparation or implementation plan development.

Socio-economic benefits

- Adding a new source of power to serve the societal and economic needs, especially in areas that are far away from the grids, isolate islands; creating more jobs and enhancing quality of life
- Reducing fossil fuel, particularly oil, consumption
- Helping to ensure energy security.

Application potential

In the renewable energy strategy and master plan by 2015 and 2025, proposed by the Ministry of Industry and Trade to the GoV, strategic goals of 689 MW (basic level) and 1870 MW (advanced level) of wind power will be achieved by 2025.

Environmental and GHG emission reduction benefits

Approximately, each MW of wind power emits 2000 tonnes of CO2 less than coal-fired thermal power
Vietnam's wind energy potential is high, with a possible capacity up to 1000-2200 MW. Producing 1280 MW of wind energy can reduce 28.4 million tonnes of CO2 compared to producing 400 MW of coal-fired thermal power.

Barriers

- Requiring large spaces.
- Low capacity factor (20-30%) due to fluctuating wind resource over time (season, month or even day), leading to increased capital costs and longer payback time.
- Higher capital and production costs than other conventionally generated energies. As a result, it is harder for wind generating companies to make a contract on wind power purchase with local electricity utilities without governmental support.
- Lack of supporting policy.

I.4 Small-scale hydropower

Technology status

There are 400 small-scale hydropower stations across Vietnam, with nameplate capacity ranging from 5 kW to 30 MW, accumulating a total of 1000 MW (2009). In addition, thousands of super small-scale stations on rivers and streams, with capacity ranging from 0.2 to 5 kW, have been or are going to come into operation to dispatch electric power to households in remote areas.
Small-scale hydropower technology are very developed and commercialized in Vietnam. Nonetheless, this kind of power generation has a number of technical limitations; for example, the turbine water column needs to be lower, operation and maintenance (O&M) costs are high, or lack of maintenance services after project completion, etc.

Socio-economic benefits

Developing small-scale hydropower in rural and remote areas where hydropower potential is high and electric dispatch from the national grid is not viable can produce social and economic benefits by:

- Providing jobs through construction and operation of the hydropower plant to local population.
- Promoting and creating new economic activities, providing job opportunities and enhancing income in areas that are supplied with electricity.
- Facilitating irrigation and drainage, improving productivity and enhancing product quality.
- Improving quality of health service, education and freshwater supply in the area.
- Reducing fossil fuel and oil import expenditure.

Environmental benefits

- Small-scale hydropower produces no carbon dioxide during operation, thus significantly contributing to GHG emission reduction efforts.

- In contrast to large-scale hydropower plants, small-scale plants barely alter the river flow, hence it has few effects on the environment.

Application potential

Research by the Power Engineering Consulting JSC 1 (PECC1) shows that hydropower potential in Vietnam varies widely. A 5-30 MW hydropower plant can produce 3000 MW, mostly in northern mountainous provinces, central Vietnam or on Central Highlands.

GHG emission reduction potential

Vietnam has the potential to produce about 2000 MW of electricity by small-scale hydropower instead of 1200 MW of coal-fired thermal power, therefore reducing 120 million tonnes of CO_2.

Barriers

Despite high small-scale hydropower potential, Vietnam still has to face many difficulties in developing this kind of energy, including:

- Operating time varying seasonally; in the dry season, several plants can only operate for a few hours a day.
- Many small-scale plants lack budget for management, repairing and operation, risking termination of operation.
- The majority of equipment is low-quality, made in China or domestically produced, while repairs and maintenance services are beyond local technical capacity.

  Electric power transmission costs are high, especially in remote areas.

I. 5 Pumped-storage hydroelectricity

Technology status

Vietnam: under feasibility study
World: popular in some countries, operating stably and efficiently.

Socio-economic benefits

- Regulating and saving water resources
- Providing more electricity during peak demand periods, generating high revenue and socio-economic benefits.

Environmental benefits

Utilizing water and other renewable energies effectively, reducing the fossil fuel consumption and, in the end, GHG emissions.

Application potential

- Vietnam has a high hydroelectricity potential, with conventional hydropower accounting for 35% of the total generating capacity.
- Regulating and using water resources effectively to meet the peak demand is imperative. According to the electric power planning, Vietnam is still capable of building another 10 hydropower plants in the North and Central Vietnam, with total generating capacity of 10,000 MW.

Barriers

Still under debate on location and scale.

I.6 Energy-saving compact fluorescent lamps

Technology status

CFLs are called energy-saving lights because they use less energy than conventional incandescent light bulbs. A CFL's power ranges from 20 to 25 W, giving the same amount of visible light as an incandescent light bulb with power of 100 W. Moreover, CFL lifetime lasts 8000 hours, compared to 1000-2000 hours of a normal incandescent bulb.

Since 2005, EVN has carried out a program to replace incandescent light bulbs to CFLs at a reasonable cost through the EVN distribution network of local electricity utilities. A million CFLs were sold to local people at a subsidized price during 2005-2006, alongside many other awareness raising activities. In 2007-2010, EVN resumed the program, setting a goal of 5 million CFLs sold.

Economic benefits

The price of a CFL is more expensive than that of a incandescent light bulb, but this will be compensated by the longer lifetime of and the amount of energy saved by the CFL. The purchase price can be returned after 900 hours in use, and the electricity cost saved is 10-20 times more than the cost for buying a CFL. In times when electricity costs increase, using CFLs will save more money and thus the payback period is even shorter.
Using CFLs can contribute greatly to reducing electric power consumption, resulting in more investments on increasing generating capacity.

Social benefits

Using CFLs can reduce household electricity costs thanks to lower electricity usage and subsequently less demand to the national grid. In addition, they can create more jobs and increase income through the production, distribution and retail system.

Environmental benefits – GHG emission reduction benefits

Electric lighting is one of the major sources of carbon dioxide. According to the International Energy Agency (IEA), an CFL can help to reduce 0.5 tonnes of CO_2 during its lifespan (2006).
Vietnam's population is projected to be 104 million in 2030, equivalent to 23 million households. If each household uses four light bulbs, 90 million incandescent light bulbs can be replaced by CFLs in Vietnam by 2030, reducing 70 million tonnes of CO_2.

Application potential

It is estimated that there are 50 million incandescent light bulbs currently in use for household lighting, the majority (about 80%) of which are 60W, 75W and 100W types. Therefore, potential to apply CFLs to household electricity usage is very high.

Barriers

Despite its many social, economic and environmental benefits, CFLs still have a number of disadvantages; for instance, there are no international standards on minimum quality and technical properties of a CFL. Therefore, quality and light visibility of CFLs is still under evaluation.

Due to low, instable voltages, CFLs' actual lifetime is usually lower than its nameplate lifetime, which may affect its commercial viability.

I.7 Solar water heaters

Technology status

In solar water heating technology, a set of solar panels are used to collect energy to heat water before the heated water is circulated into a tank. Large-capacity tanks can be used to store hot water during the night or when there is no sunlight.
This technology is developed and used globally.
In Vietnam, thousands of solar water heaters have been installed for household usage and this technology is useful for water heating for recreation, such as in hotels, motels, etc..

Economic benefits

Solar water heaters have a significant role in reducing heating energy consumption in public and residential sectors. Most of energy consumed for heating is during peak time (18:00-20:00). Therefore, water solar heaters can help to reduce the pressure on electric power generation.
This technology has a good prospect, and will have a help to cut costs on fuel importing. As a result, the money saved can be averted to other socio-economic needs.

Social benefits

Solar water heaters are widely used by communities because it is an environmentally friendly technology and user-friendly because it can easily be installed on the rooftop.

In terms of social benefits, this technology can contribute to the sustainable development, as it is simple enough for local people to carry out with a little training. As a result, it can help provide work, enhance life quality and reduce energy costs and reliance on fossil fuel imports and impacts of oil price fluctuation.

Environmental benefits

Solar water heating can reduce fossil fuel consumption and subsequently GHG emissions.
If 50-65% of households, equivalent to 125 million households, use solar water heaters by 2030, the emission reduction potential can reach 10,039 million tonnes of CO_2.

Application potential

Vietnam has an enormous solar energy source. At the present, solar energy can be extracted to heat water in place of electric heaters in urban areas and providing electric power to areas without access to the national grid.
Household income, especially in big cities, has increased in many parts of the country, and hot water has become a basic necessity. Many families want to include solar water heaters to their house's rooftop and hot water system designs. Moreover, hotels and motels in urban and rural areas also use electric water heaters to supply hot water to customers. All of these create a prosperous market future for solar water heaters.

Barriers

- Solar energy potential in Vietnam is abundant, but development of this energy is still stagnant because of the following reasons:
- Solar energy is not a stable source, thus unable to meet the demand, especially in the winter.
- Extracting solar energy in areas where solar radiation is low and not stable is expensive.

Lack of a support policy to appeal to investors and users.

I.8 Underground coal gasification

Technology status

Vietnam: still under research
World: successful application in countries like Russia, Germany or China.

Socio-economic benefits

- Ensuring coal (coal gas) supply for electricity generation and large-scale industries, highly beneficial for the economy.
- High technology efficiency will help cutting prices.

Environmental benefits

- Minimizing environmental impacts around mine areas.
- Higher efficiency and lower CO_2 emissions than direct burning of fuels.

Application technology

Vietnam has large reserves of lignite (brown coal) in the Red River Delta, but current conventional extracting technologies are not efficient and badly impact the local environment and communities.
Coal gasification is suitable to the geophysical characteristics of coal mines.

Barriers

- Requiring more experimenting
- Requiring a full technology transferring process

Capital-intensive.

I.9 Compressed Natural Gas (CNG)

Technology status

Cars run by CNG can function as well as petrol cars as they all use spark-ignited engines. Natural gas is compressed in high pressure fuel tanks on the car platform.

The use of CNG in transportation is highly widespread in the world today. At the moment, there are about 10 million cars fueled by CNG and more than 15 thousand CNG supply stations in 75 countries. The four leading countries in CNG use are Pakistan (2.4 million cars), Argentina (1.8 million cars), Iran (1.7 million cars) and Brazil (1.6 million cars).

Social, economic and environmental benefits

Vietnam has a medium potential for natural gas, therefore using CNG in transportation can contribute to maintaining energy security, reducing dependency on oil imports.
In terms of environment, this technology can bring about several benefits; for example, CNG is a clean, low in NO_x and dust emission fuel, so it can enhance urban air quality.
Natural gas emits less CO_2 than other oil-based fuels.

Application potential

Having large natural gas reserves, Vietnam has great advantages in developing CNG technology for transportation. Over the last few years, Vietnam has made some efforts in promoting CNG-run vehicles in industry and public transportation. The first CNG manufacturing factory was founded in Phu My Industrial Compact I (Ba Ria – Vung Tau) in 2008.
CNG use in transportation is being promoted, from two CNG buses in Ho Chi Minh City in 2010 to 28 buses in 2011. In the near future, CNG will be in wider use in industries and public transportation when CNG Nhon Trach factory comes into operation in 2012. According to plan, Hanoi will be the next city to use CNG in transportation.

Application potential

Potential to use CNG in urban transportation is high. Vietnam is expected to have 193,000 buses by 2025, up from 79,000 buses in 2005. If one third, or 60,000, of the buses use CNG, it is estimated to reduce 4 million tonnes of CO_2.

Barriers

- Lack of CNG manufacturing infrastructure on a national scale. CNG stations require much higher capital costs than oil and petrol stations. Furthermore, users only accept to use CNG cars if there are enough CNG stations. In turn, investors insists on waiting for at least sufficient demand or increase in sales of CNG cars before agreeing to invest on the station.

Costs to change into using CNG are high (about US$ 3,000 -4,000 for petrol cars and US$ 20 ,000 for oil-fueled car).

I.10 Bus rapid transit (BRT)

Technology status

In general, BRT can fit into the current urban and transportation systems in developed and developing countries. BRT is competitive and more advantageous than subways or overhead railways, as its capital costs are low, but it requires a separate right-of-way.
Brazil is the first country in the world using BRT back in 1970s, with current volume of 70% of frequent bus commuters.
To date, BRT have proved to adequately meet the market demand. It has been successfully applied in many countries and is a potential technology for world's urban cities.

Social, economic and environmental benefits

BRT contributes significantly to sustainable urban transportation development. It is an more effective transport system than conventional bus transport thanks to its high volume and fast speed, and helps to change public transport behaviors. Moreover, it can contribute to sustainable development by:

- Reducing environmental pollution
- Reducing GHG emissions
- Minimizing traffic congestion
- Securing energy security due to reduction in oil imports
- High-quality transportation system which help to enhance life quality and socio-economic development.

As noted by the World Bank, by using 20 systems of BRT and other supporting measures, Mexico can reduce 2 million tonnes of CO_2 each year.

Application potential

BRT is system of transportation using an own line and transporting in high volume, fast speed. This technology is frequently used in developed countries and can encourage moving from private vehicles to public transport to reduce traffic congestion, air pollution. BRT is suitable to all people.
As traffic congestion has become a serious issue in Hanoi and Ho Chi Minh City, BRT is a feasible measure due to lower capital costs than subway and shorter construction time. Urban planners only have to study and rearrange the transport system in the city, reserve righ-of-way passages for BRT in big streets, build bus stops for BRT. At the moment, Hanoi and Ho Chi Minh City is preparing for piloting BRT in several roads which will be expanded later.

GHG emission reduction potential

Vietnam has a high potential to develop BRT in big cities, especially in Hanoi and Ho Chi Minh City, where traffic jams occur regularly. BRT is already under consideration for implementation.
By 2030, if there are 30 BRT routes in operation, 3 million tonnes of CO_2 can be reduced (according to Mexico example).

Barriers

- High capital costs for building own line for BRT.
- Limited community awareness on BRT and its social, economic and environmental benefits
- Lack of management and planning experience, making it difficult to define BRT routes during the planning phase.

II. Prioritized sector: Agriculture

II.1 Controlled nitrogen fertilizer application

Technology status:

- Creating a formula to determine the necessary amount of fertilizer; applying fertilizer deep into the ground; growing winter crops to absorb residual nitrogen from previous crops

Social, economic and environmental benefits

- Facilitating production diversification a unit of area

- Maintaining soil fertility

- Improving soil physical and biological properties

- Activating effective and beneficial soil microorganisms

- Improving efficiency of fertilizer use

Application potential

- Can be practiced on 3.8 million hectares of rice field

- Can be applied to more than 3 million hectares of other agricultural crops

Barriers

- Excessive nitrogen fertilizer application due to pressure from high productivity demand

- Lack of an appropriate master plan for crops and crop strucuture

II.2 Wet and dry irrigation in certain rice growth stages

Technology status:

- Draining water from the field during two of rice growth stages: maximum tillering and ripening. Reducing methane emission while increasing productivity

- Researched and developed since 1998 in the process of developing low cost GHG emission reduction measures under the project “ALGAS”.

- Developed for 40 hectares of rice in for 4 co-operatives in Dien Ban rural district

Social, economic and environmental benefits

- Saving water and electricity consumption by pumping

- Increasing yeild

Potential

This technology can be applied for about 3 million hectares by 2020 and 5.4 million hectares by 2030.

Barriers

- Drainage system of most rice fields in Vietnam are not completed. This is the biggest barrier in applying this technology, because without a complete system, it is very difficult to use the technology during the rice growth stages

- Farmer understanding of the technology is not sufficient, because they are not used to draining water during rice growth stages.

- Channel systems in many places are not concrete; water leakage is high. This is also an issue of the whole agrcitultural production sytem in general and irrgation and drainage in particular.

II.3 Wet and dry irrigation on rice paddies

Technology status:

- Practicing irrigation on rice fields by using the wet and dry cycle (which lasts about 20-25 days) after tilling. Increasing productivity and reducing methane emissions.

Social, economic and environmental benefits

- Saving water and electricity consumption by pumping

- Increasing yeild

Applicaton potentail

- On constantly wet rice field area (approximately 1 million hectares)

Barriers

- Drainage systems of most rice fields in Vietnam are not completed.

- Farmer understanding of the technology is not sufficient, because they are not used to draining water during rice growth stages.

- Channel systems in many places are not concrete; water leakage is high. This is also an issue of the whole agrcitultural production sytem in general and irrgation and drainage in particular.

II.4 Changing from perennial crops to short-term crops

Technology status

- Growing short-lived (more or less than 100 days), high-yielding, disease- and pest- resistant rice varieties that can survive unfavorable conditions, instead of perennial ones (more than 140 days).

Social, economic and environmental benefits

- Reducing labor for tending, irrigation and applying fertilizer

- Enhancing resilience to extreme weathers (drought, flooding, pest, etc.)

- More time for other crops to grow

- Reducing methane emissions due to shortened wet period.

Application potential

- Can be applied for about 3.8 million hectares of rice nationwide

Barriers

- Not enough research to find a suitable rice variety that is high-yielding and resistant to unfavourable conditions and pests

- Farmers are used to current rice varieties and cultivation practices

- Lack of a master plan for crops and crop strucuture

II.5 Nutrition improvement through controlled fodder supplements

Technology stauts

- Using several fodder additives as feed for cattle under close control (MUB, urea, etc.)

- Feeding cattle (meat and diary) with fodder addtives has been practiced in Vietnam and tends to increase.

Social, economic and environmental benefits

- Providing a well-balanced diet for cattle, improving cattle producitivity, and increasing their appetite and digestion.

- Component of MUB feed: mostly agircultural residues, such as molasses or bran, etc. These materials are cheap and easy to collect for processing and applying and contains sufficient nutrition for cattle

- Processing costs are not high because inputs are not imported but local

Application potential

- By 2020, about 183,000 diary cattle and 2-3 million meat cattle will be fed with MUB; by 2020 the number of diary cattle fed with MUB will increase to 292,000, meat cattle to 4-5 million

Barriers

- Free-range is still a common practice; farmers pay very little attention to intensive farming to increase productivity

- Fragmented livestock raising makes it hard to apply the technology.

- Need for storage for MUB, while building storage for feed is not common.

II.6 Growth hormones for cattle

Technology status

Using growth hormones such as bovine sometotropin (BST) và anobolic steroid to increase meat and diary productivity while decreasing methane emissions per product unit

Social, economic and environmental benefits

- Increasing efficiency in feeding cattle to enhance cattle meat and dairy productivity.

- Reducing methane emissions per product unit.

Application potential

- Provide enough hormones for 10 million of pigs by 2020 and 20 million by 2030

Barriers

- Limited understanding of farmers in using hormones

- Fragmentated, small-scale cattle farming

- Little investment on technology

II.7 Anaerobic manure digestion to produce biogas fuels

Technology stauts

- Addressing environmental pollution due to cattle raising; reducing N_2O emissions; recovering energy to replace burning materials, electricity and gases

- So far, about 140,000 biogas digesters with an average volume of 10 m^3 have been built and active, serving 1 million people and reducing million tonnes of CO_2e

Social, economic and environmental benefits

- Cost for a family biogas digester (6-8 m^3) in 2006 was 5 million VND (according to 51% of surveyed households), using biogas instead of burning fuels and using bigoas residues as fertilizer, each family can save 120,000 VND/month, thus the return period for a biogas digester will be 3.5 years. In addition, biogas residues can be used as food for pig, fish, worm, mushroom growing, etc.

- Effective treatment of cattle and human organic waste

- Toxic waste is well treated by biogas digesters, with COD and BOD_5 more than 90%

- Creating more jobs, especially in rural areas.

Application potential

In rural areas in the North, the formerly Nam Khu 4, South Central Region and the Southern deltas, there will be about 280 thousand digesters by 2020 and 560 thousand digesters by 2030

Barriers

- Limited investment on biogas diesger building; requiring governmental susidies

- Fragmented livestock ranching and lack of concentrated livestock farms make it hard to develop large-scale digester for farms or for electricity purpose.

- Biogas digester technologies are still under development to be applied in different areas.

- Low range of input, most digesters just use cattle waste, not organic plant waste such as hay, grass, etc. Lack of input materials for biogas digesters.

II.8 Crop rotating technologies to avoid soil organic carbon (SOC) loss

Technology stauts

Conservative farming to maintain soil humidity and prevent soil loss. Grow leguminous plants to increase soil nitrogen fixation. Applying appropriate crop rotating techniques to climate and soil conditions.

Social, economic and environmental benefits

- Increasing soil organic carbon

- Retain soil and soil moisture

- Diversigying corp products

Application potential

- Applying this technology to reduce SOC loss on 1 million hectares of annual upland crops (maize, potato, bean, etc.) by 2020 and 2 million hectares by 2030.

Barriers:

- Lack of a master plan for crops and crop strucuture

- Not enough research on crop varieties.

II.9 Covering steep lands with trees to prevent soil erosion and keep soil moisture

Technology stauts

Planting various types of trees in contour rows to retain moisture. Use sediment traps on steep terrain to prevent soil erosion.

Social, economic and environmental benefits

- Preventing soil erosion, ensuring soil porosity and increasing SOC

- Retaining soil and soil moisture

- Diversigying crop products

Application potential

By 2020, plainting trees on steep land to reduce soil eriosion and retain soil mositure for a bout 2 million hectares of steep land in highlands and northern and nothern central mountains. By 2030, on 2 million hectares of steep land in the Central Highland and the Southern Central Region.

Barriers

- Lack of a master plan for crops and crop strucuture

- Not enough research on crop varieties.

II.10 Nutrition improvement through mechanical and chemical fodder processing

Technology stauts

Fodder is processed mechanically (grinding, milling, mixing, etc.) and chemically (fermentation, ensilage micronutrient enrichment, etc.) to accelerate cattle metabolic rates, and thus increase cattle weight per unit of fodder.

Social, economic and environmental benefits

- Increasing cattle digesting efficiency, enhancing cattle productivity on a unit of feed.

- Cutting feed costs and farmer labor

- Promoting concentrated livestock farming

Application potential

Supply mechanically and chemically processed fodder for 5 million cattle, 10 million pigs and 100 million poultry, by 2020; 8 million cattle, 30 million pigs and 150 million poultry by 2030,

Barriers

- Free-range is still a common practice; farmers pay very little attention to intensive farming to increase productivity

- Fragmented livestock raising makes it hard to apply the technology.

- Lack of planning for cattle feeding

II.11 Cattle genetic modification

Technology status

Genetic engineering techniques to create new breeds which grow faster, have better tolerance to diseases and higher feed efficiency

Social, economic and environmental benefits

- Higher digestion efficiency
- Higher resistance to diseases
- Increasing livestock productivity

Application potential

- This technology will be applied first on cow and pig: 70% of the diary cattle and 50% of the pig population b 2020, 50% of milk cow and 60% of pigs by 2030.

Barriers:

- Lack of planning and investment for cattle breeding farm

- Free-range is still a common practice; farmers pay very little attention to intensive farming to increase productivity

- Fragmented livestock raising makes it hard to apply the technology.

III. Prioritized sector: LULUCF

III.1 Sustainable forest management

Technology status:

This technology is related to silvicutural technology such as reforestation, forest fire control, insect and pest control, invasive species prevention, forest degradation and deforestation prevention. Sustainable management of forest is the most important technology in reducing GHG emissions in the world and Vietnam.

Socio-economic-environmental benefits

Economic: Increased income through sustainability-verified timber trading (higher prices by 30%).

Social: more jobs and increased income.

Environmental: sustainable forest use and management.

Application potential

Widely used in Vietnam.

Barriers:

Low modernization level (IT, digital data, etc.), old warning systems, limited financial resources.

III.2 Afforestation and reforestation

Technology status

This has been a popular technology in Vietnam since 1990s. This technology uses conventional forest planting techniques such as plant planning, plant selecting, land preparation, fertilizer application (rarely used), irrigation, protection, etc. and there are other associated technologies, such as creating new species, tissue culture, seeding, etc.

Social – economic – environmental benefits

Economic: High economic efficiency, especially from material plantations.
Social: more job opportunities, increased income
Environmental: covered barren and degraded lands, increased vegetation cover, ensuring local and national ecological security for climate change adaptation.

Application potential

Widely used, high potential in forestry and can be further developed.

Barriers

Low state budget for forestry

Limited access to quality seed for local people

III.3 Rehabilitation and development of mangrove

Technology status:

A special, valuable ecosystem in terms of biodiversity and important to environment protection and socio-economic development, mangroves are facing overexploitation to the point of destruction due to establishment of agricultural areas, residential areas and shrimp farms long the coastline or the river, leading to shrink in mangrove areas. Invasion into mangrove swamps for rice cropland also decreases the amount of sediment deposits on tidal zones, leading to coastal erosion around mangrove areas. Mangrove rehabilitation is being piloted in some provinces such as Hai Phong or Ca Mau and shows some results in protecting sea dykes and bringing economic benefits to local people. Currently there are 606,000 hectares of saline and lands, including 155,290 of mangrove swamps 226,000 hectares of shrimp farms with dykes and ditches in brackish water. In 15 years' time, there will another 50,000 hectares of mangrove swamps.
In terms of technology, rehabilitation of mangrove habitats is simpler than reforestation on land, with a lot of options.

Social – economic – environmental benefits

Economic: benefits from plants and aquaculture products
Social: more jobs and increased income.
Environmental: Mangrove swamps are considered a low-cost, efficient "green dyke" to prevent wave or storm. Apart from adaptation potential, mangroves can help to mitigate GHG emissions due to its carbon storage. Building mangrove swamps along the coast can protect sea dikes, increase sedimentation rates, farm shrimps. Rehabilitating mangroves can occur on degraded shrimp farming areas, etc.

Application potential

Widely used, high potential in forestry and can be further developed.

Barriers

High capital costs in some areas. Protecting mangrove swamps is also one of the biggest challenges of forestry.

III.4 Planting of scattered trees

Technology status

Land for planting scattered trees is not included in forestry planning, but funded by individuals or private organizations. Phase I (2006-2011): 1 billion trees; Phase II (2011-2020): expected to extract and processing from 400 million small timber trees planted in Phase I and planted new 1 billion trees. Technology of scattered tree planting is simple and efficient.

Socio-economic-environmental benefits

Economic: Providing lumber for consumption, utilizing land.
Social: more jobs and increased incomes
Environmental: protecting the environment, protecting agricutlural production from wind effects.

Application potential

Widely used and highly potential.

Barriers:

Limited area for scattered trees.

III.5 Reducing emissions from forest degradation and deforestation (REDD+)

Technology status

Reducing emissions from forest degradation and deforestation in the world is developing rapidly, including conservation, sustainable management, increasing carbon sinks, and biodiversity (REDD+). Participating in REDD+, developing countries should implement projects and policies that prevent deforestation and forest degradation to increase forest carbon stocks; developed countries may not have to reduce GHG emissions, instead they can pay for developing countries for their carbon stocks. This management technique is an important aspect to mitigate global climate change.

Benefits

- Sustainable forest use and management, reducing poverty rates, especially in rural areas.
- Reducing soil degradation, protecting water sources, resisting pests and diseases, creating more jobs and increasing income for people.

Application potential

In short- and medium-term, deforestation and forest degradation is still a challenge. Increasing carbon stocks and reducing deforestation and forest degradation is a cheap method so REDD+ is a priority in tropical countries.

Barriers

- Risks in monitoring and quantifying forest degradation.
- REDD is still experimental.

Annex II. Market maps for Technologies

A proposed method for technology innovators to find barriers and problems is mapping market.

By this method, the group of experts discussed and exchanged information to build up a comprehensive picture of the entire existing system elements related to the development of new technologies and the linker / binding can cross between them. The relevant factors are mainly considered include:

- Environment that allows the introduction of new technologies (such as legal, institutional, organizational,...)
- The relevant object in the system (such as manufacturers, wholesalers, retail dealers, consumers, households producers ...)
- Supporting services (such as finance, quality management, performance, standards, etc ...).

Based on this picture, the Steering Committee and other stakeholders to identify existing problems in the system, from which barriers would be found out for each technology and common barriers to all technologies in the same field of sector. Next, by simple voting groups, implementation groups have pointed out the barriers that need to be addressed prior to deciding which measures short-term, medium term and long term for each field.

The market mapping is only applied for technologies which are classified by consumer and capital goods. In mitigation technologies, there are 3 technologies of consumer goods category as Compact Fluorescent Lamp, Biogas and Combined Heat and Power technology; and there is only one technology of capital goods category as wind power technology.

For Compact Fluorescent Lamp (CFL) technology, the market chain includes application, production; merchant; retailers and consumers. Next, the main factors related to the market chain in the transfer and diffusion process of this new technology are defined, such as prices, effect, benefit, quality standards, capital cost ... About prices factor, it can be easily seen that the merchant, retailers and even consumers are interested in price of the product. If price is high due to large investment costs, it will be difficult for merchant and retailers to consume goods. Consumers have also attention to the price of the product. If the price is too high compared with the benefits it brings, they will think a lot before buying. Therefore, high price can be considered as a barrier during the transfer and diffusion of this technology. Then, we can also offer some solutions to overcome the barrier such as reducing tax, subsidies ... to somewhat reduce products price, popularise new products to consumers. About effective and benefit factor, of course, consumers care about this issue. Besides price problem, they also need to interested in the effect and benefit of products. The products are practical benefits, high efficiency will attract the attention of consumers. And conversely, the benefits it brings not much, low efficiency will certainly lead to a few people have attention to this product. Thus, effect and benefit are also considered as barriers in the transfer and diffusion of CFL technology. And some possible solutions are devised to overcome the barriers such as the research, development, international cooperation ... to improve product quality. Similarly, other barriers are also identified and even sollutions for overcoming the barriers are accompanied.

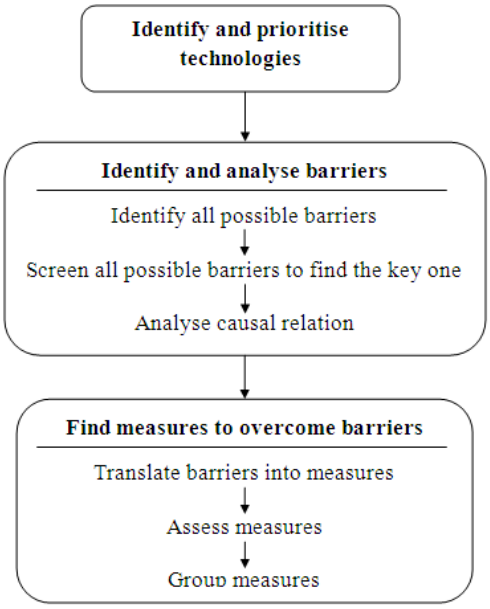
For biogas technology, the market chain includes application, production and household producer. Next, the main factors related to the market chain in the transfer, promotion and diffusion of the technology are also identified as: infrastructure, capital cost, information system, effect, benefit ... About capital cost factor, biogas technology require high investment, operation and maintenance cost of farmers. Thus, capital cost is regarded as a barrier in the transfer and diffusion process of biogas technology. And few possible solutions which are devised to overcome this barrier are to build the policies for preferential loans, tax exemption ... Or about information system factor, how to popularize knowledge to the people, the household producers so that they understand the benefits of biogas technology. It is also considered as a barrier and the solutions for this barrier may be: building information systems, propagation, promotion to people or opening skills training, education class ...

For combined heat and power technology, the market chain includes application, production and plants with self-production capabilities. Next, the main factors related to this market chains are the same as biogas technology. Therefore, the barriers and overcoming solutions are also identified similar.

For wind power technology, the market chain, includes application, production and producers, investors. Next, the main factors related to the market chain are the same as 2 above technologies of capital goods group. Therefore, the barriers and overcoming solutions are also identified similar.

Specific market map for each mitigation technology is presented below respectively. Following that, maps of analysing framework condition for them are shown parallel.

Map of analysing framework condition for consumer goods and capital goods of mitigation technologies which based on two processes: Identifying and analysing barriers process and measures to overcome barriers process is given in the below figure:



Identify and analyse barriers

Based on the analytic barriers in the actions plan for mitigation technologies to find the major barriers. Using causal relation hierarchy based on Logical Problem Analysis (LPA) to find the causes which affects to the main barriers. The purpose of the LPA method is to arrange the cause of barriers to a system. To link causes and barrier together into a tree diagram "causal retations" which shows why technolohy is not optimal. Causal factor tree is described as follows:

Cause → Barrier → Technology not optimal

Find measures to overcome barriers

Having established a thorough understanding of the barriers, the next step is to analye how the barriers can be removed or overcome.

Because of using Logical Problem Analysis in the barrier analysis, so the "causal relations" of the causal factor tree are converted into "measure-result relations" is described as follows:

Measure → Result (overcome barriers) → Technology optimal

However, the measures to overcome barriers in "measure-result relations" diagram must be suitable to solve the causes in the "causal relations" diagram, which lead to a complete system.

Thus, by dint of using the above measures, the process of identifying and analysing barriers came through "causal relations" diagram, and the process of finding measure to overcome barriers came through "measure-result relations" diagram. The flow charts are created for consumer and capital goods of each mitigation technology as below:

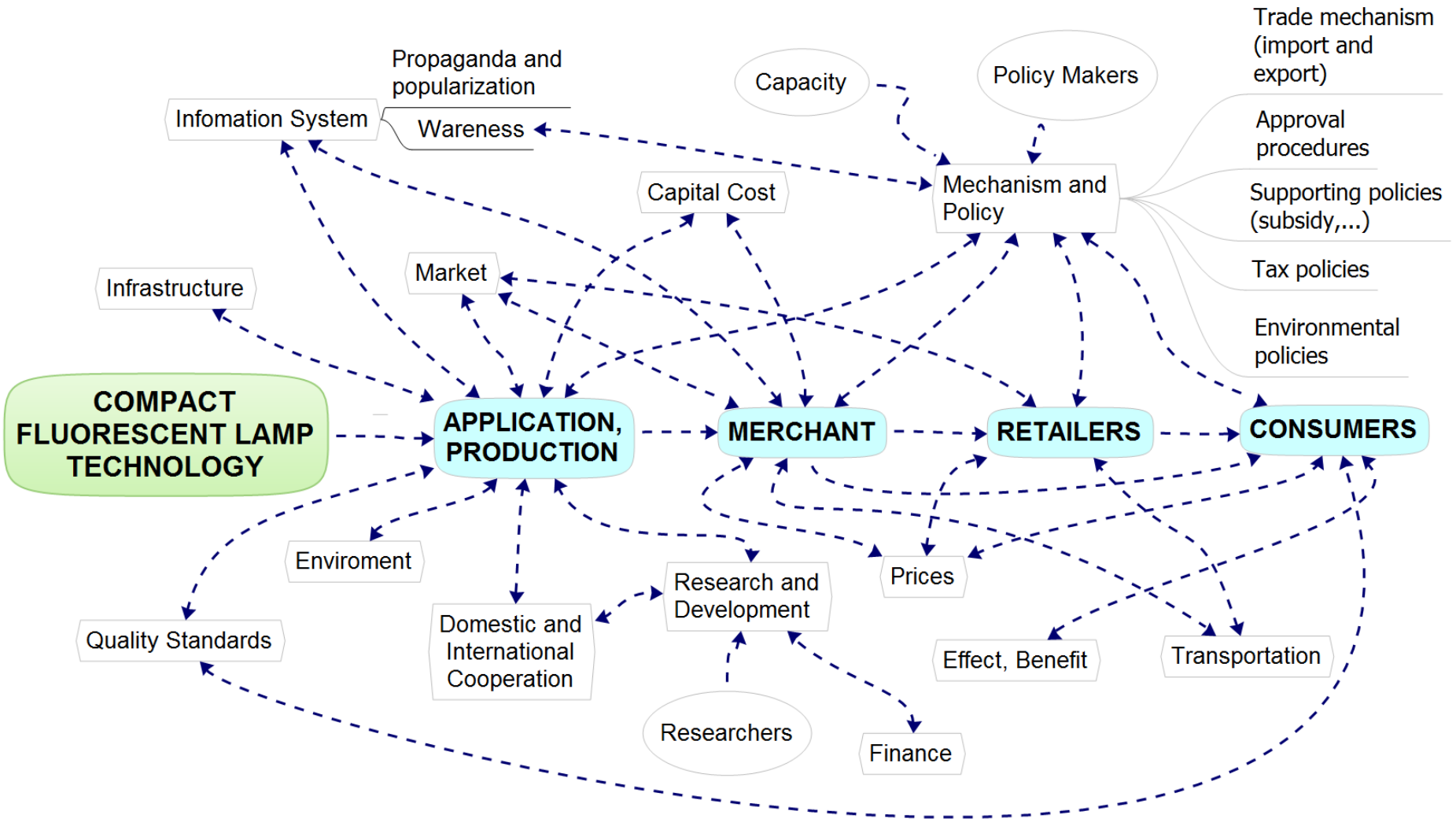


Figure 9 - Market map for Compact Fluorescent Lamp Technology

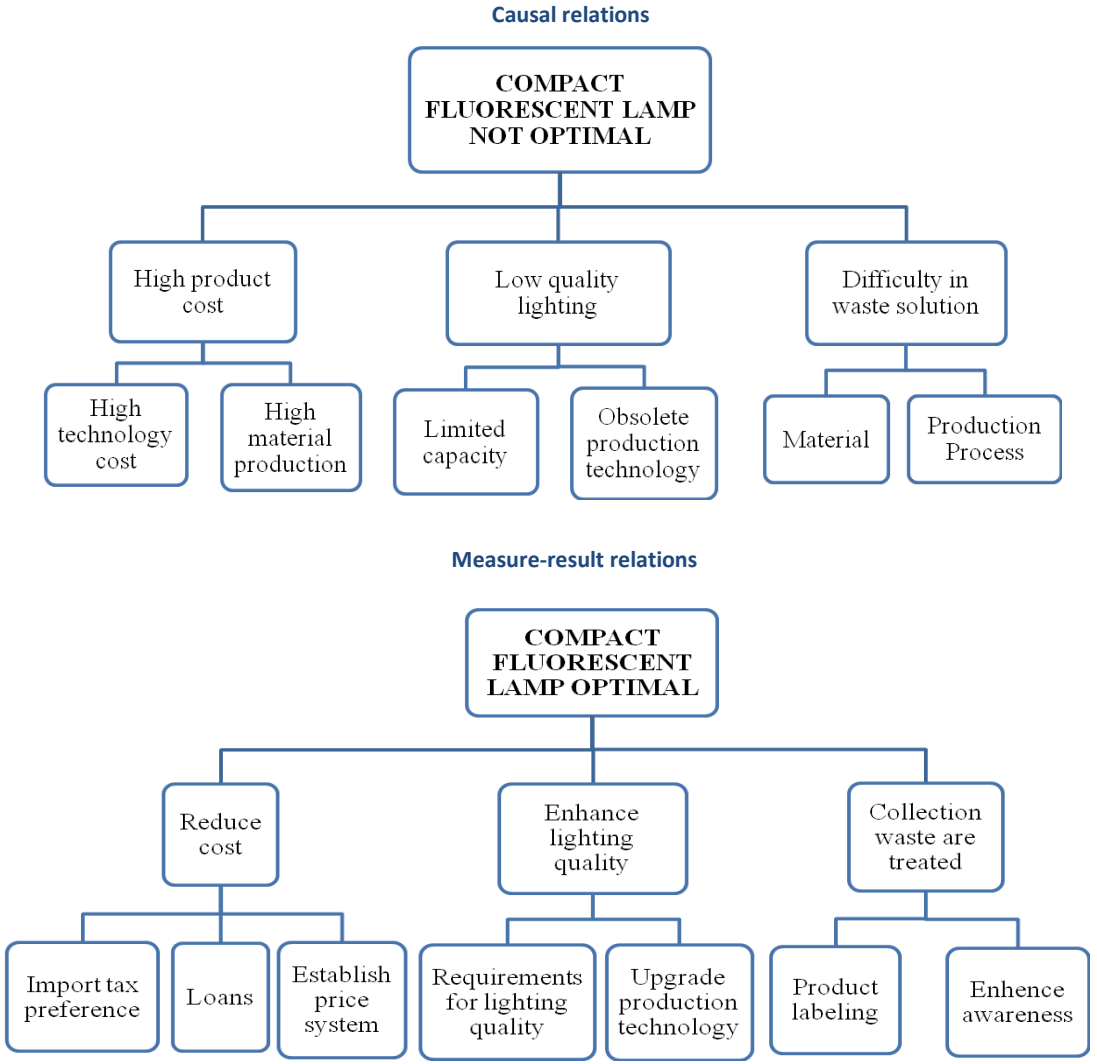


Figure 10 - Map of analysing framework condition for Compact Fluorescent Lamp Technology

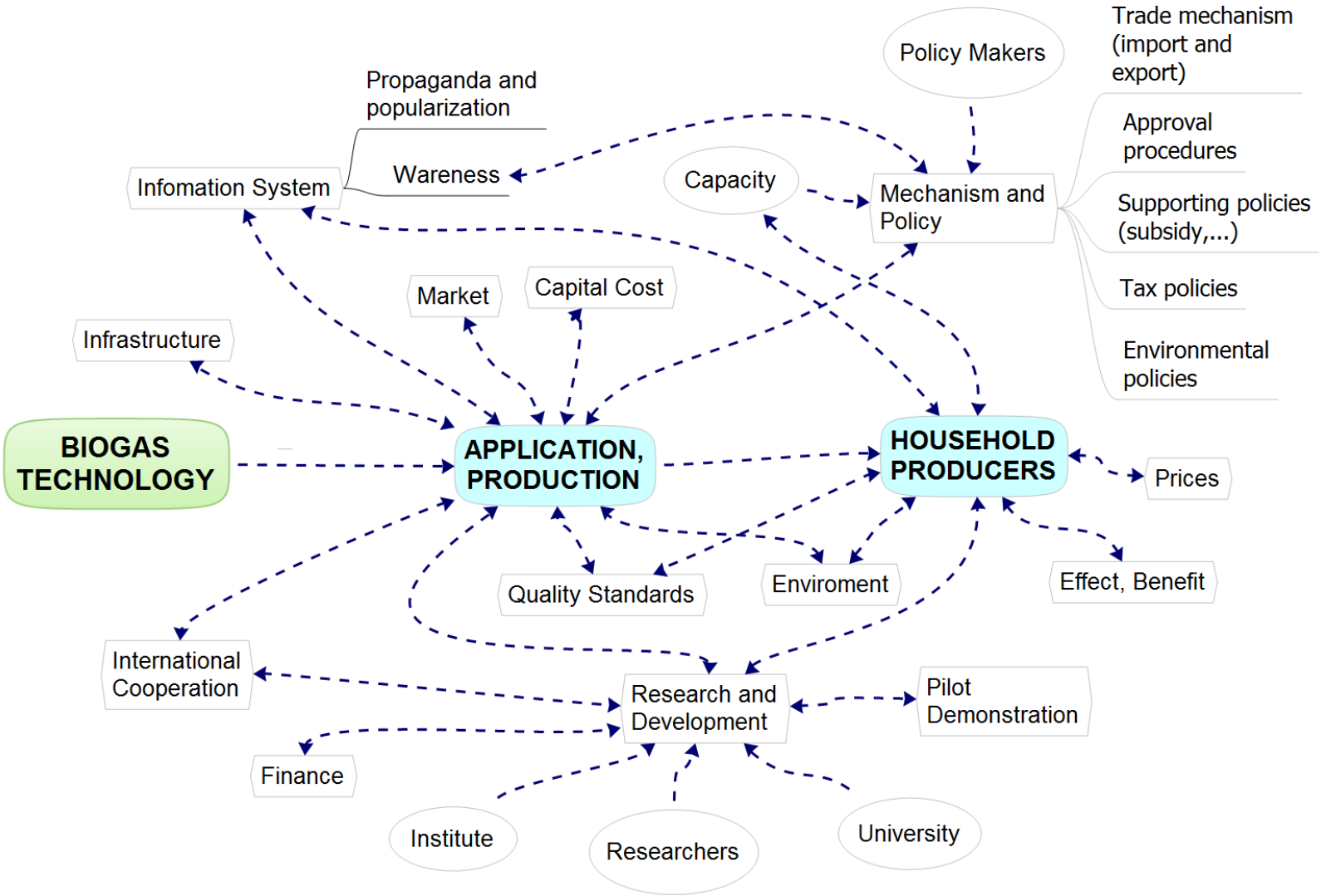


Figure 11 - Market map for Biogas Technology

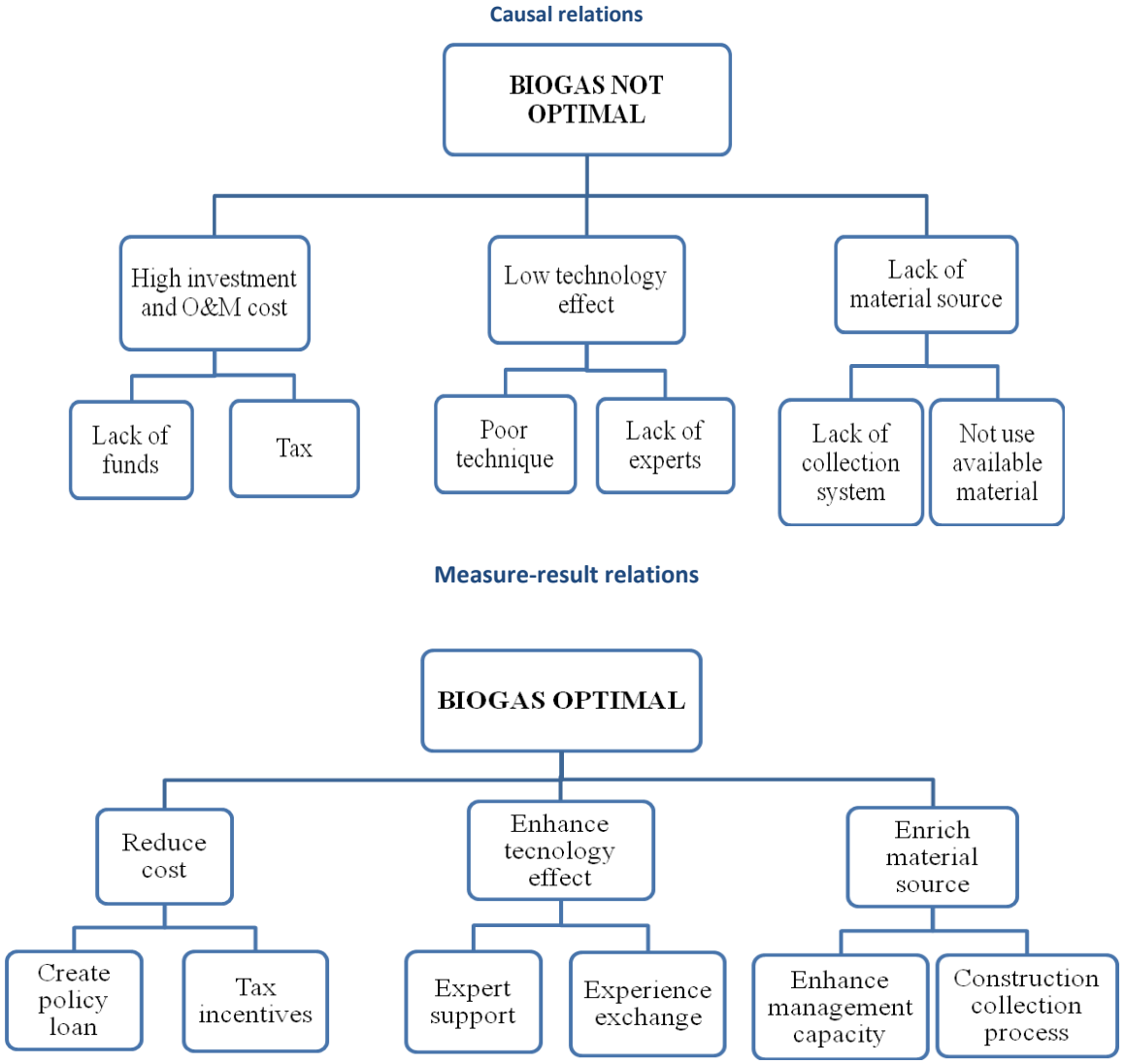


Figure 12 - Map of analysing framework condition for Biogas Technology

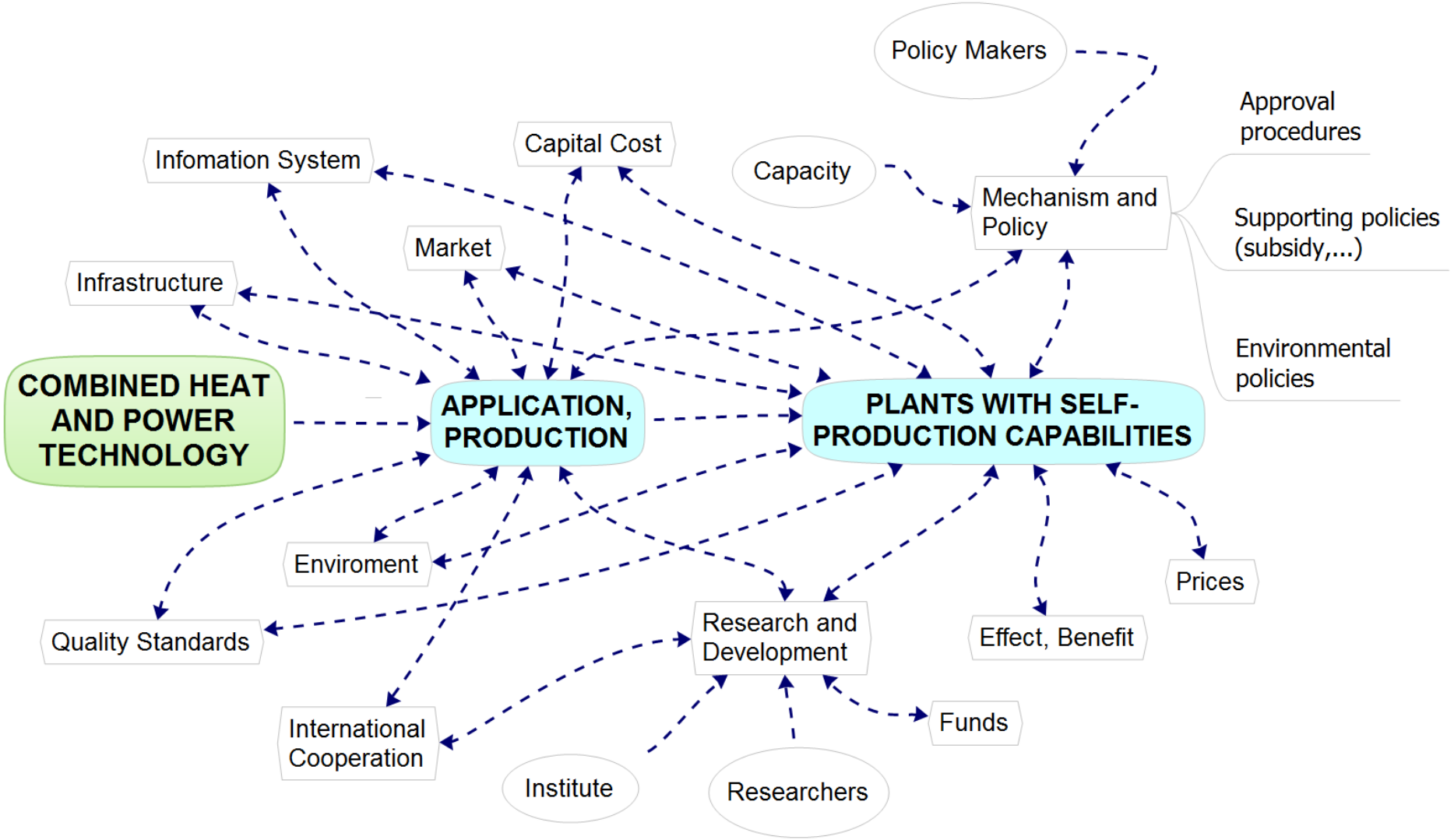


Figure 13 - Market map for Combined Heat and Power Technology

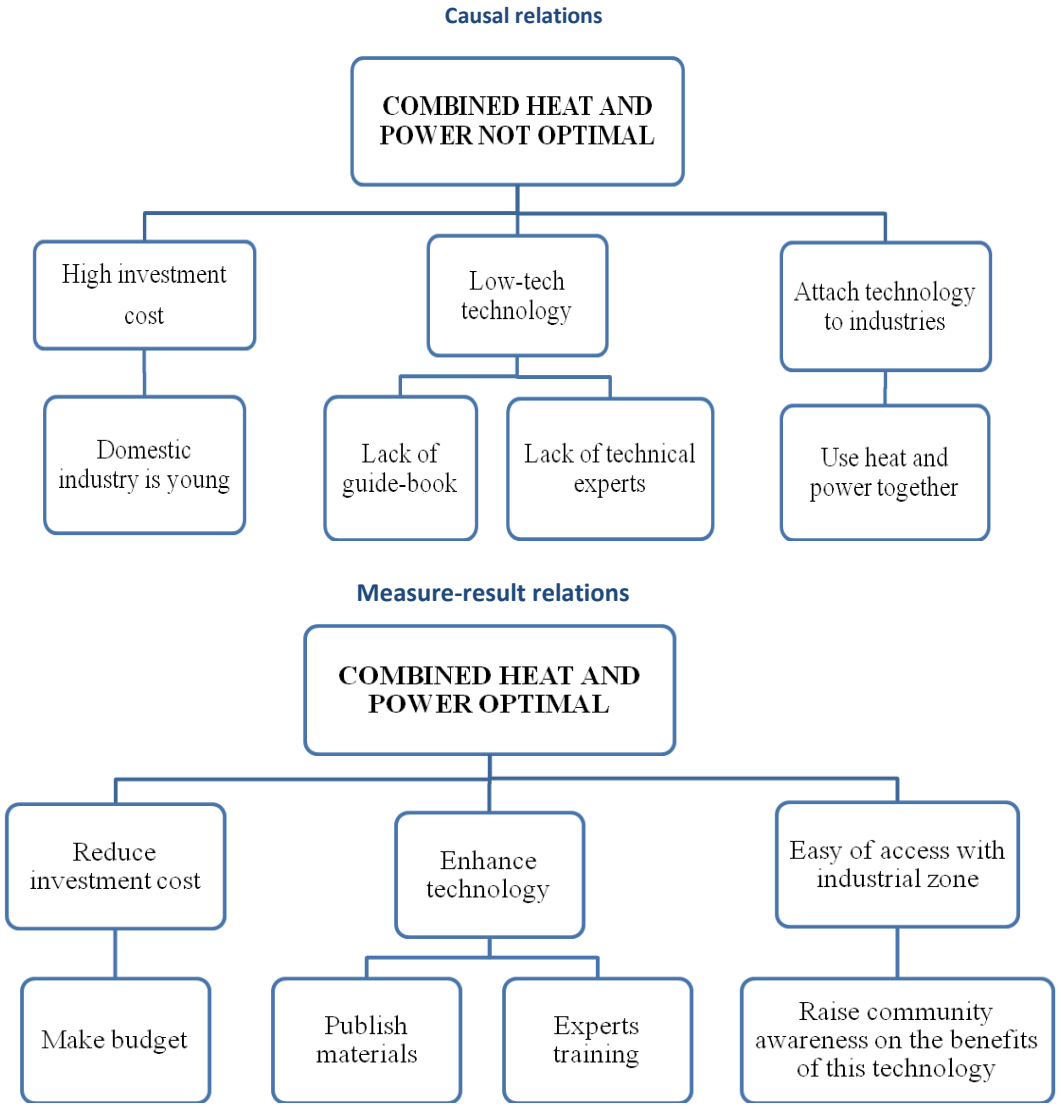


Figure 14 - Map of analysing framework condition for Combined Heat and Power Technology

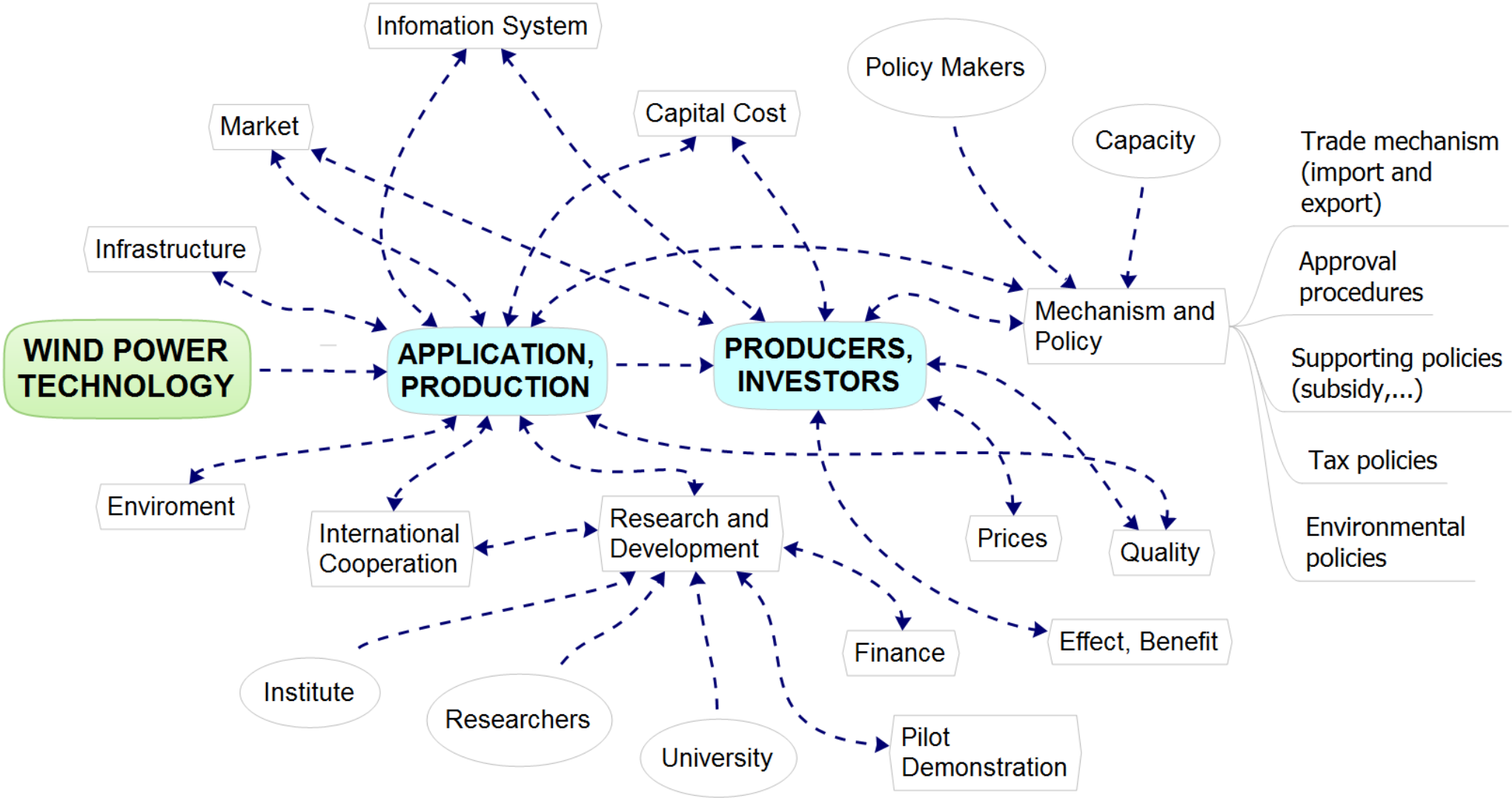
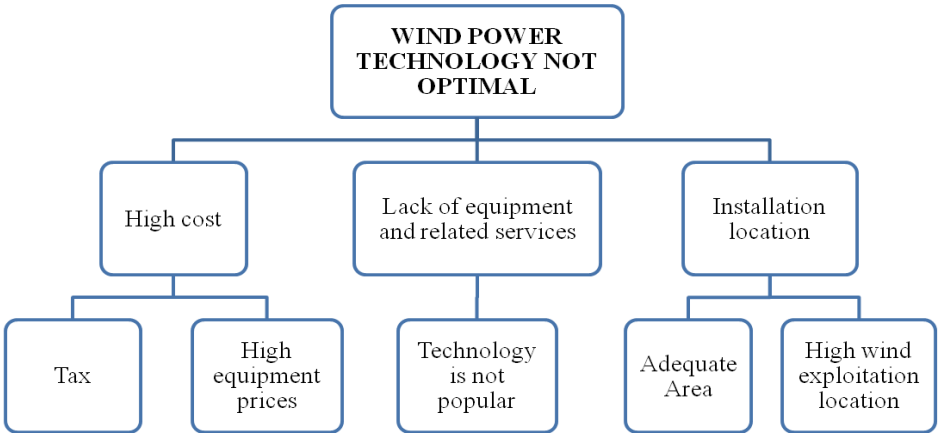


Figure 15 - Market map for Wind Power Technology

Causal relations



Measure-result relations

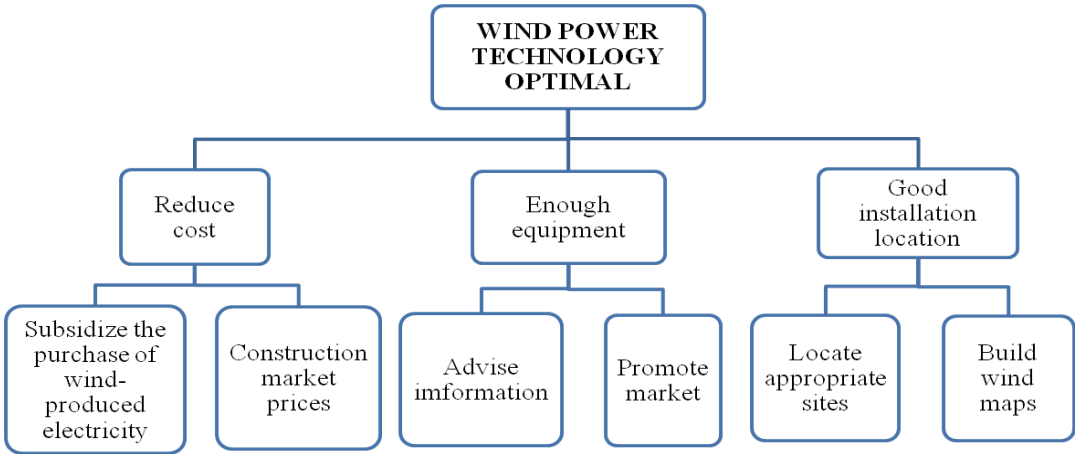


Figure 16 - Map of analysing framework condition for Wind Power Technology

Annex III. Project Ideas

1.Project 1:

a) Name of proposed project:

Designing financial support mechanisms and subsidizes for wind power

b) Information of the proposed project:

- Introduction/Background:

Wind power potential of Vietnam is quite abundant. But up to 2010, proportion of wind power is very small in comparable with total power production. The development of wind power is not still commensurate with current potential due to high cost and lack of financial support mechanisms and subsidizes for it.

- Purpose and objectives:

Purpose: To design the financial support mechanisms and subsidizes for wind power in Vietnam.

Objectives:

Identify and classify barriers; check current legal documents related to support and investment of the renewable energy sources.

Propose reasonable power cost and subsidize mechanisms for each project in order for EVN to buy it and ensure the benefits of stakeholders.

- Relationship to the country's sustainable development priorities:

Wind power sources are clean energy and in line with economic development orientation of cleaner production and environment; the dependence on energy import is reduced and contribute to energy security.

Wind power is one of prioritized technology for GHG mitigation.

- Project deliverables:

To create suitable market and encourage the development of wind power projects and brings important economic, social and environmental benefits.

- Project scope and possible implementation:

Contribute to mitigate GHG emission;

Encourage internal and external investors to active participate in wind power market. Project has feasibility in current stage when Vietnam is encouraging the development of renewable energy.

- Time lines: 2012-2015
- Budget/Resource requirements:

Estimated budget: 50,000 US$

Source: International: 70%, State budget: 30%

- Responsibilities and coordination:

Governing agency: MOIT

Cooperating agencies: MOF, MONRE and EVN.

2.Project 2:

a) Name of proposed project

Consult and research feasibility report to apply suitable cogeneration technology for Dung Quat economic zone.

b) Information of the proposed project:

- Introduction/Background:

Dung Quat economic zone includes 110 investment projects which have big heat and electricity demand for oil filter and petrochemical, food, drink, paper productions, etc. So It's convenient condition for applyingcogeneration technology to improve the electric supply efficiency and heat energy for this economic zone. Taking advantage of available Biofuel in place, the research and technology consultancy for selection cogeneration technology based on leveraging Ethanol biomass will be realistic and highly feasible, contributing to reducing GHG emissions from energy supply.

- Purpose and objectives:

Purpose: Improve general heat efficiency from emery supply; utilize onsite bio fuels and save energy through apply technology outline "Biofuel engine CHP plants + heat recovery steam generator (HRSG)" for Dung Quat economic zone.

Objective; building feasibility report to apply cogeneration technology through outline Biofuel engine CHP plants + heat recovery steam generator (HRSG)" for Dung Quat economic zone.

Propose to develop CDM project which can be applied above-mentioned technology outline.

- Relationship to the country's sustainable development priorities:

This project is relative to national tasks and strategies to respond to climate change in the energy sector. This is new development orientation which contributes to sustainable development of the Vietnam's electricity.

- Project deliverables:

Contribute to quantify and quantity energy saving, environmental protection and GHG mitigation benefits from the energy sector through cogeneration technology.

Contribute to implement the general objective of the UNFCCC and NAMA.

- Project scope and possible implementation:

This is a consultation project.

This project has a feasibility due to its commercialization and utilization.

This project is relative to the oil filter, petrochemical; building material, cement and paper productions; hotel complex projects which have energy demand, etc. of Dung Quat economic zone.

- Time lines: 18 months.
- Budget/Resource requirements:

Expected budget: 250,000 USD.

- Measurement/Evaluation:

Quantify and quantity economic and financial benefits due to energy saving and GHG mitigation.

- Possible Complications/Challenges:

General awareness on cogeneration technology and its benefits is still limited.

- Responsibilities and coordination:

Coordination agency: DMHCC

Cooperation agencies: INDUTEC and Center for Ozone Layer Protection

3.Project 3

a) Name of proposed project

"International cooperation: Development of the bio energy in the live stock sector to replace energy used in agriculture zone and mitigate GHG emission*".*

b) Information of the proposed project:

- Introduction/Background:

The increasing development of animal husbandry of Vietnam leads to animal wastes are not treated and environmental pollution. The use of straw, firewood and coal for cooking is one of GHG emission source.

To build biogas cellar on animal husbandry region is not only contribute to waste treatment but also environmental cleaning and reduce firewood for cooking and woman worker in agriculture region.

- Purpose and objectives:

Improve farmer life, save burning material and reduce environmental pollution.

Create methane for cooking in agriculture region to mitigate GHG emission.

- Relationship to the country's sustainable development priorities:

Project is suitable with development orientation of agriculture which mentioned in it's development strategy and contributes to mitigate GHG emission, reduce environmental pollution, eliminate hunger, reduce poverty and improve farmer's life.

- Project deliverables:

Project will encourage the use of renewable energy in agriculture region and help decision makers to have suitable plans in exploiting and developing renewable energy in agriculture region and facilitate the application of renewable energy and protection of environment in Vietnam.

- Project scope and possible implementation:

Project is proposed to implement nationally. It will bring practical benefits to farmers and contribute to hunger elimination and poverty reduction.

According to the assessment of experts, this project has high feasibility due to it's benefits and not to request high technologies.

- Time lines: expected in 7 years.
- Budget/Resource requirements:

Expected budget: 8 million USD.

- Measurement/Evaluation:

Tangible results: The biogas cellars will be 280 thousand and 560 thousand in 2020 and 2030, respectively. Besides, biogas residues will be used as additional food for pigs, fish, plants, etc.

- Possible Complications/Challenges:

Lack of fuel for methane sinks

- Responsibilities and Coordination:
  Farmers Association, Agriculture Expansion, Experts, Farmers,

4.Project 4:

a) Name of proposed project

Management of the irrigation to mitigate methane emission and improve water irrigation efficiency in Red and Cuu Long river deltas.

b) Information of the proposed project:

- Introduction/Background:
  National strategy on improving irrigation system to 2020 has been developed. Project contributes to implement general objectives of this strategy. Water resources protection is one of important policy of the country.
- Purpose and objectives:
  Saving water irrigation, improving rice productivity and production and famer's life and mitigate methane emission.
  Reducing methane emission on rice field
  Building perfect irrigation process to improve rice productivity
  Capacity building for technical officials to implement suitable irrigation process
- Relationship to the country's sustainable development priorities:
  Project is suitable with development orientation of agriculture which mentioned in it's development strategy and contributes to mitigate GHG emission, reduce environmental pollution, eliminate hunger, reduce poverty and improve farmer's life.

- Project deliverables:
  It's objective is to reduce methane emission through suitable management of irrigation which is drained at 2 stages, tillering and ripening and save water irrigation and improve rice productivity. Amount of the CH_4 reduction by this technology can be estimated as follows:
  Amount of CH_4 reduction: 75kg CH_4/ha/season
  Up to 2020: 75kg CH_4 * 3,000,000 ha = 225 Gg CH_4 ≈ 4,725 Gg CO_2 equivalent.
  Up to 2030: 75kg CH_4 * 5,000,000 ha = 375 Gg CH_4 ≈ 7,875 Gg CO_2 equivalent.
  If 1 million ha of rice field are applied this technology, 75 Gg Ch_4 will be reduce per year ≈ 1,575 Gg CO_2 equivalent/year.

- Project scope and possible implementation:
  Project is proposed to implement nationally. It will bring practical benefits to farmers and contribute to hunger elimination and poverty reduction.
  According to the assessment of experts, this project has high feasibility due to it's benefits and not to request high technologies.
- Time lines: expected in 6 years.
- Budget/Resource requirements:.
  Expected budget: 15 million USD.

- Measurement/Evaluation:
  Tangible results: The rice area which is irrigated follow this technology is estimated 3 million ha and 5.4 million ha in 2020 and 2030, respectively. The increasing productivity is about 3-5%. The methane reduction is about 50-100 kg/crop.
- Possible complications/Challenges:
  Irrigation system has not built completely.
  Famers are still afraid of implementing these technologies because they are worried about the reduction of rice productivity.
- Responsibilities and coordination: Irrigation Associations, Local Irrigation Companies.

5.Project 5:

a) Name of proposed project

"Afforestation on sandy land at coastal zone of South Central".

b) Information of the proposed project:

- Introduction/Background:
  Afforestation on sandy land to combat desertification is implemented at coastal zone of South Central where are high desertification risk.

According to the plan, 900ha casuarinas and acacia forests will be planted at Quang Nam and Quang Ngai provinces.

- Purpose and objectives:

Afforestation at Quang Nam and Quang Ngai provinces is to reduce desertification risk, protect land and residential areas, transportation routes and other infrastructures.

- Relationship to the country's sustainable development priorities:

This project is relative to desertification combating, new agriculture development and coastal zone protection forest programs.

- Project deliverables:

Improve agriculture productivity of zones behind planted protection forests

Facilitate to use wild and bad land for agriculture production and wood plant

- Project scope and possible implementation:

This project is implemented at coastal zones of central provinces. It has practical benefits and contributes to hunger elimination and poverty reduction for local residences.

This project has feasibility and suitable with afforestation programmes in the coming time as well as bring land and water protection benefits.

- Time lines:

Expected in 5 years (3years for planting and 2 years for protecting)

- Budget/Resource requirements:

Expected budget: 1 million USD

- Measurement/Evaluation: estimated to reduce 450 thousand tonnes of CO2 equivalent in the period of 20 years.

It's expected to plant 900 ha casuarinas and acacia forests on 260 km length of coast.

- Possible Complication/Challenges:

South Central zone has severe and drought weather which creates some difficulties for afforestation.

Demand of developing aquaculture sinks is increasing.

Land plans have not been clear yet.

- Responsibilities and coordination:

Governing agency: MARD

Cooperating agency: People Committees of Quang Nam and Quang Ngai provinces.

6. Project 6

a) Name of proposed project

"Reforestation and protection of mangrove forests".

b) Information of the proposed project:

- Introduction/Background:

Coastal forest system, especially mangrove forests, plays an important role in disaster combat and environmental protection as well as aquaculture keeping and development.

- Purpose and Objectives:

Combating mangrove degradation; protecting environment and developing aquaculture income

- Relationship to the country's sustainable development priorities:

This project is suitable with national climate change strategy, national forest protection and development programme, national action plan to respond to climate change in the agriculture sector

- Project deliverables:

Creat tree belt at coastal zones; Improve the cover rate of mangrove forest; make ecological balance

Reduce environmental pollution, especially water environment at coastal zones

- Project scope and possible implementation:

Creat jobs for residences in project zone; income increase for people who paticipate in forestation

Develop community forestry, environmental and landscape protection awarenesses; capacity building on forest protection

- Time lines: 5 years (2015-2020)
- Budget/Resource requirements:

Expected budget: 1000 billion VND (state budget: 10%; ODA: 90%)

- Measurement/Evaluation:

Forestation: 63000 ha; additional forestation: 33000ha; protection: 200000ha.

Lifetime of coastal infrastructure projects can be extended 1.5 times

- Possible Complication/Challenges:
  Land plans has not been clear which lead to project land disappear due to unprompted land use change.
  Climate change makes increase tidal intensity and erosion
- Responsibilities and Coordination:
  Governing agency: MARD
  Cooperating agencies: provinces that have mangrove forests

Funding agency: international organizations

Annex IV. List of stakeholders involved and their contact

P.o	Agency	Contact
1	Ministry of Natural Resources and Environment:	
	- Department of Meteorology, Hydrology and Climate Change	No. 8 Phao Dai Lang street, Hanoi, Vietnam
	- Department of Science and Technology	No. 83 Nguyen Chi Thanh street, Hanoi, Vietnam
	- Institute of Strategy and Policy for Natural Resources and Environment	No. 1116 Hoang Quoc Viet street, Hanoi, Vietnam
	- International Cooperation Department	No. 83 Nguyen Chi Thanh street, Hanoi, Vietnam
	- Vietnam Environmental Administration	No. 67 Nguyen Du street, Hanoi, Vietnam
	- Science Institute of Meteorology, Hydrology and Environment	No. 62/23 Nguyen Chi Thanh street, Hanoi, Vietnam
2	Ministry of Foreign Affairs: Department of International Organizations	No. 6 Chu Van An street, Hanoi, Vietnam
3	Ministry of Planning and Investment: Department of Science, Education, Natural Resources and Environment	No. 2 Hoang Van Thu street, Hanoi, Vietnam
4	Ministry of Agriculture and Rural Development:	
	- Department of Science and Technology	No. 2 Ngoc Ha street, Hanoi, Vietnam
	- Vietnam Administration of Forestry	No. 2 Ngoc Ha street, Hanoi, Vietnam
	- Institute of Agricultural Environment	Thanh Tri, Hanoi
5	Ministry of Industry and Trade	
	- Department of Energy	No. 54 Hai Ba Trung street, Hanoi, Vietnam
	- Institute of Energy	No. 6 Ton That Tung street, Hanoi, Vietnam
	- Vietnam Mine – Metallurgy Science and Technology Institute	No. 30 B Doan Thi Diem street, Hanoi, Vietnam
	- Vietnam Electricity	434 Tran Khat Chan street, Hanoi, Vietnam
	- Vietnam National Coal, Mineral Industries Holding Cooperation Limited	
6	Ministry of Science and Technology: Department of Social and Natural Science	No. 113 Tran Duy Hung street, Hanoi, Vietnam

7	Ministry of Transportation: - Department of Environment - Department of Science and Technology	No. 80 Tran Hung Dao street, Hanoi, Vietnam
8	Ministry of Finance: Department of Legislation	No. 28 Tran Hung Dao street, Hanoi, Vietnam
9	Ministry of Construction: Vietnam Cement Industry Corporation	No. 37 Le Dai Hanh street, Hanoi, Vietnam
10	Vietnam Academy of Science and Technology: - Institute of Environmental Technology - Institute of Geological Sciences	No. 18 Hoang Quoc Viet street, hanoi, Vietnam
11	Institute of Industrial and Chemical Safety Technology	No. 283/18 Doi Can street, Hanoi, Vietnam
12	Hanoi University of Technology	No. 1 Dai Co Viet street, Hanoi, Vietnam
13	Voice of Vietnam	No. 45 Ba Trieu street, Hanoi, Vietnam
14	Vietnam Television	No. 43 Nguyen Chi Thanh street, Hanoi, Vietnam
15	JSC of Consultancy Service and Technology for Natural Resources and Environment	No. 160 Nguyen An Ninh street, Hanoi, Vietnam
16	Research Centre for Climate change and Sustainable Development	Trung Hoa, Nhan Chinh, Hanoi, Vietnam
17	Vietnam Mining Science and Technology Association	No. 3 Phan Dinh Giot, Hanoi, Vietnam
18	Vietnam Union of Science and Technology Association	

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