Central Institute for Economic Management (CIEM)

Final Report

"Study into the Economics of Low Carbon, Climate-Resilient Development in Vietnam – Scoping Phase".

Submitted to the Department for International Development (DFID)

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List of Acronyms and Abbreviations

CCS	Carbon capture and storage
CDM	Clean Development Mechanism
CIEM	Central Institute for Economic Management
DFID	Department of International Development of British government
GoVN	Government of Vietnam
GSO	General Statistical Office
IMHEN	Vietnam Institute of Meteorology, Hydrology and Environment
IPS	Institute for Industry Policy & Strategy
KP	Kyoto Protocol
MARD	Ministry of Agriculture and Rural Development
MOF	Ministry of Finance
MOIT	Ministry of Industry and Trade
MONRE	Ministry of Natural Resources and Environment
MOST	Ministry of Science and Technology
MPI	Ministry of Planning and Investment
MT	Ministry of Transportation
NIAPP	National Institute for Agricultural Planning and Projection
NTP-RCC	National Target Programme to Respond to Climate Change
UNFCCC	United Nation Framework Convention on Climate Change
UNFCCC	United Nations Framework on Climate Change

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Executive Summary

During the last decades, Vietnamese government has already acknowledged the challenges of climate change and harmful impacts of increasing environmental pollutions in the country. Economic growth is no longer a sole development objective in Vietnam but a more sustainable and high-quality growth is targeted in a number of policy documents. Supporting these policies and building capacity in Vietnam to undertake and update analyses of the economics of low carbon development and climate change, Department of International Development (DFID) of British government in association with the Ministry of Investment (MPI) of Vietnam initiated a study namely "Study into the Economics of Low Carbon, Climate-Resilient Development in Vietnam" and Central Institute for Economic Management (CIEM) was chosen as the main implementing agency. The scope of this overall study comprises three phases: i) Scoping phase; ii) Input studies phase; and iii) Main study.

The objectives of the scoping study are: i) To collate and assess what data and studies exist that will be of use to the study and identify what work will need to be commissioned to fill key gaps; ii) To review the proposed methodology and note where new tools will need to be developed or existing models adopted; iii) To assess what skills exist in Vietnam against those required for the study and identify in-country training needed and/or what international support will need to be brought in for the subsequent two phases (Input Studies and the main Study phases); iv) To identify and consult with key stakeholder groups on the work scope, its phasing and key steps for engagement. During the process of completing these four tasks, the "business as usual" scenarios for Vietnamese economy at least by 2020 (some indicators are actually set out for 2030) will also be formulated.

The main methodology applied is desk study in addition to participating in training courses, organising domestic workshops, consultation meetings and seminars to seek information, knowledge and opinions of studies and experts in relevant fields. The main human resources for conducting the scoping study include six national consultants led by a CIEM team leader. Among these six members, three experienced experts are from the Central Institute for Economic Management (CIEM), two from Vietnam Institute of Meteorology, Hydrology and Environment (IMHEN), Ministry of Natural Resources and Environment, and one from Institute for Industry Policy & Strategy (IPS), Ministry of Industry and Trade. In addition, a very experienced international expert was also part of the study team working closely with national consultant team providing basically methodology guidance for the team. The study team also called for and was benefited with technical assistance of a number of the WB, USAID and AUSAID specialists.

In order to fulfil the objectives of the scoping study, both the current status and future projections of the demographic information, the economy and climate of Vietnam need to be first considered. According to the forecasted results, the population of Vietnam would reach 96 millions in 2020, 103 million in 2030 and about 108.8 million in 2050. The population growth, however, would decline substantially to about 1% in 2020, 0.06% in 2030 and only 0.01% in 2050. In contrast, the urbanisation rate would increase significantly reaching 36% in 2020, 43% in 2030 and almost 60% in 2050. This information, in addition to the other, is very useful for estimating energy consumption of household sector in Vietnam for the investigating periods. Vietnam's economy has also undergone relatively high growth during the last decades averaging at 7.2% during 2001-2010 period. During the last five years, its economic growth, however, has shown a sign of slowing down a little bit with 6.18% and 5.32% for 2008 and 2009 respectively. One of the reasons for this slow down is due to the considerable negative though indirect impacts of the global financial crisis. However, other reasons may come from domestic macroeconomic instabilities themselves. In 2010, the economy somehow recovered and grew up better with an estimated 6.8% growth. Among the major sectors in the economy, industry-construction sector grew up at the fastest speed during 2005-2007 and slowed down during the last few years (2008-2010). The services sector, on average for 2005-2010 period, is the second fastest in its growth. However, the speeds of these two sectors are almost the same for the current time at around 7.5-7.7% annually. The economic structure of Vietnam continues to move toward a more industrialised economy. While agriculture-forestry-fishery sector takes up a smaller share in total GDP, industry-construction and service sectors are always increasing. In 2009, each of these sectors accounts for around 40% of the total GDP of Vietnam. The manufacturing sector alone accounts for more than 20% for 2005-2010 period. The expansion of industry-construction sector reflects high speed of industrialisation and urbanisation and this has substantial impacts putting challenges for low carbon development path of the country.

In 2009, Vietnam GDP in current price was USD 96.317 billion (ASEAN Secretariat, 2010) which was just about 36% of that of Thailand and 60% of the Philippines in the same year. In 2010, GDP of Vietnam reached USD 101 billion and is expected to grow at 7.5-8% during the period of 2011-2015 as indicated in the 5-year Socio-economic Development Plan (MPI, 2010). The size of Vietnam economy in 2020 would be more than double that of 2010 and once again double in the next subsequent ten years (2030). The similar increase is expected for GDP per capita indicator. Different sectors may grow at different paces and this has different implications for CO2 emissions of the whole economy. These can also be considered as "business as usual" scenarios for the Vietnamese economy.

Climate conditions have changed in recent decades in Vietnam. Over the past 50 years (1958 - 2007), average temperature has increased about 0.5 - 0.7°C (NTP, MONRE, 2008). Climate change has made natural disasters, especially typhoons, floods, and droughts more severe. On average for the whole country, the rainfall over the past 50 years (1958 - 2007) decreased by about 2%. There have been more typhoons with higher intensity affecting Viet Nam. Typhoon track has a tendency of moving southward and typhoon season tends to end later. There were more typhoons with abnormal movement. Data from tidal gauges along Vietnam coasts show that sea level rise was at the rate of about 3mm/year during the period of 1993 - 2008 which is comparable with the global tendency. In the past 50 years, sea level at Hon Dau station rose about 20cm (NTP, MONRE, 2008). The climate change scenarios for 2020, 2030 and 2050 were developed by MONRE based on: (i) Plausibility of global climate change scenarios; (ii) Level of details of climate change scenarios; (iii) Inheritability; (iv) Up-to-date; (v) Local appropriateness; (vi) Completeness of scenarios; and (vii) Possibility of self updating. In medium emission scenario: By the first year (2020, 2030) and between 2050 of the 21st century, annual mean temperatures in Northern climate zones would increase by 0.5 to 1.5°C relative to the baseline period (1980 -1999). The increase in temperatures in Southern climate zones is expected to be less than that of Northern climate zones and is about 0.3 to 1.0°C. By the end of the 21st century, annual mean temperatures would increase about 2.6°C in the North West, 2.5°C in the East West, 2.4°C in the North Delta, 2.8°C in the North Central, 1.9°C in the South Central, 1.6°C in the Central Highlands, and 2.0°C in the South compared to the average of 1980 - 1999. In terms of rainfall and with medium emission scenario: By the first years of 2020 and 2030 and by 2050 of the 21st century, annual mean rainfall in Northern climate zones would increase by 1.4% to 4.1% and about 0.3%-1.7% in Southern climate zones (South Central, Central Highlands and South zones) relative to the baseline period (1980 -1999). The sea level rise by medium scenario for Vietnam is projected at about 30 cm by 2050 and 75 cm by 2100.

The future scenarios of energy consumption coming along with future demand for energy can be seen in the forthcoming National Energy Policy (MOIT, 2011). In this draft policy, the energy demands for major sectors are estimated. In the next 20 years or beyond, energy demand is getting large with substantial changes. For industrial sector, the demand by 2010 is about 13.4 – 14.0 million TOE, by 2020 approximately 25.4 – 28.0 million TOE and by 2050: 110 - 131 mill. TOE (average growth rate of period 2001 - 2020 is 9.2 – 9.7%/year, 2021 - 2050: 5 – 5.3%/year). The transportation sector energy demand is also increasing fast. By the year 2010, it is estimated to be approximately 11.3 - 12 mills. of TOE; by the year of 2020 about 21.5 - 24 mill. of TOE and by the 2050 about 55 - 72 Mill. of TOE. The demand for energy consumption of service sector by the

year of 2010 is about 2.2 Mill. TOE, in 2020 approximately 3.7 – 4.3 Mil. TOE, in 2050 about 16 - 21 Mill. of TOE. The figures for agricultural sector are forecasted at about 1 Mill. TOE in 2010, about 1.4 – 1.5 Mil.TOE in 2020 and 3.4 – 3.8 Mil. TOE in 2050. Vietnam would turn to be an energy imported country in the near future based on the information from (MOIT, 2011). This is expected to happen from 2013 and the proportion of energy import would reach 25 - 27% in 2020, and about 57 - 62% by 2050 if nuclear power is not taken into account.

Specifically, electricity demand (baseline scenario) is increased at a rate of 14.0%/year for period 2011-2015 and 11.1%/year for 2016-2020 according to Proposed Master Plan on electricity development for period 2011-2020, with its vision up to 2030. The power production is proposed to be 194 billion kWh in 2015, 329 billion kWh in 2020 with the maximum capacity in 2015 of 30,803MW and 2020 of 52,040MW. Up to 2030, power production is estimated at 695 billion kWh with its maximum capacity of 110,215MW. Nuclear power is planned to develop in the next decades with the first Nuclear Power Plant proposed to be run in 2020. Hydro-power would reduce its proportion to 25.7% in 2020 and 15.3% in 2030; oil & gas thermal power would be 19.4% in 2020 and remain 12.7% in 2030; while coal thermal power would increase its ratio up to 46.4% and 56.1% in 2020 and in 2030 respectively. Renewable energy would have its ratio of 4.5% in 2020 and 5% in 2025, due to its potential have been not clarified, especially its wind power has little change in renewable sources structure. After 2025, its proportion is coming down to 3.5%-4%. Nuclear power will be increased, comprising 6.1% in 2025 and 7.8% in 2030 while other energy imported would comprise 2.6% and 4.6% respectively to the year 2020 and 2030.

From the literature review of previous and on-going studies, it can be seen that although the number of studies on low carbon development and climate change impact is large, they analysed only specific aspects of low carbon and climate change impact such as potential for Vietnam to participate in the CDM, benefits on climate change adaptation from small and medium scale hydropower plants, promotion of renewable energy, energy efficiency, rural energy, forest sector development, priority infrastructure investment, demand-side management and energy efficiency, biodiversity etc… It is therefore that a comprehensive study on patterns of economic growth that will be climate resilient and low carbon for the whole economy is still lacking. There has not been any study investigating both adaptation and mitigation processes and inter-sectoral impacts during these to processes for Vietnam. In addition, the data serving for low carbon and climate resilient studies seem to be somehow out-of-date with the latest information came from 2000. Methodologically, there has not been any study combining both top-down and bottom-up approaches in a very comprehensive manner. This proposed study would be a very good evidence-based research providing policy makers with various options of lowering carbon

intensity and adapting with climate changes and their impacts on the economy while keeping economic growth in the long term.

Appraisal of the scope and methodology proposed for the Study and selection of relevant models for Vietnam

This is one of the major tasks of the scoping study. Low carbon development planning in Vietnam will require a consensus to be reached involving all Ministries and multiple other stakeholders on an achievable long term development trajectory that will allow the country to maintain its growth targets while emitting less greenhouse gases to the atmosphere than could have been expected under previous development plans. Low carbon development planning requires that priorities be determined across sectors; deciding where investments should be made to reduce the future emission of GHGs, and the time frame in which each should best be made. This involves trade-offs and agreements across the entire economy.

Scenario modelling and sharing of data is an important part of this process. Modelling helps understand where a country and each sector – energy, transport, land use, agriculture, forestry and waste management – currently stand, the direction in which they are developing, the impact of this development on the level of GHG emissions, and resources that would be needed for abatement. Scenario modelling typically involves establishing a macroeconomic outlook. This entails forecasting population, GDP, and other macro-economic variables for a pre-defined time horizon – typically 20 or 25 years which were presented in the previous subsection. A base year should also be selected with information from various sectors of the economy from which it will be possible to forecast the future impact of development objectives and national strategies relating to greenhouse gas emissions mitigation. It is the needed to develop a forecast for the time horizon that takes account of current development plans and constraints to arrive at a best case option. This forms the basis of what is called a 'Reference' scenario. A Reference scenario or Best Business scenario is built by evaluating the best-business decisions that would be made over future years, without taking into account the need for GHG emissions reduction, based on the existing situation, as well as commitments and targets 20-25 years into the future. The lower greenhouse gas emissions options which help identify where the mitigation potential lies, are called Low Carbon Scenarios which are contrast to the reference scenarios. These scenarios help identify the mitigation potential with least costs and subject to institutional capacity and barriers.

From the literature reviews of relevant models for low carbon and climate resilient development objectives, there are various approaches to modelling low carbon pathways, typically grouped into top-down and bottom-up. Top-down, macro-economic models are used to assess the economy-wide impacts of greenhouse gas policies and actions whilst bottom-up engineering style models

can focus on, and quantify, the distinct impacts of a large number of specific abatement options. Whilst top-down models can take into account feedback effects from adjustment in prices by analyzing an energy-demand relationship through a reduced-form equation, they cannot evaluate the specific abatement technologies in details. Bottom-up models examine the ownership and the use of energy-consuming devices and consider efficiency scenarios from an engineering point of view. Engineering style models can focus on specific abatement options while using micro data reflecting individual and household behaviour. Vietnam would benefit from using different models to help understand and get answers to different questions. This is a rationale for Vietnam to choose hybrid-models classified as a combination of bottom-up and top-down models as appropriate approach for the study.

Several bottom-up modelling tools are planned to use in the Main study phase for the case of Vietnam following the World Bank approach which is proven successful in many cases of developing countries. They include EFFECT model consisting Power generation, large-Scale energy intensive industry, On-road Transport, Households Electricity Use, Non-residential Energy Use; MAC tool, LULUCF model applied to land use change and forestry modelling as in the case of Brazil which include two complementary models: Brazilian Land Use Model (BLUM) and Stimulate Brazil (SIM Brazil) supporting simulation of a reference scenario and the impact on land use of different policies. The specific top-down model which is proposed to use for Vietnam is General equilibrium models widely known as CGE model in Vietnam. This is based on both the World Bank and CIEM experiences in utilizing this kind of models. The CGE model applied by CIEM is an IFPRI standard CGE model calibrated to the 2007 SAM of Vietnam. The SAM covers 63 sectors of which 23 sectors are of agriculture, 12 sectors of services and others in industry containing the sectors strongly related to low carbon growth such as forestry in agriculture, transportation and electricity, mining, oil and gas in industry. One component to access the low carbon growth is planned to be added in the CGE model. To link the bottom-up and top-down models, the outputs from bottom-up models such as energy usage and GHG emissions are used as these exogenous inputs to CGE model. The results of top-down models are supposed to provide the economy-wide effects of low carbon scenarios on GDP, employment, income distribution and other macroeconomic indicators.

Adding the dimension of "climate resilience" adds an additional level of complexity to the low carbon development planning study. The study will need to evaluate not only what lower carbon options exist for electricity production, for example, but also where to locate them. To achieve this, a suite of models needs to be selected that will develop these plausible longer-term scenarios

and that can help answer a series of key questions about each particular sector and the economy as a whole. Once again, the hybrid-model approach is proposed to be applied.

On the data requirements and data gaps for selected models and in order to link bottom-up models with top-down model to assess the low carbon growth scenarios in Vietnam, it is first necessary to identify data gaps, which are available and not available at the moment but can be collected, to run models.

For general data, the only group of data which are unavailable is Energy Content and Emissions Factors for Fuels while other groups can be assessed mostly through GSO and SBV websites such as Exchange Rate, GDP, Population, Total Land Area, Price of Fuels (after tax), Ambient Temperature and Tax Rate for Fuels (Cost plus basis) from MOF. Similarly, it is estimated by the team that 97% of data for power sector are available.

Industrial data, however, are mostly not available at the moment and need to be collected by surveys. Data available include Finished Steel demand and production for Steel sector and Aluminium factors, Primary Aluminium demand and production, Alumina demand and production, Secondary Aluminium demand and production for Aluminium sector. All data for Cement, Fertilizer (Ammonia), Petroleum Product demand and production, Paper demand and production need to be collected by surveys. For transport and vehicle class data, these are available at macro levels. Data at micro levels such as Vehicle usage (km per year) by years of operation etc.. need to be collected by surveys. For household data, data at macro level are available through GSO survey such as Household Electrification, Population percentile, Monthly Per Capita Expenditure percentile, Total Electricity Usage per month. Data at micro level for household uses need to be collected only by surveys in Vietnam. Similarly, selected non-residential data are available from GSO. However, specific data for base year energy intensities for existing floor space and new construction, lighting and heating/cooling technology mix, data for lighting, cooling, fans and other appliances are only available through surveys. For other sectors such as land use, land use change, forest and agriculture, data can be collected and calculated from data of General Department of Land Management.

Detailed scopes for the Input Studies and main Study phases

Input Study phase: As indicated in the previous sub-section, the hybrid models integrating two approaches, namely bottom up and top down are recommended for Vietnam. The data requirements are very extensive and it is needed to plan for a second phase of providing inputs for the main analysis. This is called the Input Study phase.

The objectives of this phase are: i) to collect and fill the gaps of data, which are the input data for the designed models, such as EFFECT model (bottom up approach) and CGE, Land Use, Land Use Change, Forest model (LULUCF), GHG emission from waste (top down approach) and combine the bottom up and top down approach; ii) to start training Vietnamese staff on integrated low carbon and climate resilient development into the country's economic planning process, skill using the designed models for evaluate the economics of low carbon and climate resilient development.

The data need and data availability status was already identified. Based on this information, a time schedule for collecting all necessary data was set up. Due to the data is very scattered among institutions in Vietnam, it takes time to collect all the available data. For the un-available (not yet available) data, surveys are planned to be conducted as well.

In this phase, total budget is designed to cover expenditures for three main tasks: data collection (66%), training the capacity and skill for Vietnamese staff (23%), and other tasks including organizing workshops and reporting. A considerable number of organizations and agencies from different ministries and organizations will be mobilised in this phase to meet the objectives of the study. These organisations are planned to participate in the study as they are capable to provide the best sources of information and data for the study. As a general economic ministry which is assigned by the government to draft Socio-economic development Strategies and Plans and recently assigned by the Prime Minister of designing a "green development" (low carbon) strategy[1], the Ministry of Planning and Investment (MPI) is designed to be implementing agency for the overall project. The Central Institute for Economic Management (CIEM) of MPI, which has full capacity for running the project, is designed to be project coordinating organisation. This structure is designed for both phase 2 and phase 3 of this project.

A steering committee including representatives from MPI, MARD, MOIT, MONRE, MOF, MoT and donors could be a useful body for making consensus during the project implementation process. The project champions are CIEM, GSO and appropriate departments or key research institutes of respective line ministries above. These institutions can be nominated by respective steering committee members of the proposed line ministries. While each "champion" can be responsible for its sectoral package, CIEM is designed to coordinate all these project partners and be the project leading institution/champion that is responsible for final report. A technical advisory group including both national and international specialists should be established to make technical advices for the study team as well as to review the completed works.

The time estimated for this study phase is 12 months.

[1] By the Notice No. 38 of the Prime Minister dated March 3, 2011

Main Study phase: Once the information and data are gathered in the Input Study phase, the Main Study phase can be started to be undertaken. The general objectives of this phase is to analyse low carbon portfolio and identify growth patterns that help the economy increase its resilience to climate impacts and reduce its carbon intensity. Using the common economic evaluation methodologies to identify and assess a number of promising low-carbon interventions in Vietnam, in the short, medium and long term (5-10; 10 -20; 20 - 30 years). Low-carbon interventions would be selected on an integrated approach, with multiple sectors: i) having a good emissions reductions potential, low net financial and economic costs, and that are socially and politically feasible; ii) whose benefits are not jeopardized by potential climate change impacts; In this phase, the study will assess the impacts from different scenarios of low-carbon development within the National Target Program on Climate Change (NTPCC) and those of low carbon development on macroeconomic indicators such as investment, GDP, employment, and income distribution.

Expected outputs of this study phase are: i) A portfolio of low-carbon interventions by key sector: The analysis will include an assessment of the costs (including investment requirements) and benefits of each intervention, in addition to the analysis of costs and benefits of the economic, social, and political feasibility of undertaking the interventions, and a set of policy recommendations that would be needed to implement the sectoral intervention program; ii) Economic, carbon emissions and climate-resilient modelling and policy recommendations to the government based on macroeconomic impacts of each policy option.: The study will construct a series of baseline emission scenarios for the years 2020, 2030, and 2050 for key emission sectors, including power, industry, transport, agriculture and forestry. Compared to these baseline scenarios will be one or more low-carbon development scenarios constructed from the low-carbon portfolio analysis. The macro modelling exercise will also evaluate the impacts of implementing low-carbon programs on income, employment, and income distribution, etc.; iii) A report of analysis of costs and financing, policy options, enabling environment: According to the results of running the models, the experts write a report on the analysis of cost and financing, policy options, enabling environment for Vietnam and it will be sent to the Government of Vietnam

In this phase, the total budget is estimated to cover three main tasks including the development of Portfolio of low-carbon climate-resilient development by sector (50%), Economic and carbon emissions and climate-resilient modelling (30%), and workshop (13%), and the rest for other activities. The number of organizations which meet capacity to involve in this phase is not as large as in the Input Study phase. The involvement of these institutions is planned for specific tasks. CIEM is designed to take the leading role in this phase. A specific time schedule for project

activities is also set up showing the planned progress for the study. The time estimated for this main study phase is 12 months.

It is concluded that it is feasible to conduct the next two phases of Input Study and Main Study of the "Study into the Economics of Low Carbon, Climate-Resilient Development in Vietnam". The information, data and skill gaps for conducting these phases can be filled-in by the efforts of Vietnamese institutions as well as supports from international experts.

I. Background

Climate change poses substantial challenges and risks in Vietnam which is considered as one of the world's most climate vulnerable countries. Scientific data indicate that Viet Nam is 'particularly vulnerable to the adverse effects of climate change'. Its effects include sea level rise, temperature increases, river floods, drought, typhoons and storm surges, water supply problems etc … harming economic growth, poverty reduction and threatens to lose decades of development efforts.

Having acknowledged the challenges of climate change and aspiring to fulfilment of UNFCCC commitments, the Government of Vietnam (GoVN) devised a "National Target Programme to Respond to Climate Change" (NTP-RCC) with the strategic objective "*to assess climate change impacts on sectors and regions in specific periods and to develop feasible action plans to effectively respond to climate change in the short-term and long-term to ensure sustainable development of Vietnam…*". The NTP-RCC provides the basis for action planning in all sectors and localities until 2015, supports research and awareness rising, and helps coordination. It provides a framework for formulating an overall climate change strategy with long term goals on adaptation as well as greenhouse gas (GHG) emissions mitigation in Vietnam.

In addition, the Vietnamese government has recently set out a 2010-2020 Socio-economic Development Strategy in which macroeconomic stability, economic restructuring and environmental protection are key priorities. The strategy also reaffirms that sustainable development should be integrated into all socio-economic planning and policies.

The Department of International Development (DFID) of British government in association with Ministry of Investment (MPI) of Vietnam initiated a study namely "Study into the Economics of Low Carbon, Climate-Resilient Development in Vietnam" in order to support this policy and further build the capacity of policy-makers and other actors in Vietnam to determine actions, options, and opportunities available to Vietnam to undertake a low-carbon and climate-resilient path. The scope of this overall study comprises three phases: i) Scoping phase; ii) Input studies phases; and iii) Main study. The Study is ambitious in its objective of not only analysing patterns of growth that will be climate resilient and low carbon but also in making the links between these two.

This report is produced for the first phase - scoping phase of the overall study with the main objective of scoping out the feasibility and appraise the design of the proposed overall study.

II. Objectives of the scoping study

To achieve the above overall objective of the scoping study, the following specific objectives (or tasks) are identified as follows:

i) To collate and assess what data and studies exist that will be of use to the study and identify what work will need to be commissioned to fill key gaps;

ii) To review the proposed methodology and note where new tools will need to be developed or existing models adopted;

iii) To assess what skills exist in Vietnam against those required for the study and identify in-country training needed and/or what international support will need to be brought in for the subsequent phases (Input Studies and the main Study phases);

iv) To identify and consult with key stakeholder groups on the work scope, its phasing and key next steps;

v) To ensure that subsequent phases do not duplicate past or existing efforts and thereby ensure that Vietnam gets value for money from ODA.

During the process of completing these tasks, the "business as usual" scenarios for Vietnamese economy at least by 2020 (some indicators are actually set out for 2030) will also be formulated. This would help to draw the context for analyses in the subsequent phases of the overall study.

III. Methodology, activities and personnel inputs

In this scoping phase, the main method applied is desk study which includes:

i) Reviewing literature;

ii) Appraising the methodology to find out what models are appropriate for Vietnam;

iii) Identifying data requirement, data gaps, and training needs etc…

To support this, training sessions have been held to provide technical skills for team members (such as PAGE model training in Kuala Lumpur in September, 2010). Domestic workshops, consultation meetings and seminars have also been organised to seek information, knowledge and opinions of studies and experts in relevant fields. This would help appraise the methodology, identify training needs and make training plans for subsequent phases. The Desk study and literature review also sets out detailed, costed and time-bound plans for the Input Studies and main Study phases as well as to draft terms of reference for tasks to be either sub-contracted to Vietnamese organisations or for international support.

The main human resources for conducting the scoping study included six national consultants led by a CIEM team leader. The national experts were from the Central Institute for Economic Management (CIEM), two from Vietnam Institute of Meteorology, Hydrology and Environment (VIMHE), Ministry of Natural Resources and Environment, and the Institute for Industry Policy & Strategy (IPS), Ministry of Industry and Trade. In addition, a very experienced international expert was part of the study team to provide basic methodology guidance for the team. The study team also benefited from technical assistance of a number of the WB, USAID, DFID and AUSAID specialists. They provided very useful advices and consultations during the scoping study implementation process.

IV. Current state, future scenarios and projections of the economy and climate of Vietnam

4.1. The demographic features and economic development of Vietnam

In terms of population, Vietnam is a large country in Asia and the third largest in Southeast Asia (after Indonesia and the Philippines). Its population reached 85.8 million people in 2009. The population density of the country is relatively high compared to many other countries, with 260 persons/km2 in 2009 – with 932 persons/km2 in the Red River Delta. The population growth has been deceasing during the last decades. The population growth reached around 2.1 per cent during period 1976-1989 but declined to 1.2% during 1999-2009 and at 1.06% in 2009 (GSO, various years). According to the 2009 Vietnam Population and Housing Census, the number of households of Vietnam was 22,628,167 households[2] and the average household size was 3.8 persons. The difference in household size between urban and rural areas is minor with 3.9 persons per household in rural areas and 3.7 persons per household in urban areas.

Table 1: **Basic demographic indicators of Vietnam, 2009-2050 (Unit: 1000 people)**

Item	2009	2015	2020	2030	2050
Total population	85,847	91,642	96,162	103,156.2	108,826.6
Urban population	25,437	30,215	34,671	44,839.4	63,919.8
Rural population	60,410	61,426	61,492	58,316.8	44,906.9
Population growth	1.06%	1.00%	1.00%	0.06%	0.01%
Urbanisation rate	30%	33%	36%	43%	59%
Number of households (on 1/4/2009)	22628167	-	-	-	-

Source: GSO (forthcoming) and own estimations based on GSO data.

[2] Figure was for the 1st April, 2009

Projected population scenarios are presented in Table 1. According to these results, the population of Vietnam is due to rise to 96.1 million in 2020, 103.2 million in 2030 and about 108.8 million in 2050. The population growth, however, is expected to decline substantially to below 1% by 2030 and even lower thereafter. In contrast, the urbanisation rate (the ratio between urban population and that of the whole country) is forecast to double from 30% in 2009 to almost 60% in 2050. This information is crucial in estimating likely business as usual energy and transport consumption of the household sector in Vietnam.

Vietnam's economy has undergone relatively high growth during the last decades. During the last five years, its economic growth, however, has shown signs of slowing down. As seen in Table 2, the annual economic growth of Vietnam was always more than 8%, while it was reduced to 6.18% and 5.32% for 2008 and 2009 respectively. One of the reasons for this slow down is negative indirect impacts of the global financial crisis. However, domestic macroeconomic instabilities also played a role. In 2010, the economy recovered with an estimated 6.8% growth. Among the major sectors in the economy, industry-construction sector grew fastest over 2005-2007 but slowed down during the last few years (2008-2010). The services sector, over the 2005-2010 period, was the second fastest in its growth. However, the two sectors are now growing at a very similar rate. Vietnam's economy up to now used basically non-renewable energy sources such as coal, oil and gas. These natural resources have been extracted for years in Vietnam for both domestic consumption and exports. The demand for low carbon development is increasingly larger as these traditional energy resources are being exhausted. For the period 2006-2010, Vietnam exploited about 25-30 Million TOE/year, of which domestic crude oil production is 18-19 Million tones, over sea output are 0.2-1 Million tones, Gas yield is 8-10 billion m3; For period 2011-2015, it reach 31-34 Million TOE/year, of which there is domestic crude oil targeted at 16-18 million tones, over sea crude oil put in to plan 3.5-5.5 million tones, gas exploitation is 11-15 billion m3; for 2015-2025, it is to plan 34-35 million TOE/year, of which domestic crude oil exploitation is 13-15 million tones, over sea output is 3.5-5.5 million tones, and gas extraction is 15-16 billion m3.

In 2011-2020 Socio-economic Development Strategy, the government set a target of reducing energy intensity on GDP by 2.5-3% per year for a lower carbon economy in the coming time.

Table 2: GDP growth by sector, 2005-2010 (%)

Sector	2005	2006	2007	2008	2009	2010
GDP	**8.44**	**8.23**	**8.46**	**6.18**	**5.32**	**6.8**
Agriculture-forestry-fisheries	4.02	3.69	3.76	4.07	1.83	2.78
Industry-Construction	10.69	10.38	10.22	6.11	5.52	7.70
Services	8.48	8.29	8.85	7.18	6.63	7.52

Source: GSO (various years) and MPI (2010)

The economic structure of Vietnam continues to move toward a more industrialised economy as shown in Table 3. The share of agriculture-forestry-fishery sector has been declining as a proportion of GDP, in contrast to the industry-construction and service sectors, which, in 2009, each accounted for around 40% of GDP. The manufacturing sector alone accounted for over 20% of GDP over the 2005-2010 period. The construction sub-sector has expanded particularly significantly, growing by 10% in 2010, reflecting an increase in urbanisation. In 2011-2020 Socio-economic Development Strategy, all sectors including industry, agriculture and services are oriented toward high-value, modern, efficient and sustainable development. Among these sectors, agriculture and construction especially transportation infrastructure may be potentially more affected by climate changes. These sectors are also among biggest sources of employment and thus need to be supported by the government during the affected periods. Service sector would be a good employment option for many people in the economy.

Table 3: GDP structure by sector, 2000-2009 (%)

Sector	*2000*	*2005*	*2006*	*2007*	*2008*	*2009*
Agriculture-forestry-fishery	24.53	20.97	20.40	20.34	22.10	20.66
Industry-Construction	36.73	41.02	41.54	41.48	39.73	40.24
Manufacturing	*18.56*	*20.63*	*21.25*	*21.26*	*21.10*	*20.90*
Services	38.73	38.01	38.06	38.18	38.17	39.10
GDP	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Source: CIEM (2010)

It is not easy to make **projections for Vietnamese economy** in the long term although some main trends may be forecasted. In 2009, Vietnam GDP in current price was USD 96.317 billion (ASEAN Secretariat, 2010) which was just about 36% of that of Thailand and 60% of the

Philippines in the same year. In 2010, GDP of Vietnam reached USD 101 billion and is expected to grow at 7.5-8% during the period of 2011-2015 as indicated in the 5-year Socio-economic Development Plan (MPI, 2010). Let's assume to take the lower annual growth rate of Vietnam economy of 7.5% by 2020, which is more matched with the current growth rate of 6.8% for 2010, the projections for Vietnam GDP and GDP per capita by 2030 can be seen in Table 4. This can also be considered as "business as usual" scenario for the Vietnamese economy.

Table 4: Projections for Vietnam GDP and GDP per capita by 2030

Item	2009	2010	2015	2019	2020	2030
GDP (current price, billion USD)	96.32	102.87	147.68	197.22	212.01	424.92
GDP growth	5.32%	6.8%	7.5%	7.5%	7.5%	7.2%
GDP per capita (USD)	1081.00	1154.51	1657.45	2213.47	2379.48	4769.02
GDP by IMF (billion USD) (*)			171.20	259.90		

Note: GDP per capita is assumed to grow at the same rate with GDP.

Source: CIEM (2010) and ASEAN Secretariat (2010) for 2009 figures; Own estimations based on 2011-2015 SEDP information; The average GDP growth for the period 2021-2030 is assumed to equal to that of 2001-2010 (from 2011-2020 SEDS); (*) IMF forecasts.

It can be seen from Table 4 that, the size of Vietnam economy in 2020 is likely to more than double that of 2010 and once again double in the next subsequent ten years (2030). A similar increase is expected for GDP per capita. However, different sectors may grow at different paces and this will therefore have different implications for CO2 emissions of the whole economy. The general development orientation of Vietnam presented in the 2011-2020 Socio-economic Development Strategy is that of sustainable development which is considered as a "through road" in the future time.

4.2. Emissions in Vietnam

The emission level in Vietnam is not updated regularly due to the lack of investigation. The official emission information is provided by the 2nd National Communication to the UNFCCC in 2010. Table 5 below with the results of national GHG inventory in 2000 shows that the total GHG emissions at about 150.9 million tons of CO2e was an increase of nearly 1.5 times over 1994 levels. Emission from energy increased two-fold from 25.6 million tons of CO2e to

52.8 million tons of CO2e. However, emissions from LULUCF declined from 19.4 million tons of CO2e to 15.1 million tons of CO2e[3]

Table 5. GHG emissions by sector, in 1994 and 2000 (thousand tons of CO_2 e)

Year	1994		2000	
Sector	Emissions	Percentage	Emissions	Percentage
Energy	25,637.09	24.7	52,773.46	35.0
Industrial processes	3,807.19	3.7	10,005.72	6.6
Agriculture	52,450.00	50.5	65,090.65	43.1
LULUCF	19,380.00	18.6	15,104.72	10.0
Waste	2,565.02	2.5	7,925.18	5.3
Total	**103,839.30**	**100.00**	**150,899.73**	**100.0**

Source: Viet Nam's second national communication to the UNFCCC, 2010

Total greenhouse gas emissions in 2000 amounted to 150.9 million tons of CO_2 equivalent (tCO_2e), of which 65.1 million tCO_2e came from agriculture, 52.8 million tCO_2e from energy, 15.1 million tCO_2e from LULUCF, 10.0 million tCO_2e from industrial processes, and 7.9 million tCO_2e from waste[4] . In other words, agriculture is seen as the largest emitter in the economy following by energy and LULUCF sectors respectively.

Based on LEAP model inputs, outputs such as GDP, population, past trends of energy consumption, and end-use energy demand by sector are summarized in table 6 below[5]

Table 6: GHG emission estimates by source (thousand tones CO2 e)

Source	2010	2020	2030	Growth rate of 2010 - 2030 (%)
1. Energy industries	31,841.0	110,946.0	238,039.0	10.58
2. Energy use	81,280.0	140,062.0	232,748.0	5.40
Industry	*31,340.0*	*52,992.0*	*76,544.0*	*4.57*
Transportation	*28,236.0*	*48,601.0*	*86,037.0*	*5.73*
Agriculture	*2,066.0*	*2,444.0*	*2,901.0*	*1.71*

[3] Viet Nam's second national communication to the UNFCCC, 2010
[4] Source: Viet Nam's second national communication to the UNFCCC, 2010
[5] Viet Nam's second national communication to the UNFCCC, 2010

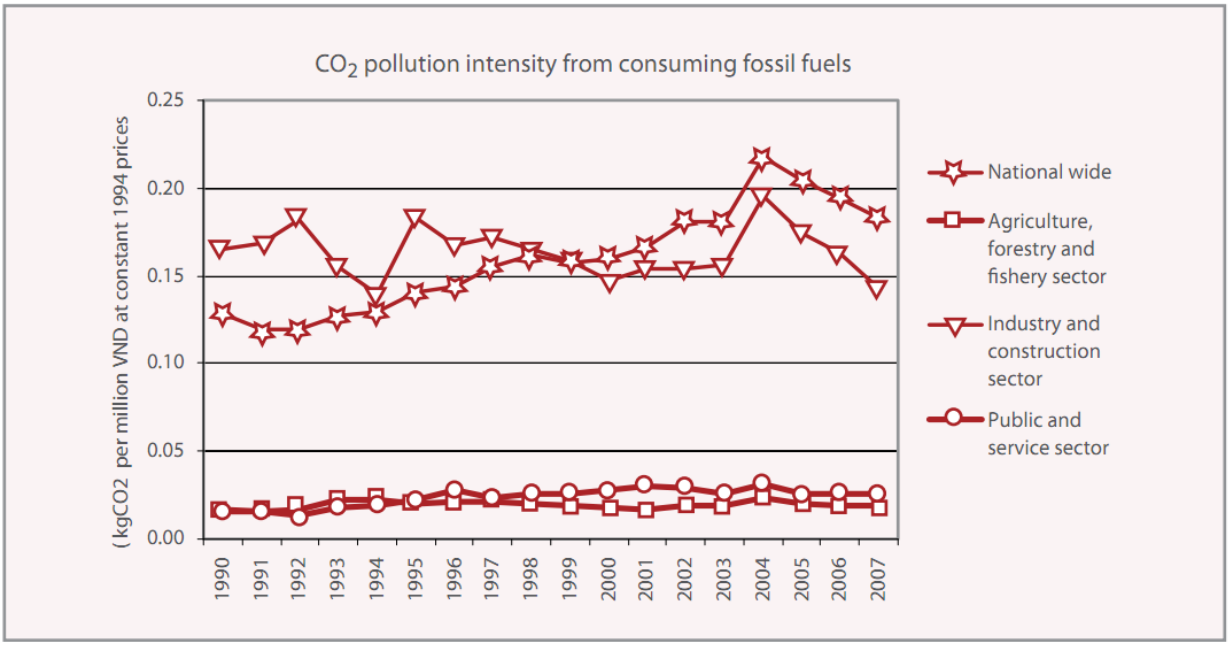
Residential sector	*13,994.0*	*25,313.0*	*49,373.0*	*6.32*
Commercial/institutional sector	*5,644.0*	*10,712.0*	*17,893.0*	*5.94*
Total (1+2)	**113,121.0**	**251,008.0**	**470,787.0**	**5.9**

Source: Viet Nam's second national communication to the UNFCCC, 2010. (LEAP model outputs).

In terms of energy use, transportation sector is increasing fast coming from behind industry sector in 2010, but would overtake it in 2030. The growths of energy use of residential and commercial sectors are also high with 6.32% and 5.94% per year respectively.

The intensity of CO_2 pollution from consuming fossil fuels was the highest in the industry-construction sector, and exhibited rather erratic movements in 1990-2007. The intensities of CO_2 pollution in the agriculture-forestry-fishery and services sectors, albeit being small, tended to increase gradually, resulting in the increase in intensity of CO_2 pollution for the economy as a whole (Figure 1). The key reasons to this are: i) increase in demand for fossil fuels, particularly from the industry-construction sector to support economic growth and industrialization; ii) outdated industrial technology which increase the use of highly CO_2-polluting energy inputs.

Figure 1: CO_2 pollution Intensity from consuming fossil fuels



Source UNESCAP, 2010. Eco-efficiency Indicators: Measuring Resource-use Efficiency and the Impact of Economic Activities on the Environment

4.3. Climate conditions and climate-related policies in Vietnam

4.3.1 Overview of the past and current climate conditions

Climate change is one of the most significant challenges facing human beings in the 21st century. Climate change will seriously affect life, production and environment worldwide. Temperature rise and sea level rise may cause floods and salt water intrusion, thus harm agriculture and pose risks to industries and socio-economic systems in the future.

The results of analysis of observed data indicated changes of climate parameters and sea level with the following noticeable features in the country:

- Temperature: During the last 50 years (1958 -2007) temperature in Vietnam increased about 0.5 to 0.7°C. Winter temperatures increased faster than those of summer and temperatures in Northern climate zones increased faster than those of Southern climate zones. The agricultural production in the North therefore has increasingly more disadvantaged conditions to the South. The annual average temperature for the last four decades (1961 to 2000) was higher than that of the three previous decades (1931 to 1960). Annual average temperatures for 1991 to 2000 in Ha Noi, Da Nang and Ho Chi Minh City were all higher than the average for 1931 – 1940 by 0.8; 0.4 and 0.6°C respectively. In 2007, the annual average temperatures at the, three locations were all higher than the average for 1931 - 1940 by 0.8 - 1.3°C and similarly higher than the average for 1991 - 2000 by 0.4 - 0.5°C (NTP, MONRE, 2008)

- Rainfall: At every location, change of annual average rainfalls for the last 9 decades (1911 - 2000) was not distinct and not consistent with each other. There were ascending and also descending periods. The annual rainfall decreased over Northern climate zones while increased over Southern ones. Rice production in the North has actually suffered more than in the South with its productivity has not increased much in the North. On average for the whole country, the rainfall over the past 50 years (1958 - 2007) decreased by about 2% (NTP, MONRE, 2008).

- Cold fronts: In the last two decades, the number of cold fronts affecting Viet Nam was reduced remarkably. Anomalous events, however take place more frequently such as the most recent extremely and damaging cold surge lasting consecutively 38 days during January and February 2008 in Northern Vietnam (NT, MONRE, 2008) and the most recent one at the end of 2010 and beginning of 2011 as well.

- Typhoons: In recent years, there were more typhoons with higher intensity affecting Viet Nam. Typhoon track has a tendency of moving southward and typhoon season tends to end later. There were more typhoons with abnormal movement (Vietnam Initial National Communication under the United Nations Framework Convention on Climate Change, MONRE, 2003). Agriculture was

the most affected sector by the typhoons with significant declines in its outputs. Construction was also considerably affected in the damaged areas.

- Drizzles: The average number of drizzle days in Hanoi gradually decreased since the decade of 1981 - 1990 and in the last 10 years, there was only half (15 days/year) of the long-term average number.

- Sea level: Data from tidal gauges along Vietnam coasts show that sea level rise was at the rate of about 3mm/year during the period of 1993 - 2008 which is comparable with the global tendency. In the past 50 years, sea level at Hon Dau station rose about 20cm (NTP, MONRE, 2008).

4.3.2. Climate-related policies: Policies responding to climate change and developing a low carbon society in Vietnam

a) National Target Program to Respond to Climate Change (NTP-RCC)

The program comprehensively addresses climate change effects, impacts and adaptation, specifically with regards to sea level rise, as well as GHG emissions mitigation. It touches on most sectors and will help address many challenges, and is a means to ensure inter-ministry communication and collaboration. This last task is supported by a steering committee chaired by the Prime Minister and an Executive Board, both with membership from several ministries.

b) Environmental policies

There a wide range of existing environmental policies in Vietnam. These are described below.

- *Legal Provisions in Environmental Protection Sector:*

+ The Law on Environmental Protection provides control of air emission in general: Organizations and individuals engaged in production, business and service activities that emit dust and gaseous wastes shall have the responsibility to control and treat dusts and air emissions to comply with environmental standards; Means of transport, machinery, equipment and construction works that release dust and gaseous wastes must be provided with filters and devices that reduce gaseous wastes to comply with environmental standards, and with coverings or other measures to minimize dust to comply with environmental standards.

+ The Law on Environmental Protection prescribes two sets of standards for air emissions:

i) A set of standards for industrial air emissions and other air emissions released from domestic, industrial and medical solid waste treatment and disposal facilities and other waste treatment; ii) A set of standards for vehicle emissions and other emissions released from specialized machinery and equipment.

To date, 95 technical standards to address air protection have been issued, including 26 technical standards for air emissions. Nitrogen oxides (NO_x) is one of the technical indicators mentioned in the industrial air emission standards for dust and inorganic substances. However, the enforcement of complying with these standards is not good in practice.

- *Legal Provisions on Environmental Impact Assessment.*

The Law on environmental protection requires owners of 162 new or improved projects to prepare an environmental impact assessment (EIA), including many projects having GHG emissions, such as projects involving cement production (designed capacity from 300,000 tons of cement upwards), thermal power (designed capacity from 30 MW or more), forest harvesting (with an area of 200 ha or more), and cattle raising (with 1,000 cattle or more). In addition, the Minister of MONRE has jurisdiction to decide which projects must prepare an EIA report, besides those mentioned above. One significant element of an EIA report is to assess in detail specific methods to mitigate adverse effects to the environment in general and air in particular.

- *Clean Development Mechanism*

The Clean Development Mechanism (CDM) under the Kyoto Protocol regulates the creation and trading of emissions reduction credits that are an offset against agreed emissions reductions in developed countries, from where revenue comes. The CDM is functioning in Viet Nam but not yet on a large scale. Barriers to full development of the CDM in Viet Nam include a lack of awareness in the business community, a lack of high-risk investment capital, a lack of appreciation among officials of the benefits of CDM projects, and limited capacities.

c) Energy policies

Vietnam also has a range of energy policies which have effects on emissions:

- *Policy on Electricity savings:* Electricity savings is one important element of the Law on Electricity of 2004. The law encourages all sectors to apply science and technology in electricity activities, to improve the efficiency of energy use, to protect the environment, and to exploit and use new and renewable energy to develop electricity. The competent State agencies are responsible for developing policies on electricity pricing that allows reasonable return on investments in electricity development, but also to save energy, use new and renewable energy in electricity activities, and contribute to the promotion of socio-economic development, especially in rural, mountainous, and island areas.

Existing legislation also provides for measures to encourage: i) Thrifty and efficient use of energy in industrial production, in buildings, for energy-consuming equipment and means, and in domestic life of people; ii) Mobilizing all people to participate in saving electricity, implementing

electricity saving in offices, activities, business and services, industrial production, electricity production and business, electricity-consuming equipment and means, and in lighting, using alternative energy; iii) The government also has established policies to develop new and renewable energy production like nuclear power and biofuels. The rate of nuclear power in the total national electricity supply will be increased gradually (about 11% in 2025 and 25-30% in 2040-2050). Biofuels will be developed to replace some conventional fossil fuel use. By 2025, biofuel production technology in Vietnam will be at its highest level, and ethanol production and vegetable oil will attain 1.8 million tons and meet 5% of gasoline demand. However, the policy to develop nuclear power should consider the safety of power plant operation and its economic effectiveness. The policy to develop biofuels should consider its impact on food security, especially the recent food crisis.

- *Energy efficiency policy:* Vietnam has one of the lowest per capita energy consumption rates amongst ASEAN nations, but at the same time has one of the highest energy intense economies. This indicates that energy efficiency of Vietnam in both, final users and conversion sector is very low. The inefficient energy use has caused so many problems for the country's economy and environment. Vietnam has therefore recently developed a national program to enhance effective use of energy with emphasise on both, supply and demand sides. The program is aimed at saving from 3-5% and 5-8% of the total energy consumption for the period 2006-2010 and 2011-2015 respectively.

Despite so much Vietnamese government's effort on energy efficiency, the results are still limited due to some inadequacies of the existing policy on energy efficiency.

Firstly, the policy emphasises promotion of effective management measures and advanced technologies on both the supply and demand side, but insufficient time is given to introduce those new technologies. Useful life time of the energy technologies, particularly the generation plants is usually 30-40 years but the program on energy efficiency is aimed at saving between 5 and 8% total amount of energy consumed within 5 years (from 2011 to 2015). To meet this target, almost old coal-fired plants must be retired. This is almost impossible as Vietnam's economy needs huge investment every year in the power sector in order to meet the increasing electricity demand which comes from increasing economic development activities. This program is too ambitious and was formulated without considerations of the country's economic conditions and the long-term perspective when analyzing the energy policy.

Secondly, there is a weak link between policy on energy efficiency and other policies such as energy pricing and environmental protection. At present subsidies are equally provided among different income groups instead of focus on affordable energy for disadvantaged one. This would

lead to less encouragement on the rich people in saving energy because they could enjoy the cheap subsidised energy prices. So, they can use more energy. Besides, the cross-subsidies would make industry less competitive due to high energy prices they have to pay for. Finally, the lack of focus on the area of high energy consumption growth, such as cooling would make the program failed because with limited resources, especially investment capital, Vietnam can not, at the same time, carry-out all activities for energy efficiency improvement.

- *Legislation and Programs Promoting Energy Efficiency:* The National Project in the period of 1996-2000 was set up for formulating the energy policy and it was submitted to the government and the document has still not yet endorsed by the Government.

In place of an existing legislation on energy efficiency, there are many programmes being supported by the international organisations like the World Bank, to lay foundation work to assist the Vietnamese Government to promote National policies on Energy Management and Efficiency. Some such efforts are:

i) Energy Efficiency Programs: A national wide program coordinated by the MOSTE. This Project is assisted by organisations from Japan, Netherlands and Germany. Programme supports several projects like Energy Saving in Small and Medium Sized enterprises.

ii) DSM Project: This project is coordinated by the MOI and supported by the MOSTE, The Ministry of Construction and the EVN. Funded by the World Bank, the project is in Phase II and in preparation of building up a demonstration project on commercial energy saving.

iii) Energy-Efficient Public Lighting: This project is coordinated by the National Centre for Natural Science and Technology and sponsored by the GEF. The first phase was finished in this year as PDFB. The phase II is in the National Energy Policy Review – Vietnam process of preparation. The aim of phase II is the realisation of efficient public lighting system in some big cities as a full scale demonstration project. GHGs abatement is also a subject of project. Presently a Governmental decree on Energy Saving and Efficiency is being drafted.

- *Policy on environmental protection:* In 1991, Vietnam approved a detailed environmental plan called the National Plan for Environment and Sustainable Development. The plan provides a comprehensive framework for establishing the strategies, policies, institutions, laws, regulations and programs needed to address environmental issues. The governing law on environmental protection came into force in 1993. This policy and legislation aim to develop the energy sector while preserving a clean environment at the national and international levels.

Despite a system of laws and regulations for environmental protection in place, the results of implementation of this legal framework in protecting environment from damage caused by energy activities are still limited..

The inadequacy of the environmental policies and regulations is one of the main reasons responsible for ineffectiveness of the legal system in environmental protection in Vietnam. That is because the existing environmental policies were formulated without carefully analysing their wider impacts on the economy and society. In other word, the environmental policy issues have not been addressed in a comprehensive way taking socioeconomic impacts into account. As a result, the contemporary environmental policies do not reflect the close relationship of energy, economy and environment leading to limitation in their application.

The poor communication and education on environment protection has caused poor public awareness about this issue. For example, pollution control generally appears to be non-productive, while the existing administrative system lets local government officials be judged almost entirely by how much they are able to increase their region's economic growth. Hence, they are sometimes likely to ignore polluters. This also leads to poor cooperation between the environmental monitoring agencies and polluters.

- *Legislation and Programs Promoting Co-generation:* In 1996-2000, Vietnam carried out the National Science Technology program on Strategy and Policy for Sustainable Energy Development for Period of 2001- 2020. Main target of this program is to create scientific bases for National Energy Policy. Based on these results Draft of National Energy policy was prepared and submitted to the Government. Some contents related to co-generation are outlined in this Draft as follows:

- In the context of policy for power development there are articles of priority of using combined cycle, clean coal technologies for co-generation.

- In the context of policy for energy conservation, co-generation system is considered an appropriate measure for energy conservation and environment protection.

To date, Vietnam does not have a separate program, legislation or national policy promoting cogeneration.

- *Legislation and Programs Promoting Biomass:* Biomass is a major component of noncommercial energy in Vietnam. It has more than 50% share in national energy balance in the past and will continue in the same status in the future (until 2020).

It is the main energy source in the rural area where 70-80% of the population still use it mostly for heating and cooking. It makes up about 98% of energy consumption in this area. To tackle use of biomass as a fuel efficiently, some of the suggestions from the studies conducted are:

- Rural energy development must be integrated into other development programmes such as poverty elimination, education and cultural development, health care, new life style, and protection from natural disasters.

- Encourage the use of commercial energy such as coal, gas, oil and support the use of renewable energy by financing, subsidising and provide similar financial assistance.

- Rational and efficient use and production of biomass resources by agriculture and forestry by-product processing into fuel, by special forestation for woods, by switching from wood to other fuel in ceramic, brick, lime production.

d) Agricultural and transportation policies

Other climate-related policies include those in agriculture, forestry and land use change; in industrial production; in transportation or even selected regulations on import-export policies etc… These policies all have impacts on the level of carbon intensity in the economy and climate change of the country.

According to the Prime Minister released decision No 661/1998/QD-TTg 29/7/1998 and 100/2007/QD-TTg 6/7/2007 regarding objectives, tasks, policies and organizing the implementation of a project designed to replant 5 million hectares of forests by the year 2010. The project was approved during the second session of the tenth NA to aim to increase forest coverage to 40% of the country area, protect existing forests and plant new ones, effectively promote the biological function, create a material area combining with the development of forest product processing, create jobs and increase incomes for people, contribute to poverty reduction, and ensure national defence and security. The target of the project is to plant five million hectares of forest in the 1998-2010 period, including 2 million hectares of protective and specialized forests, and 3 million hectares of productive forest. The project also targets to restore 2 million hectares of natural forest. The total capital for the project is expected to reach 31,650 billion VND[6]. For the last decade, this policy has had strong impact on lowering carbon level in Vietnam.

Other policies may include the Directive No. 85/2007/TC-BNN on 11/10/2007 of MARD on promoting reforestation and planting coastal barrier trees and the Resolutions No. 26 NQ/TU dated August 5, 2008 at the 7th Conference of the Central Committee of Vietnam Communist

[6] http://www.cpv.org.vn/cpv/Modules/News/NewsDetail.aspx?co_id=0&cn_id=100477

Party on agriculture, farmers and rural areas. The Resolution emphasized the goal of "capacity building the capacity on natural hazard prevention and mitigation and rescue; implement works for a step to reduce the harmful effects of climate change and sea level rise ... "The Prime Minister also directed at the Decision No. 172/2007/QD-TTg November 16, 2007 approved National Strategy for natural hazard prevention and mitigation to 2020. The Ministry of Agriculture and Rural Development (MARD) is now also developing a Project for reducing GHG emissions in the agricultural and rural areas by 2020.

The ministry of transportation has also promulgated Action plan adapting to climate change in the period 2010-2015 of transportation sector just signed by the Minister in the decision No. 199/QĐ-BGTVT on issuing the action plan adapting to CC of the ministry for period of 2011-2015. According to the decision, general objective of the action plan is to build capacity for adaptation to CC to develop transportation sustainably. Content of the action plan is to assess impact of climate change on fields of transportation sector; build, propose and implement measures adapting to climate change for the sector; propagate and disseminate information, develop human resource, and build capacity for agencies and units. To implement these objectives and content successfully, the Ministry proposed measures on mechanism and policy, measures on organization, management and international cooperation, measures on finance and technique.

4.3.3. Supports from development organizations on low carbon and climate-resilient development in Vietnam

World Bank:

Globally, the World Bank Group plays a key role in financing climate change (CC) adaptation and mitigation, including a leading role in the development of carbon markets that are now directing funds towards low-carbon, 'clean' development.

In Vietnam, the Bank has a wide range of activities and investments underway, and these will be scaled up substantially in the coming years. Coordination with the Government and with other donors and NGOs is critical, as there are a large and diverse array of climate change studies and projects underway or planned in Vietnam. In collaboration with many parties, the Bank has produced and maintained a simple matrix of climate change activities in Vietnam. The matrix includes brief information and links to further information on about 25 CC activities the Bank is involved with in Vietnam. The World Bank is already making investments that will help Vietnam respond and adapt to climate change - for example on disaster risk reduction, agricultural diversification, and infrastructure development. On the mitigation side, the Bank support investments to reduce the country's footprint on the global climate commons through supporting

renewable energy development, energy efficiency improvements, and improved forest management.

UNDP:

UNDP Viet Nam recognizes that long-term environmental management is a key to sustainable development. It has made a major commitment to provide advocacy, expertise and resources to help Viet Nam's government and people protect their health and preserve their natural resources. UNDP supports the need for integration of environmental issues into education, investment planning and decision making.

Viet Nam's rich biodiversity and natural environment must be managed for future generations. Supporting the linkage of poverty reduction and environmental stewardship, UNDP is working with international partners to develop laws, expertise and public awareness. Education and outreach are essential. UNDP also supports developing more sustainable environmental practices in urban areas, providing people with environmentally-sensitive alternatives for income generation and the development of a National Education Strategy.

GEF:

The Global Environment Facility (GEF) is the official financing mechanism of the UNFCCC, and is expected to receive increased funding if governance of the GEF is improved. Viet Nam may also get financial resources from the Adaptation Fund (funded by a CDM levy under the Kyoto Protocol); from climate financing windows of the development banks; and from REDD or (other) new financing windows that are expected to be created under the UNFCCC. This would all be in addition to focused bilateral ODA. These financing opportunities are expected to follow different ODA modalities and will result in partnerships with different stakeholders in Viet Nam, including sector ministries and provincial authorities. Viet Nam will need substantial capacities to access such funds, requiring concerted efforts to learn about funding options, as well as excellent cooperation between the MOF, MPI, MONRE, MARD, MOIT, and other sector ministries. Viet Nam could also follow the example of other countries and take a programmatic approach to addressing the research, technical and capacity building aspects of the NTPRCC as well as the actions currently being formulated under the sectoral and provincial actions plans. This could then become the programmatic basis for setting up a climate change Trust Fund to receive and manage international funds according to nationally appropriate, harmonized rules, especially for funds aiming at technical assistance and capacity building.

JICA:

Measures against climate change are closely related to development issues in Viet Nam and need to be implemented based on a long-term vision that also realizes sustainable development. JICA supports the formulation and implementation of policies that both tackle climate change and drive sustainable development in Viet Nam by drawing on past experiences and results.

JICA provides assistance associated with low-carbon development in Viet Nam by leveraging Japan's experience and technology, including those of the private sector. Support efforts focus on stimulating sustainable development while reducing greenhouse gas emissions and include promoting the use of renewable energy, electrification in regions without electricity through clean energy, establishing low-carbon transport systems and forest conservation and forestation programs. JICA also helps link Clean Development Mechanisms (CDM) with poverty reduction by providing financial assistance for CDM registrations of development projects. By making use of the additional benefits afforded through CDM in poverty reduction programs, JICA can get Viet Nam to aim for both poverty reduction and sustainable growth.

4.3.4. Review of low carbon and climate resilient projects and studies in Vietnam

In recent years, studies have been carried out by governmental agencies, science academies, universities, institutes and NGOs with international assistance at different levels and in various forms. In general, research themes focus on: i) Basic climate change knowledge, and vulnerability analysis and assessment of Viet Nam's coastal zones; ii) Analysis of climate change impacts on the natural conditions and resources of Viet Nam and mitigation and adaptation strategy formulation to ensure Viet Nam's sustainable social and economic development; iii) Agro-climate change impacts in seven eco-regions; adjustment strategies for agricultural planning and production, and rural sustainable development; iv) Climate change impact assessment for water resources; v) Climate change and sea-level rise scenarios for Viet Nam; vi) Development of electricity grid emission factor for the preparation of Viet Nam's CDM projects; vii) Development of renewable energies and energy efficiency; viii) Development and assessment of mitigation options for energy, agriculture, forestry and land-use change; ix) Piloting adaptation measures in some provinces, such as Quang Nam, Ben Tre and Thua Thien Hue; x) National CDM strategy and CDM project formulation capacity-building; xi) Technology needs assessment for adaptation and mitigation to climate change.

As part of the implementation of the National Target Program to Respond to Climate Change, Viet Nam is developing the Scientific and Technological Program on Climate Change, with the aim of establishing a scientific foundation to support policy making, strategy formulation and action plan development for climate change response. Furthermore, Viet Nam is part of UNEP's

Global Technical Needs Assessment Project - Phase I (2010-2011), which assesses the country's technical needs with support from UNEP.

The summary of the projects which involved in Vietnam's CDM projects, renewable energies and energy efficiency, mitigation options for energy, agriculture, forestry and land-use change are presented in Appendix 8.

Conclusion of review of existing/current studies

From the previous and on-going studies, it can be seen that although the number of studies on low carbon development and climate change impact is large, they analysed only specific aspects of low carbon and climate change impact such as potential for Vietnam to participate in the CDM, benefits on climate change adaptation from small and medium scale hydropower plants, promotion of renewable energy, energy efficiency, rural energy, forest sector development, priority infrastructure investment, demand-side management and energy efficiency, biodiversity etc… It is therefore that a comprehensive study on patterns of economic growth that will be climate resilient and low carbon for the whole economy is still lacking. There has not been any study investigating both adaptation and mitigation processes and inter-sectoral impacts during these to processes for Vietnam. In addition, the data serving for low carbon and climate resilient studies seem to be somehow out-of-date with the latest information came from 2000. Methodologically, there has not been any study combining both top-down and bottom-up approaches in a very comprehensive manner. This proposed study would be a very good evidence-based research providing policy makers with various options of lowering carbon intensity and adapting with climate changes and their impacts on the economy while keeping economic growth in the long term.

4.3.5. Future scenarios of energy consumption and climate change

4.3.5.1. Future scenarios of energy consumption

Large demand and large change

The MOIT has currently finalized the draft report on National Energy Policy for submission, there are has been assessment and analyse of Vietnam's energy situation and making forecast of energy demand for coming years.

Table 7: Vietnam energy demand for the next decades

Demand type	2010	2020	2050
Industrial energy demand (Mill. of TOE)	13.4-14.0	25.4-28.0	110-131
Energy demand for transportation sector (Mill. of TOE)	11.3-12.0	21.5-24.0	55-72
Energy demand for agricultural sector (Mill. of TOE)	1	1.4-1.5	3.4-3.8
Energy demand for service sector (Mill. of TOE)	2.2	3.7– 4.3	16-21
Household energy demand (Mill. of TOE)	4.4	8.2-8.6	22-24
Electricity elasticity/GDP	>1	<1	<1
Domestic coal demand (Mill. tones)	20-30	30-40	150-190
Consumption growth of petroleum products	6-7%		4-4.5% (2011-2050)

Source: Draft report on National Energy Policy (MOIT, 2011)

According to the report, the average growth rate of period 2001 - 2020 is 9.2 – 9.7%/year, 2021 - 2050: 5 – 5.3%/year for industrial energy demand. Ratio of industrial energy consumption comes up to 42% by 2020 and 52 - 53% by the year 2050. For the transportation sector, the ratio of its consumption is expected to come down from 35% currently to 27% by 2050. For the service sector, the ratio of service sector's consumption is stable in range of 7 - 8%. For the household use, its energy consumption will be increased relatively upon population increasing, urbanization and income level. The ratio of its consumption will be coming down from 14% at present to 10 - 12% after 2020.

Up to period 2010 - 2020, the electricity demand is continuously increased rather than GDP growth rate, with its electricity elasticity/GDP more than 1; Since 2020, its elasticity will be less than 1. Coal use will be increased constantly. Especially, Vietnam is developing country, it is therefore petroleum products consumed that will be increased, with its growth rate of about 6 - 7%/year for the period 2011 - 2020 and 4 – 4.5%/year for 2021 - 2050.

Vietnam will be turned into energy imported country

Based on the country of energy export, but it may be from 2013, Vietnam will be turned into energy- imported country with rate at 25 - 27% in 2020, and about 57 - 62% by 2050 (not including nuclear power). These figures of imported energy will be increasing, if from now on

Vietnam has no investment plan in order to balance supply and demand for energy. According to estimation made by EVN, total investment for whole energy sector for period 2002 - 2020 will be reached 78.5 Billion USD, of which the plan of 2002 - 2010 needs 36.9 Billion USD, and 2011 - 2020 requires about 41.6 Billion USD. The investment in electricity sector will consist of 4% GDP for period up to 2010, and 2.5% for the period 2011 - 2020; the investment for oil and gas sector will account for 1.7 - 2% GDP for period after 2011; Coal Investment will comprise 0.15 – 0.2% GDP for the same period.

The energy saving and efficiency

According to MOIT assessment, Use of energy saving and efficiency has significance in energy development. It is anticipated that if power elasticity come down (the growth rate of energy consumption /GDP growth rate for the same period) from 1.46 at present to 1 in 2010, and 0.9 in 2020 and 0.8 for the years after , it can save about 1 Million TOE, equivalent to 250 Mil. USD in 2010, and 2 Million TOE (approx. 500 Million USD) by 2020. The focus of reducing elasticity is given priority to industry and transportation - 2 sectors of most energy use (accounting for 38% and 35% of energy needs), and then commercial, service and household.

Vietnam's industry currently has high energy intensity: to get 1,000 USD of value added, it needs 600 - 700 kg of TOE. Main solution applied in "National Energy Policy of Viet Nam" are technology innovation, management improvement, maintenance, equipment incentive; upgrade technology, replacing low effective machinery by modern and high effective ones; implementing solution science and technology in order to create equipment and facilities of energy saving and efficiency. According to estimate of MOIT, to increase 1 VND of GDP, the energy requirement in Viet Nam should be doubled , while the same ratio in developed countries is 1. Energy effectiveness in coal and oil electricity Plants currently is about 28-32%, less than 10% compared to other countries, and the effectiveness of industrial steamed units only reach 60% , mean less than the international average level of 20%... Energy use for product unit in Vietnam is also higher than that ones in other developed countries, especially in steel and cement industries.

Energy low effectiveness due to backward technology

In 2006, the Vietnam's Government has approved National Target Program on use of energy saving and Effectiveness, established Energy Conservation Committee (ECC) in MOIT. The Law on use of energy saving and Effectiveness has been approved by Vietnam National Assembly in Oct/2010, and being effective from 01/01/2011. According to assessment, beside the weak production management, it is backward technology that is main reason to consume more energy. Statistics pointed that, there are 50-60% of total enterprises using backward technology, including

new purchase of equipment , but in fact, that is backward technology. The Vietnam's enterprises like to import Chinese equipment and technology of cheap price, but that are causing high pollution and energy consumption.

National Energy Development Strategy

National Energy Development Strategy of Vietnam up to 2010, outlook to 2050 (NEDS) was approved by the Prime Minister at Decision No. 1855/QD-Ttg dated 27/12/2007. The General objectives of the strategy is to contribute to the successful implementation of the objectives in the Party's socio-economic development strategy, the general objectives of NEDS include: ensuring national energy security in order to maintain national security and defence and to develop an independent and sovereign economy; ensuring sufficient and high-quality supply of energy for socio-economic development; ensuring effective exploitation and usage of domestic energy sources; ensuring investment and business diversification in the energy sector, establishing and developing a healthy competitive energy market; accelerating the development of new and renewable energy, biological energy, nuclear energy to meet the demand for socio-economic development, especially for remote, border, and island areas; ensuring rapid, effective and sustainable development of the energy sector together with environmental protection.

The government also approved or in the process of approving a number of master plans on energy development for period 2011-2030 such as VII Electricity Master Plan, Coal Exploitation Master Plan, Oil and Gas Exploitation Master Plan and Nuclear Power Master Plan. All these Master Plans give a clear picture of the government plans for meeting estimated energy demand and supply. More detailed information of these Master Plans is presented in Appendix 5.

4.3.5.2. Climate change scenarios for 2020, 2030 and 2050

The purpose of developing the scenarios of climate change, sea level rise for Vietnam is to provide the basic information of the future trends of climate change and sea level in Vietnam, corresponding to different scenarios of global socio-economic development which cause different emission rates of green house gases. These scenarios of climate change, sea level rise are the preliminary basis for ministries, sectors and provinces/cities to assess possible climate change impacts on socioeconomic sectors, to develop and implement their respective action plans for responding to and reducing potential impacts of future climate change.

- Criteria for the selection of methods for climate change scenario development in Vietnam include: (1) Plausibility of global climate change scenarios; (2) Level of details of climate change scenarios; (3) Inheritability; (4) Up-to-date; (5) Local appropriateness; (6) Completeness of scenarios; and (7) Possibility of self updating.

- Based on the analysis of the above mentioned criteria, the results of the calculations using MAGICC/ SCENGEN 5.3 software and statistical downscaling method are selected for the development of climate change scenarios, sea level rise for Vietnam in the 21st century.[7]

Greenhouse gas emissions scenarios selected for the development of climate change scenarios: Low emission scenario (B1), Intermediate emission scenario of the medium scenario group (B2), and intermediate scenario of the high scenario group (A2). (B2) scenario is most expected to happen and thus its results are presented here.

a) Temperature

Temperatures in winter can increase faster than those in summer for all climate zones. Temperatures in Northern climate zones can increase faster than those in Southern climate zones.

In medium emission scenario (B2): By the first year (2020, 2030) and between 2050 of the 21st century, annual mean temperatures in Northern climate zones would increase by 0.5 to 1.5°C relative to the baseline period (1980 -1999). The increase in temperatures in Southern climate zones is expected to be less than that of Northern climate zones and is about 0.3 to 1.0°C (Table 8).

By the end of the 21st century, annual mean temperatures would increase about 2.6°C in the North West, 2.5°C in the East West, 2.4°C in the North Delta, 2.8°C in the North Central, 1.9°C in the South Central, 1.6°C in the Central Highlands, and 2.0°C in the South compared to the average of 1980 - 1999 (Table 8).

Table 8: Changes in Annual Mean Temperature ((0C) relative to period of 1980 - 1999 Medium emission scenarios (B2)

Climatic Region	Decades in the 21Century								
	2020	2030	2040	2050	2060	2070	2080	2090	2100
North West	0.5	0.7	1.0	1.3	1.6	1.9	2.1	2.4	2.6
North East	0.5	0.7	1.0	1.2	1.6	1.8	2.1	2.3	2.5
North Delta	0.5	0.7	0.9	1.2	1.5	1.8	2.0	2.2	2.4
North Central	0.5	0.8	1.1	1.5	1.8	2.1	2.4	2.6	2.8
South Central	0.4	0.5	0.7	0.9	1.2	1.4	1.6	1.8	1.9
Central Highlands	0.3	0.5	0.6	0.8	1.0	1.2	1.4	1.5	1.6
South	0.4	0.6	0.8	1.0	1.3	1.6	1.8	1.9	2.0

MONRE, 2009: Climate change, sea level rise scenarios for Vietnam

[7] MONRE, 2009: Climate change, sea level rise scenarios for Vietnam

b) Rainfall

Rainfall in dry season would decrease in most climate zones, especially in Southern climate zones. Rainfall in the rainy season and the total annual rainfall would increase in all climate zones.

In medium emission scenario (B2): By the first year (2020, 2030) and between 2050 of the 21st century, annual mean rainfall in Northern climate zones would increase by 1.4 to 4.1% and about 0.3-1.7% in Southern climate zones (South Central, Central Highlands and South zones) relative to the baseline period (1980 -1999).(Table 9). Rainfall in the period of March to May would decrease about 0.9 – 5.2% in Northern climate zones; rainfall in the middle of the dry season in Southern climate zones would decrease up to 2.0 – 9.1%, relative the period of 1980 - 1999. Rainfall in the middle of the rainy season would increase 2.4-7.9% for the Northern climate zones and increase 2.4-6.8% for the Southern climate zones, relative to the period of 1980 - 1999.

Table 9: Changes in Annual Rainfall (%) relative to period of 1980 – 1999, Medium emission scenarios (B2)

Climatic Region	Decades in the 21Century								
	2020	2030	2040	2050	2060	2070	2080	2090	2100
North West	1.4	2.1	3.0	3.8	4.6	5.4	6.1	6.7	7.4
North East	1.4	2.1	3.0	3.8	4.7	5.4	6.1	6.8	7.3
North Delta	1.6	2.3	3.2	4.1	5.0	5.9	6.6	7.3	7.9
North Central	1.5	2.2	3.1	4.0	4.9	5.7	6.4	7.1	7.7
South Central	0.7	1.0	1.3	1.7	2.1	2.4	2.7	3.0	3.2
Central Highlands	0.3	0.4	0.5	0.7	0.9	1.0	1.2	1.3	1.4
South	0.3	0.4	0.6	0.8	1.0	1.1	1.2	1.4	1.5

Source: MONRE, 2009: Climate change, sea level rise scenarios for Vietnam

c) Sea level rise

Sea level rise is one of the most negatively affected factors of climate change in Vietnam. The forecasted sea level rises of the country in the next decades are presented in Table 10.

Table 10: Sea level rise (cm) relative to period 1980 - 1999

Scenarios	Decades in the 21 Century								
	2020	2030	2040	2050	2060	2070	2080	2090	2100
Low emission scenario (B1)	11	17	23	28	35	42	50	57	65
Medium emission scenario (B2)	12	17	23	30	37	46	54	64	75
High emission scenario (A1FI)	12	17	24	33	44	57	71	86	100

Source: MONRE, 2009: Climate change, sea level rise scenarios for Vietnam

The information from these scenarios is really useful in analysing specific impacts of climate change on various sectors in the economy.

V. Appraisal of the scope and methodology proposed for the Study and selection of relevant models for Vietnam

5.1. Scenario modeling for low carbon planning

Scenario modelling and sharing of data is an important part of the low carbon development planning process. It typically functions on two levels:

- By focusing on sectors with high greenhouse (GHG) emission levels -- energy, transport, land use, forestry, agriculture and waste management -- modelling helps understand where each sector currently stands and the direction in which it is moving with respect to the level of GHG emissions. It helps to identify emission drivers and plans, and resources for GHG abatement. It helps choose appropriate technologies, evaluate their production output and capital and operating expenditures, evaluate any climate resilience considerations, and look at the uptake of low carbon solutions from the private investor's point of view.
- Modelling at the country and regional level allows policy makers to evaluate where a country wants to be at a particular point in time and what may be needed to achieve this. It looks at relative competitiveness and trade flows with other countries and regions, changes in demand caused by price elasticities, and the impact of different development pathways on taxes, and employment.

Scenario modelling typically involves:

a. Establishing a Macroeconomic Outlook. This entails forecasting population, GDP, and other macro-economic variables for a pre-defined time horizon – typically 20 or 25 years.

b. Building a base-year picture of the sector or economy from which it will be possible to forecast the future impact of development objectives and national strategies relating to greenhouse gas emissions mitigation.

c. Developing a forecast for the time horizon that takes account of current development plans and constraints to arrive at a best case option. This forms the basis of what is called a '*Reference'* scenario. The reference scenario includes a description of primary energy resources like coal, oil, gas, biomass, and wind, geothermal and nuclear power. It identifies how those resources are used for electricity production and for multiple other purposes, such as steam production in industry or air conditioning and space heating in buildings, and transport. It describes the national demand for electricity. A Reference scenario or Best Business scenario is built by evaluating the best-business decisions that would be made over future years, without taking into account the need for GHG emissions reduction, based on the existing situation, as well as commitments and targets 20-25 years into the future. It describes primary energy resources and their uses, as well as the GHG emissions, by sector. The reference scenario also describes other energy uses and GHG emissions from other sources such as agriculture, land use change and industrial emissions. It establishes the most likely developmental path.

d. Establishing alternative development scenarios over a given time horizon, that have lower greenhouse gas emissions. These will help identify where the mitigation potential lies. It includes an assessment of financial and economic costs, institutional capacity and barriers to arrive at the Low Carbon Scenarios.

   Analysis is done by modifying the Reference or Best Business scenario by including the opportunities for climate change mitigation with an objective to minimize GHG emissions. This step involves selecting policy actions and investments from all the possible interventions aligned with the national development objectives that would lower GHG emissions. Scenarios are built as combinations of interventions. At this stage, costs and benefits of low carbon measures are estimated and the impacts of uncertainties and possible slippage are included in the analysis through sensitivity analyses and other analytical tools.

   When cost and benefit analysis is completed, mitigation measures–technological interventions, policy, regulatory, and institutional frameworks - can be prioritized. This is not a purely technical process, but rather a political decision made on the basis of modelling outcomes, as well as various political and institutional considerations that cannot be quantified in the model. A marginal abatement cost curve is one tool that helps prioritize options. It maps CO_2 emission reduction potential against the abatement cost, for a range of technologies.

However it has to be used in conjunction with other tools and data since it does not, by itself, convey the magnitude and timing of any investment needs, the difficulty of implementation and any transaction costs.

e. Identifying financing needs and options to mobilize resources to fund incremental costs associated with each low carbon scenario.

f. Identifying other actions needed to create the required enabling environment. By analyzing multiple scenarios and carrying out a comparison with the reference scenario, one can formulate a strategy that fulfils national development goals. It is important to have a realistic strategy, the one that takes into account available resources, including energy resources and infrastructure, and feasible development pathways and timetables.

In selecting models for their inclusion in this suite, there are a number of factors to be considered. In the following sections we will look at:

- Bottom-up models
- Top-down models
- Linking the two
- Data requirements

5.2. Bottom-up models

Simplified, open and transparent accounting tools are available for bottom-up modelling that have the benefit of supporting the engagement of multiple stakeholders in the planning process, sharing assumptions and scenario analysis while building ownership and consensus at the same time.

A key advantage of a bottom-up approach is that it allows the assessment of efficiency scenarios for a wide choice of technologies for demand-, and supply-side interventions, looking at how the uptake of each can affect sectoral results. This approach is also useful to evaluate the incentives that an individual investor might require to make the adoption of each low carbon technology attractive.

A core difference between the bottom-up and top-down modelling approaches is the type of input information used. In a bottom-up model, data are gathered from energy consumers and about equipment and appliances in a country. It could be for example all power plants or all types of cars that are in-use. These data are then integrated by the model to provide an assessment of the total energy consumed and produced. Since it does not project supply and demand from historic tendencies, it can react quickly to changes in technology and policy that are modelled in each

scenario. Therefore the model can be directly used for planning improvements. Since changes are based on engineering fundamentals, bottom-up models tend to be conservative in their outputs. The down side is that they require extensive data collection and validation before a valid output on a national level can be produced.

Bottom-up models thus typically require a lot of data, and the data collection can take time, however it is useful to start the data collection and modelling effort with a bottom-up approach to help build this ownership.

The objective of a low carbon development planning process is to choose the optimal pathway for the country towards a low carbon economy (green growth) and define the priorities involved in moving forward; what investments should be made, in which sectors, and in what order. However the low carbon development planning process is also a useful first step towards defining Nationally Appropriate Mitigation Actions (NAMAs) and in structuring the Monitoring, Recording, and Verifying (MRV) framework needed to monitor outcomes. Once the country embarks on this development pathway it will want to, and need to, monitor progress continually, reporting advances achieved, possibly several times per year. With this in view, the data collection process for bottom-up modelling achieves greater significance as it becomes the starting point for establishing a continually updated flow of data that can be used in MRV and for future modelling.

Thus bottom-up models should not be selected based on currently available data, but rather based on the data flows that will be required in the future. Where data gaps initially force surrogate data to be used, plans should be put in place to remove them one by one substituting better quality data for these initial estimations. Also, bottom-up models do not necessarily have to cover the whole economy; they can concentrate on those sectors in which cost-effective interventions can be made to modify the development trajectory to a greener path.

There are several good bottom-up models --such as LEAP-- that exist and can be used in a low carbon planning process. At this point in time, the scoping study has not identified any multi-sectoral models in Vietnam that are in use and populated with up-to-date data. If such are identified, the possibility of using them in this study should be considered. Additionally, there are always a number of specialized models in use in different sectors (For example: WASP for power planning or HAIDEP for transport demand forecast modelling in Hanoi) and the outputs from these models should be integrated as much as possible into any sectoral or economy-wide low carbon analysis.

The proposal, in the absence of the above, is to use and develop the following for Vietnam's low carbon planning study.

PAGE09 model

The PAGE09 model is the upgraded version of PAGE02 model by Dr. Chris Hope from University of Cambridge. This is an integrated assessment model designed for IPCC to assess globally the economic impact of greenhouse gas mitigation.

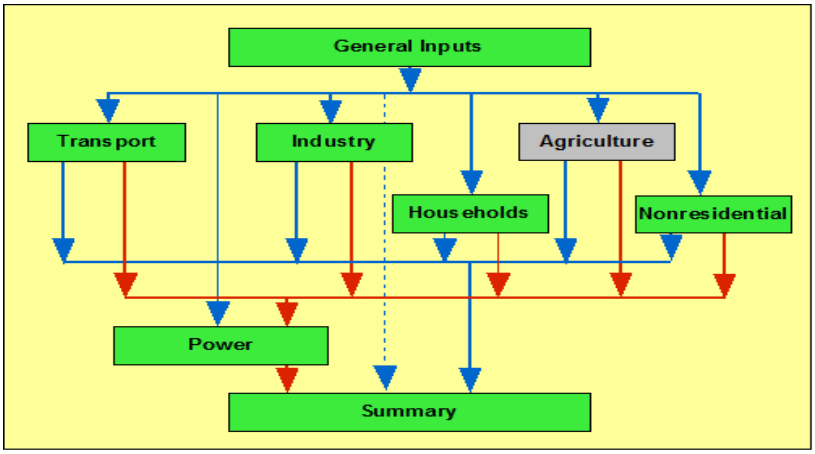
The model is based on Excel07 running with RISK 5.5 software. It covers 8 regions in the world with 4 greenhouse gas and 10 year analysis. The input is divided into deterministic and stochastic ones which RISK 5.5 software is used to estimate mean values with assumed distribution and extreme values. The model is simulated for different policies of greenhouse gas mitigation and taken the first difference to estimate the net benefit of mitigation.

Empirical evidence shows that the world will benefit 375 thousand billion USD for the next 100 years if the amount of greenhouse gas is declined by 5 per cent annually from 2016. This estimator is separated into 8 regions included in the model and the output of the model is a valuable evidence for IPCC to call for greenhouse gas reduction. The application of this model into Vietnam, however, seems to be irrelevant. Technically, Vietnam can represent one region in the model and other Asian countries can represent for the rest of Asia. However, Vietnam is practically a small country that its major inputs for the model such as GDP or population is relatively too small to other regions. This reduces the correlation between Vietnam and other regions in the model and is believed to produce inconsistent estimates.

EFFECT - Energy Forecasting Framework and Emissions Consensus Tool

The Energy Forecasting Framework and Emissions Consensus Tool (the EFFECT Model) was originally developed by the World Bank with the Government of India as a consensus-building and planning tool to analyze key sectors of the economy (Figure 2) and assess the impact of policy choices on GHG emission levels. The EFFECT model has additionally been applied in other studies; it has been used to analyze GHG emissions trajectories from on-road transport in 9 city-level studies in six countries in the East Asian Pacific region (including Ho Chi Minh City and Hanoi) and to develop the low carbon study for on-road transport in Brazil. It is being used in the Nigeria low carbon development study and the household energy module has been used to analyze consumption in Indonesia, Philippines, Thailand, and Vietnam.

Figure 2: EFFECT Model Structure



The EFFECT Model targets planners and modellers working on low carbon development scenarios. It supports engagement with a broader group of stakeholders–policymakers, research institutes, academia, private sector, civil society–on model inputs and analysis of modelling results.

EFFECT is a user-friendly, low-cost, bottom-up, engineering-style model that uses Microsoft Excel and Visual Basic to transparently share assumptions and data, and model energy supply and demand and emissions over 26 years. The EFFECT model is designed to be housed, further developed, maintained and run by local selected institutions in each country. The objectives of its design as a bottom-up model are:

- to examine alternative scenarios;
- to produce a refined and expanded set of assumptions, scenarios and outputs;
- to contribute to the assessment of available GHG projections, mitigation potential and associated costs; and
- to be sufficiently flexible to adapt easily to a changing set of assumptions and requirements in each country.

The EFFECT Model focuses on 5 sectors that contribute to and are expected to experience rapid growth in emissions and is particularly suited to a rapidly growing and industrializing economy (Appendix 2):

Supply:

- Electricity generation, both grid and captive, and transmission and distribution

Demand:

- Six energy-intensive industries with significant potential for future expansion--iron and steel, further separated into large integrated steel plants and small-scale plants; aluminium; cement; fertilizer; refining; and pulp and paper
- Non-residential buildings
- Residential electricity use
- Road transport, comprising two-wheeler vehicles to heavy-duty trucks and buses

The EFFECT model provides the following outputs in a pair-wise comparison of scenarios for multiple scenarios:

- Annual energy use at the point of consumption in each sector (e.g. power generation unit, appliance use, vehicle fuel consumption) from the initial year to the terminal year (e.g. 2008 to 2030)
- Annual GHG emissions resulting from energy consumption in each sector on an annual basis over the modelling period
- Local pollutant emissions from transport for each time period
- Process emissions from industry on an annual basis over the modelling period
- Investment, operating and maintenance costs and fuel costs by energy point of consumption in each sector for each time period
- Fuel consumption and costs by point of consumption in each sector for each time period
- Costs of reducing GHG emissions in net present value.

The model enables the construction of marginal abatement cost curves.

E-Learning Program | Low Carbon Development and the EFFECT Model

To facilitate broader dissemination and use of the EFFECT Model, an e-learning program has been developed for policymakers, planners, and modellers. It provides a detailed introduction to low carbon development planning and includes 4 courses:

1. How to EFFECT Low Carbon Development: For Policymakers
2. How to EFFECT Low Carbon Development: The Power Module
3. How to EFFECT Low Carbon Development: The Transport Module
4. How to EFFECT Low Carbon Development: The Household Module

Drawing on experience from the ESMAP and the World Bank low carbon development country study portfolio, the e-learning program introduces policy makers and practitioners to a process for developing consensus on low carbon pathways, methods and tools for constructing low carbon scenarios, the data requirements, and interpretation of results. Upon completion of the courses, users should be able to use the EFFECT Model for low carbon planning immediately.

Each e-learning course is complemented by exercises to reinforce lessons, a game that allows users to test low carbon development concepts in a virtual country, and the model itself embedded with help facilities and demonstration videos. It is recommended that the entire e-learning program is taken if you intend to use the EFFECT Model. However, this e-learning program provides a useful introduction to low carbon development planning regardless of whether the EFFECT Model is the tool you chose for scenario and consensus building. The EFFECT Model and E-learning program will be available in March 2011.

Land use, land use change and forestry, and Agriculture

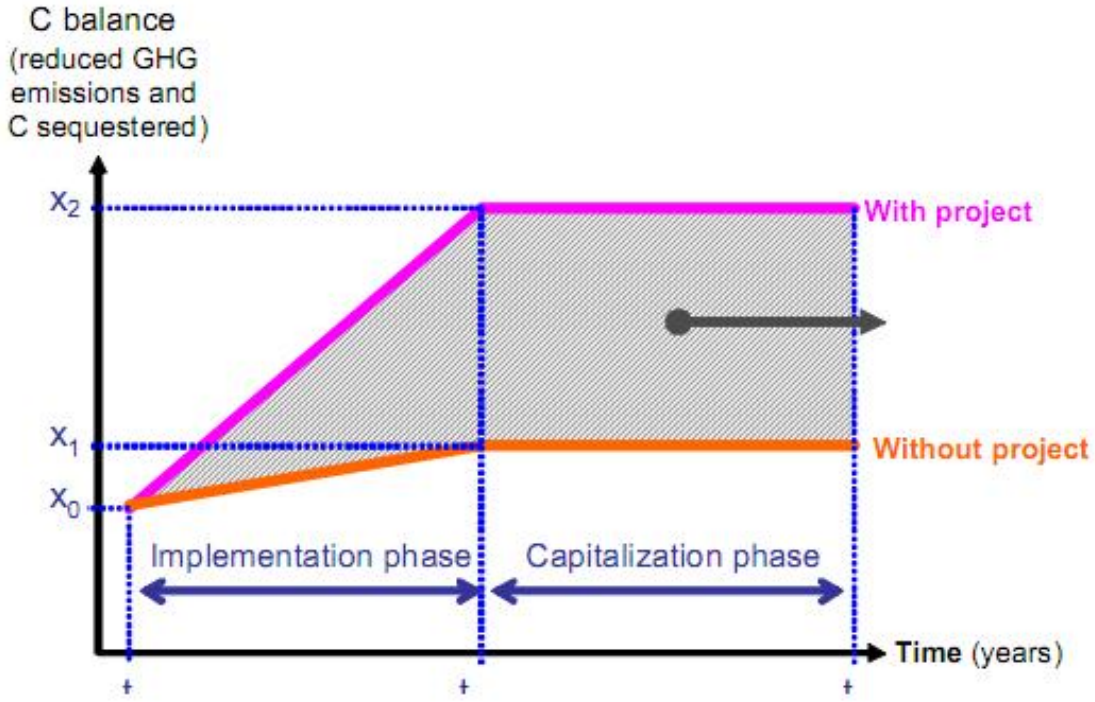
The EFFECT model currently does not include land use, land use change and forestry, and agriculture which are particularly important for Vietnam. The simple approach to include these in EFFECT would be via the use of the FAO's Ex-Act model. A more complete and recommended approach would be to develop a land use change and forestry model as was used in the Brazil low carbon development study.

EX-ACT Ex-ante Appraisal Carbon-Balance Tool

EX-ACT (EX-ante Appraisal Carbon-balance) is an Excel-based accounting system aimed at evaluating the impact of agriculture and forestry development projects on GHG emissions and Carbon (C) sequestration. EX-ACT evaluates two scenarios (with- and without-project) at over one fixed period (see Figure 3) and would have to be modified to look at a temporal changes over the 20-25 years of the typical low carbon modelling period. Whilst designed for use at the project level it can be up-scaled to the program/sector level. EX-ACT has been developed using mostly using the IPCC Guidelines for National Green-house Gas Inventories[8] completed with default values for the agriculture sector from IPCC (2007)[9] and other coefficients such as embodied GHG emissions for farm operations, inputs transportation, and irrigation systems implementation from Lal (2004)[10].

[8] IPCC, 2006. IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4
[9] IPCC, 2007. "Agriculture," in Climate Change 2007: Mitigation
[10] Lal, R. . 2004. "Carbon emissions from farm operations " Environment International 30, 981-990

Figure 3: The logic of the Ex-Act tool



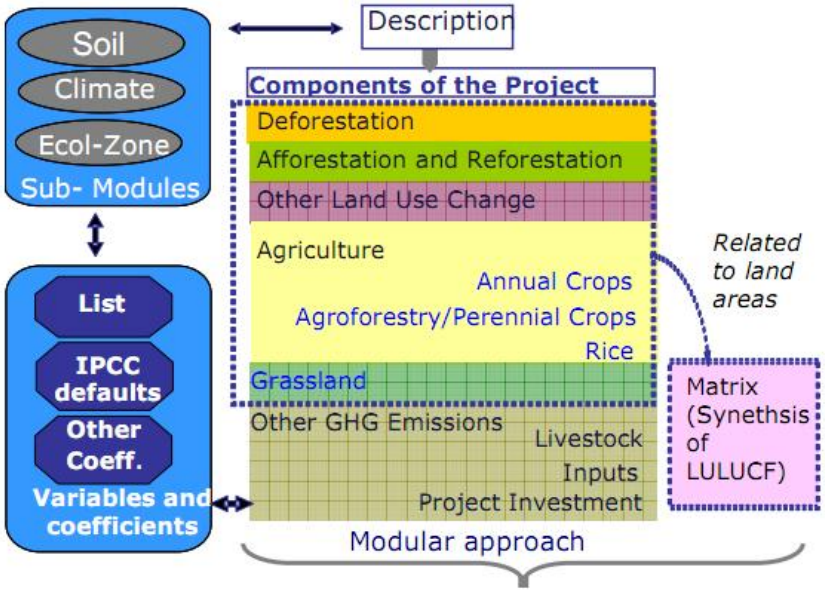
EX-ACT consists of a set of linked modular Microsoft Excel sheets (see Figure 4) in which each "module" describes a specific land use – and following a three-step logical framework:

a. general description of the project (geographic area, climate and soil characteristics, duration of the project);

b. identification of changes in land use and technologies foreseen by project components using specific "modules" (deforestation, afforestation and reforestation, annual/perennial crops, rice cultivation, grasslands, livestock, inputs, energy); and

c. computation of C-balance with and without the project using IPCC default values and – when available – ad hoc coefficients. The main output of the tool consists of the C-balance resulting from project activities.

Figure 4: Ex-Act structure



The Brazil-developed Land use change and forestry modelling

The Brazil low-carbon study placed high emphasis on the estimation of future demand for land and resulting LULUCF emissions (see Figure 5) and this experience could be usefully used by Vietnam to develop a similar model under the auspices of this project to evaluate LULUCF and agricultural changes over the modeling period. The methodology uses two complementary models to simulate land-use changes and associated emissions over a 20-year period, including GHG emissions from deforestation, agriculture and livestock and carbon removal from planted forests. The two models to be replicated are the economic Brazilian Land Use Model (BLUM) and Simulate Brazil (SIM Brazil).

The **BLUM Model** is a partial equilibrium econometric model developed by the Institute for International Trade Negotiations (ICONE) that operates at two levels: (i) supply and demand of final crops and (ii) land allocation for agricultural products, pasture, and production forests. Supply and demand are calculated simultaneously, in accordance with the microeconomic principle of market balance, whereby offer equals demand for each product. This balance occurs when there is a price that leads to the convergence between supply and demand during the same period of time. The main parameters are demand income and price elasticity, supply price elasticity and cross-elasticity.

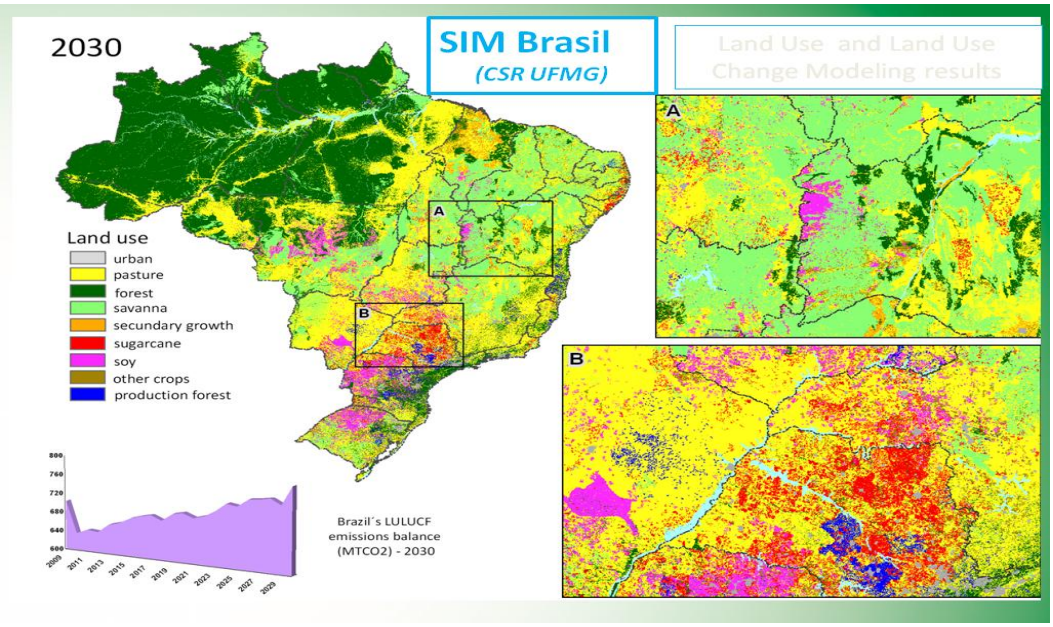
Land allocation for every crop in each region was estimated using two explanatory variables (i) regional profitability of the considered crop and (ii) regional profitability of competing crops. Regional profitability reflects soils productivity, cost of factors and technology used. Productivity gains induced by technology innovation are taken into account. Regions that show higher

expected returns for particular products have larger areas allocated to them. Estimating the quantity of land allocated to pasture depend on expected herd evolution and productivity.

SIM Brazil is a geo-referenced spatialization model structured and implemented according to the Environment for Geo-processing Objects (EGO) Dynamic, a free integrated software platform. Developed by the Remote Sensing Center (CSR) of the Cartography Department at the University of Minas Gerais (UFMG), SIM Brazil operates at two spatial levels: (i) micro-region and (ii) raster of 1-km^2 resolution. The model creates favorability maps for crop allocation via such criteria as agricultural aptitude (Assad and Pinto 2008), distance to roads, urban attraction, and cost of transport to ports, declivity, and distance to converted areas. For each micro-region, the model allocates the land-use activities projected by BLUM at a level of 1 km^2, using agricultural aptitude as a basis for each crop modelled and estimated production cost factors according to infrastructure proxies and distance to consumer markets.

When available land in a given micro-region is insufficient, SIM Brazil reallocates the distribution to neighbouring regions, creating an overspill effect, eventually leading to conversion of natural vegetation, including deforestation. In this way, calculated rates of agricultural expansion are accounted for. Three main sequences were constructed: (i) calculation of land available for expansion, (ii) simulation of land-use change and deforestation, and (iii) estimation of resulting net GHG emissions from agriculture, livestock, deforestation and forest plantations.

Figure 5: Land Use and Land Use Change Modeling Results, Brazil - 2030



This LULUCF modelling supports simulation of a reference scenario and the impact on land use of different policies, for instance aimed at increasing the production of solid and liquid bio-fuels

and increasing the productivity of livestock to free-up pasture that can be used to accommodate the expansion of crops without deforestation under a low-carbon scenario. The tool also provides the quantitative data regarding productive systems deployment that is necessary to estimate the volume of financing required in both the reference and the low-carbon scenario.

THE MAC-TOOL

The MAC-tool is being developed by the World Bank to support the decision making process in building low-emission development scenarios and is complementary to the other bottom-up tools. It allows a systematic data entry for the most relevant sectors (Energy, Land Use and Land Use Change, Transport and Waste) and consists of a user-friendly automated Excel-based tool with which users can construct a variety of country and/or sector specific GHG Marginal Abatement Cost (MAC) Curves. The tool was originally developed as part of the Brazil low carbon development study, and has been used also in Mexico. It will become freely available mid-2011 and will be supported by detailed user manual and training aids. The MAC-tool allows comparison of a selected group of mitigation options from both a societal and private sector perspectives.

In the societal approach, the net cost and benefits of the baseline scenario and of the lower carbon scenario are discounted using a social discount rate (for instance 8%) and compared. This would typically inform the decision-making process of a central ministry of planning interested in comparing mitigation options economy-wide to optimize low-carbon public policies from the perspective of the whole society.

To implement this approach, the MAC-tool:

a. calculates the Marginal Abatement Cost of each alternative in U$/t$CO_2$e avoided or removed
b. generates a MAC Curve, similar to the one popularized by McKinsey & Company, and
c. includes a series of sensitivity analysis against the value of the discount rate and other parameters (i.e. oil price).

The process of building the scenarios, the parameters and the equations used for calculations are totally transparent and can be adjusted by the user to the specificities of the country and the period considered. The tool comes with a series of technical options already parameterized that can be completed or modified.

The private approach consists of calculating the level of financial incentive that should be allocated to a considered low-carbon option to ensure that the associated Internal Rate of Return (IRR) would equal the benchmark IRR expected by the real economic agents in the corresponding

sector. This benchmark IRR, which is usually significantly higher than the social discount rate, would typically be determined by consulting commercial and public banks financing projects in that sector in that country. Such level of incentive is rated per ton of CO_2e avoided or removed by the clean option considered in the low-carbon scenario, expressed in US$/t$CO_2e$ and is called the "Break-even Carbon Price". This parameter indicates what should be the carbon market price, in the absence of other incentive mechanisms like for instance tax exemptions, to turn the considered low-carbon option attractive for the private sector in the considered country. The MAC-tool calculates the break-even carbon prices, plots them in curve similar to the MAC curve and allows for a series of sensitivity analysis.

The MAC-tool provides also a series of other quantitative and graphical information, such as Capital Intensity Cost Curves, volumes of financing needed per sector, emissions and emissions reductions curves for a reference scenario, a low-carbon scenario and for the differential between both. To facilitate the dialogue with sectoral experts and authorities, the MAC-tool also provides a series of usual sectoral indicators (i.e. installed power capacity, total area of pastures and crops, kms of metro, tons of waste managed, etc.) in both the reference and the low-carbon scenario.

5.3. Top-down models

There are many types of top-down model that are suited to different tasks and Vietnam could usefully envisage using different models in combination.

When selecting a top-down model for low carbon economy-wide analysis it is important that stakeholders are confident in each model and in the results that it generates. The models that are selected need should be consistent with:

Availability and quality of data. For a multi-region model that evaluates the interaction of policies and development in Vietnam with that of other economies, consistent data will be required from each of the included regions. Usually it is outside of the scope of any individual country study to create internationally consistent data sets, and available ones such as the Global Trade Analysis Project (GTAP) data base must be used. The current version, GTAP 7.1 is a consistent representation of the world economy in 2004 (its base year). Underlying this data base are national input-output tables, trade, macroeconomic, and protection data from several sources and substantial efforts are made by the GTAP team to make these disparate sources comparable. For these reasons, the objective of the GTAP database is not to provide IO tables, but to facilitate the operation of multi-region economic simulation models by providing a consistent set of economic facts. Whilst the standard version of GTAP does not include energy substitution or emissions trading there are extended versions that do.

For multi-sectoral analysis within Vietnam however, more recent and complete data than that in GTAP should be used. This should allow the whole economy to be modelled and the data sets should match national accounts. The data set necessarily should include energy and emissions data and even though a more recent base year is selected (such as 2008 or 2009) care must be taken to fit to recently published studies that use earlier base years such as Vietnam's Second National Communication to the UNFCCC (published in 2010, using a 2000 base year).

Capacity of local modellers/ government staff to maintain and use the model subsequently since a simpler model may serve policymakers better than a more complete but complex model that is proprietary and cannot be easily shared or updated. Here a balance is required; if the chosen model is too simple the country may grow out of it quickly and this good opportunity for modelling development may be lost. If the model is too complex and cannot be easily shared or updated its usefulness will be severely limited. Under this theme it is important to consider adequate training in the main phase of the low carbon development planning study for Vietnamese institutions. Models that require on-going assistance of International consultants or experts should be adapted to suit with Vietnam's situations with supports from domestic experts.

Scope of questions that will be the model's focus, e.g., what degree of sectoral disaggregation is needed? Are international trade dimensions important? Will global or regional scenarios such as setting of global GHG targets be important?

In selecting models to answer these questions, the first step is to identify existing macro models or energy models in the country which might be expanded to include climate analysis.

CGE modelling experience in Vietnam

One CGE model that has been used recently in Vietnam is the IFPRI standard computable general equilibrium (CGE) model. This was used by IFPRI in their " Impacts of Climate Change on Agriculture and Policy Options for Adaptation" study[11] to assess economy-wide effects through an optimization process from production (profit maximization) and consumption (utility maximization) with substitution between domestic and foreign production using a production function of constant elasticity of transformation. The model specifies macroclosures to identify the exogenous and endogenous variables. Direct tax rate rates are assumed to be fixed and the fiscal deficit adjusts to lead to balance in revenues and expenditures.

CGE modelling has been also been applied in a number of other studies conducted by CIEM.

- In 2009, the CIEM research project titled "Forecasting agricultural rural labor re-structuring and designing employment-creation measures in the process of accelerating

[11] See IFPRI discussion paper 01015 dated August 2010

industrialization, modernization and urbanization in Vietnam" used a recursive dynamic CGE model called VIPAG to forecast the demand to 2020 for rural labor due to a re-structuring of the agricultural sector in Vietnam. This model includes 113 sectors, eight factors and six types of labor by urban and rural regions. The model is run in GEMPACK and uses data from the Vietnam 2005 Input – Output table. The study assumes that there is no reforms in agricultural and rural policies, e.g. Vietnam is continuing to grow annually 6–7 percent and implements WTO commitments as baseline scenario. The result shows that with scenario 1, the growth of the number of workers in rural areas expands slightly 1.04 per cent annually. Among three main sectors: agriculture, industry and services, the growth of the number of agricultural workers reaches the smallest level, namely 0.24 per cent annually. The share of agricultural workers in rural areas declines from 68.7 per cent in 2008 to 62 per cent in 2020 while these shares for industry and services are 18.9 per cent and 19.1 per cent in 2020 respectively. The shift of labor structure in agricultural sectors is really slow.

- Another study in 2010, assessed the impact of China on Poverty Reduction in the Greater Mekong Sub-region using CGE modelling to evaluate the impact of textile and garment imports from China to Vietnam on the poor. The study used the IFPRI/TMD Standard CGE Model with data from the 2007 SAM on 16 commodities, 16 activities, four factors and four types of households. The paper assumes that the price of imported clothes and textiles from China declines by 10 per cent and thus, the price of Vietnam's garment exports also decreases by 7 per cent as Vietnam's imports of textiles and garments amounted to 70 per cent of Vietnam's exports of these products in 2007. Each scenario will have its own impact on the poor. The combined scenario is expected to provide a general assessment. Empirical evidence shows that all types of households benefit when the prices of imports from China decline. In contrast, they lose when the price of Vietnam's garment exports decreases. In the combined scenario, the income of all types of households increases from 0.16 per cent to 0.21 per cent. However, the poor benefit more than the non-poor, particularly the poor in rural areas.

- Most recently, a CGE model was applied to conduct a report on The Fisheries Sector in Vietnam: *A Strategic Economic Analysis* by the Development Economics Research Group at the University of Copenhagen and CIEM. In particular, this is recursive dynamic general equilibrium developed basically from the standard CGE model for Vietnam to analyze the strategy to 2020 of the fisheries sector to 2020. In addition, in order to reflect the characteristics of Vietnamese fisheries, each sector in the model is divided into two

regions: Mekong Delta and the Rest of Vietnam (RoV). The expected output includes the change in GDP, household consumption per capita, trading pattern of fish products, agricultural land allocation and fisheries production under different scenarios. The results show that GDP is nearly unchanged but fishing households would lose most under the decline in ocean fisheries catch. The expansion of aquaculture production would provide jobs for those who loss because of declining marine fisheries. The results also show that intensive strategy is better than extensive strategy because GDP is higher under intensive strategy. In addition, while income is evenly distributed among rich and poor households under intensive strategy, crop–only households are hurt because of large corresponding declines in food crop production and their consumption also declines sharply.

Initial work has been conducted by CIEM (but not yet published) to evaluate GHG emissions at the sectoral level by type of fossil fuel for 20 sectors. Work will be required in the next phase of this study to develop, using bottom-up modelling results, GHG emission estimates for the other sectors. Previous version of GTAP has been used in some of the above mentioned studies.

Modelling the macroeconomic impact of mitigation options on the economy

The option of modifying an existing model

The IFPRI standard computable general equilibrium (CGE) model as used by CIEM is calibrated to the 2007 social accounting matrix (SAM) of Vietnam developed from the Supply Use Table constructed by General Statistics Office. The structure of the SAM covers 63 sectors in which 23 are subsectors of agriculture, 12 are subsectors of services and most of others are in industry. This SAM is useful for the low carbon development study since it contains the sectors which are strongly related to low carbon growth such as forestry in agriculture, transportation in services and electricity, mining, oil and gas in industry.

Once the relationships between each sector and energy usage and GHG emissions are estimated and a component to access the low carbon growth with these exogenous inputs is added in the CGE model, the economy-wide effect of low carbon scenarios could be delivered. It has been estimated by CIEM that this would require three to six months work and probably represents the lowest-effort approach to country-specific CGE modelling.

Developing a specific model for Vietnam

There are many advantages to developing a macroeconomic modelling framework to provide specific recommendations for the most effective low carbon technologies and abatement possibilities for Vietnam. Given constraints, such a model should evaluate and optimize related investment measures, as well as recommendations for macroeconomic and other policy responses

to maintain growth and employment while lowering carbon emissions and could, from having a specific design, evaluate GHG reduction wedges (cost-effective alternative paths from the baseline as identified in the sectoral work) and identify actions and investments needed to achieve those reductions.

One recommended option would be to construct a large scale, multi-sector dynamic stochastic general equilibrium (DSGE) model as a climate policy assessment tool for the Vietnamese economy based on the experience that the World Bank developed in the low carbon development program with Poland. Such a model (see Appendix 4) could assess the macroeconomic impact of a diversified package of different GHG mitigation levers, which would be identified in the bottom-up sectoral analysis. It would develop a baseline and projected GHG emissions, starting from a scenario of interest to the government. The objective of this model would be to investigate the impact of mitigation options on output, consumption, and prices; on employment; and on public investment and other public spending; and on tax revenues and related investment measures, as well as recommendations for macroeconomic and other policy responses to maintain growth and employment while lowering carbon emissions.

The dynamic structure of a DSGE model allows all calculations to be performed in the different time horizons that are important from the perspective of policy makers. It allows attention to be focused on detailed microeconomic packages of GHG abatement options identified by bottom-up modelling and allows macroeconomic versions of the marginal abatement curves to be constructed which relate the impact of individual policies and their abatement potential on GDP and other macroeconomic variables.

It is estimated that building a new DSGE model based on the World Bank's experience for Vietnam would involve around 6 months work.

Although DSGE model is a very good model for low carbon growth studies in Vietnam, it requires a huge effort to build up the model as well as there would be computational challenges. In addition, we cannot utilize the current CGE model for Vietnam. DSGE model therefore would be replaced by CGE model which is added a component of energy and emission to assess the economy-wide effect of low carbon scenarios. But there is a necessary trade-off between simplicity of the tool and ability to handle extremely complex questions.

Modelling the impact of low carbon development options on regional trade and competitiveness. Whilst a DSGE model would allow the macroeconomic impact of a diversified package of different GHG mitigation levers to be assessed, it is not the framework to analyze questions about

what the implications of low carbon development in Vietnam could be on regional trade and competitiveness.

An example of such questions is illustrated by the pressure in industrial countries for additional border taxes on imports from countries with lower carbon prices or that are not fully committed to a low carbon development program. Whilst such actions would address competitiveness and environmental concerns in high income countries, they could have serious consequences for their trading partners.

These questions require a multi-region economic simulation model that uses an internationally consistent set of economic facts such as those provided by the most recent version of GTAP. There are many CGE models that can use GTAP7 including the IFPRI standard template that can be modified to evaluate these questions, and again Vietnam has the option to use a model that currently in use and highly regarded in the country. The standard GTAP Model is a multiregional, multisector, computable general equilibrium model, with perfect competition and constant returns to scale. Bilateral trade is handled via the Armington assumption.

The combination of a socio-economic CGE model with the climate module is commonly referred to an integrated assessment model (IAM).Of these, two are highlighted as being candidates for adoption and adaptation by Vietnam:

ICES (Intertemporal Computable Equilibrium System)

ICES is a top-down recursive dynamic general equilibrium model developed to assess the final welfare implication of climate change affects on regional and world economies. The model has been developed at the Climate Change Modelling and Policy Research Programme of the Fondazione Eni Enrico Mattei – FEEM, an Italian research institution. ICES is tailored to capture and highlight the production and consumption substitution processes at play in the social-economic system as a response to climate shocks. It is designed to provide a climate change impact assessment tool that offers an economic evaluation summarizing second and higher-order effects beyond direct costs. In addition to climate-change impact assessment, the model can be used to study mitigation and adaptation policies as well as different trade and public-policy reforms.

Within the climate change assessment framework, its general equilibrium characteristics have been suited to assess different global warming effects on sea level rise, agriculture, energy demand, health, and tourism; and also include emissions of the main greenhouse gases. The model uses the GTAP database to have a flexible regional and sectoral disaggregation. Because carbon dioxide emissions are closely linked to fossil fuel combustion, energy commodities have a special

treatment in ICES as a capital-energy composite factor using a top-down approach. Within this context the use and substitution of energy can be evaluated through time with the scope of analyzing climate driven policies such as those aimed to reduce GHG emissions. The model includes improved detail on nuclear, hydro, wind, and solar technologies with biofuel under development.

On the supply side, industries are modelled through a representative cost-minimizing firm, taking input prices as given. In turn, output prices are given by average production costs. The production functions are specified via a series of nested constant elasticity of substitution (CES) functions. Peculiar to ICES is the isolation in the production tree of energy factors which are taken out from the set of intermediate inputs and are inserted as primary production factors in a nested level of substitution with capital. The demand side is characterized by a representative consumer in each region, which receives income defined as the service value of national primary factors (land, labor, capital and natural resources). The model depicts international trade with capital mobility. Labor is considered to be perfectly mobile domestically but immobile internationally. Land and natural resources, on the other hand, are industry-specific. Land is considered to be imperfectly mobile across crops domestically (responding to crop prices but not to climatic or soil characteristics).

Income generated by factors is then used to finance three classes of expenditure: aggregate household consumption, public consumption and savings. The expenditure shares are generally fixed, which amounts to saying that the top-level utility function has a Cobb-Douglas specification. Demand for production factors and consumption goods can be satisfied either by domestic or foreign producers which are not perfectly substitutable according to the "Armington" assumption which accounts for product heterogeneity.

The model's dynamic is driven both by exogenous and endogenous sources. The first source stems from exogenously imposed growth paths for some key variables – population, labor stock, labor productivity, land productivity. The values for these variables are taken from available statistics and projections from other modelling exercises. The second source concerns the process of capital accumulation. Capital stock is updated over time in order to take into account endogenous investment decisions: capital goods are allocated among different regions in such a way that the current rate of return to capital grows at the same pace with the global rate of return.

A more complete option is the ENVISAGE integrated assessment model developed at the World Bank. ENVISAGE adopts a similar approach to ICES, but innovates by considering more climate change impacts, by improving parameter estimates and by being a more sophisticated model.

ENVISAGE (the World Bank's Environmental Impact and Sustainability Applied General Equilibrium Model): ENVISAGE is technically superior to the ICES model but more complex to develop and use. It includes a climate module, so that climate change is endogenous, whereas ICES relies on exogenously given climate scenarios. It distinguishes between old (installed) and new capital stock, which allows considering different degrees of capital mobility. It also includes a fully-fledged consumption demand system, which is important to account for differences in income elasticity and structural changes in demand patterns, especially relevant in the long run.

ENVISAGE includes:

- Capital vintage production technology that permits analysis of the flexibility of economies
- A detailed specification of energy demand in each economy
- The ability to introduce future alternative energy (or backstop) technologies
- CO_2 emissions that are fuel and demand specific
- A flexible system for incorporating any combination of carbon taxes, emission caps and tradable permits
- A simplified climate module that links greenhouse gas emissions to atmospheric concentrations combined with a carbon cycle that leads to radioactive forcing and temperature changes.

The ENVISAGE model's core is a relatively standard recursive dynamic global general equilibrium (CGE) model. Incorporated with the core CGE model is a greenhouse gas (GHG) emissions module that is connected to a simple climate module that converts emissions into atmospheric concentrations, radioactive forcing and changes in mean global temperature. The climate module has feedback on the economic model through so-called damage functions, affecting a number of parameters in the model, as explained in more detail below.

ENVISAGE also uses Release 7.1 of the GTAP dataset with a 2004 base year. It has been used to simulate dynamic scenarios through 2100. The 112 countries/regions and 57 sectors of GTAP are aggregated to a smaller set of countries/regions and sectors to facilitate computing. The GTAP data is supplemented with satellite accounts that include emissions of the same GHG gases as ICES plus hydro fluorocarbons (F-gases). It includes different electricity production activities (coal, oil and gas, hydro, nuclear and other), and potential land and hydro supplies. Within each time period a full equilibrium is achieved given the fixed regional endowments, technology and consumer preferences. Production is modelled as a series of nested constant-elasticity-of-substitution (CES) functions that are designed to reflect the substitution and complementarity of

inputs. Unlike many standard models, energy plays a key role as an input and is modelled as a complement to capital in the short-run but a substitute to capital in the long run. This reflects the putty/clay specification of production that incorporates vintage capital. The key assumption is that there is greater substitution across inputs in the long run (i.e. with *new* capital) than in the short run (with *old* or installed) capital. One consequence of this specification is that countries that have higher growth and higher rates of investment typically have a more flexible economy in the aggregate.

There is a single representative household that consumes goods and services and saves. The savings rate is partially a function of the demographic structure of the region. Savings rise as either the elderly or youth dependency ratios fall. The government sector is relatively passive. Aggregate expenditures are fixed as a share of total GDP and revenues adjust to maintain fiscal balance (through a lump sum tax on households). Investment is savings driven. Aggregate demand by sector is summed across all domestic agents and represents a composite of domestically produced goods and imports—the so-called Armington aggregate. The aggregate Armington good is allocated between domestic production and imports using a two-nested CES specification. The first nest allocates aggregate demand between domestic production and an aggregate import bundle. The second nest decomposes aggregate imports into import by region of origin. This generates a bilateral trade flow matrix. Domestic producers are assumed to supply both domestic and export markets without friction, i.e. the law of one price holds for domestically produced goods irrespective of their final destination. Bilateral trade is associated with three price wedges. The first wedge reflects differences between producer prices and the border (FOB) price, i.e. an export tax or subsidy. The second wedge reflects international trade and transport margins, i.e. the difference between FOB and CIF prices. The third wedge reflects the difference between the CIF price and the end-user price, i.e. import tariffs. All three wedges are fully bilateral.

Model closure is consistent with long-term equilibrium. As stated above, fiscal balance is maintained through lump sum taxes on households under the assumption of fixed public expenditures (relative to GDP). Changes in revenues, for example carbon tax revenues, imply a net decrease in household direct taxes. Investment is savings driven. This assumption implies that changes in investment are likely to be relatively minor since public and foreign savings are fixed and household savings will be relatively stable relative to income. The third closure rule is that the capital account is balanced. Ex ante changes in the trade balance are therefore offset through real exchange rate effects. A positive rise in net transfers, for example through a cap and trade scheme, would tend to lead to a real exchange rate appreciation.

The model dynamics are relatively straightforward. Population and labor force growth rates are based on the UN population's projection—with the growth in the labor force equated to the growth of the working age population. Investment, as mentioned above, is savings driven and the latter is partially influenced by demographics. Productivity growth in the baseline is 'calibrated' to achieve a target growth path for per capita incomes— differentiated for agriculture, manufacturing and services.

Emissions of GHGs have three drivers. Most are generated through consumption of goods—either in intermediate of final demand—for example the combustion of fossil fuels. Some are driven by the level of factor input—for example methane produced by rice is linked to the amount of cultivated land. And the remainder is generated by aggregate output—for example waste-based methane emissions. The climate module takes as inputs emissions of GHGs and converts them to atmospheric concentration, and then radioactive forcing and finally temperature change. The temperature change is linked back to the socio-economic model through damage functions.

A basic Comparison of ICES with ENVISAGE models is shown in Appendix 6.

5.4. Linking Bottom-up with Top-down

Top-down models can be used to examine the overall economy and incorporate feedback effects between different markets caused by policy-induced changes in relative prices and incomes. However, they typically do not provide technological details of energy conversion or use and as a consequence, cannot readily incorporate different assumptions about how discrete technologies and costs will evolve in the future. On the other hand, bottom-up models are good at describing current and future technologies in detail. They are therefore well suited to the analysis of specific changes in technology or command-and-control policies such as efficiency standards.

There have been various hybrid modelling efforts that aim at combining the technological explicitness of bottom-up models with the economic richness of top-down models. These efforts can be broadly classified into three categories.

- The first attempts to couple existing bottom-up and top-down models.
- The second focuses on one model type complemented by a ''reduced form' representation of the other.
- The third category combines bottom-up and top- down characteristics directly through the specification of market equilibrium models as mixed complementarity problems.

In this case it is proposed to use a hybrid bottom-up/top-down approach in which a bottom-up analysis of mitigation options, mitigation potential and associated costs are modelled in those

sectors that represent the greatest mitigation possibility. For these sectors, technology options (as the main source for CO_2 and other emissions) are portrayed explicitly while production technologies in other sectors are described in a conventional top-down aggregate manner, i.e. by means of CES (CET) functions. The techno-economic description of these specific sectors provides an explicit link to the sectoral bottom-up studies of emission abatement possibilities. It accommodates the view that certain technologies can eventually dominate and highlights the role of extant capital (i.e. existing power generators won't be abandoned due to emission regulation unless the CO_2-inclusive price is sufficiently high).

The analytic work considers that efficient GHG mitigation will require a mix of interventions in the area of energy efficiency, switch to low(er) carbon fuels, and (eventually) carbon capture and sequestration. The process starts with the construction of marginal abatement cost (MAC) curves for key sectors costing numerous technology choices. The details of these bottom-up abatement options and related policy measures feed into the macroeconomic models to explore various mitigation scenarios and their macroeconomic impact (including on GDP , employment, fiscal variables, and inflation) as well as their distributional impact (on sectors, regions, and income groups).

5.5. Chosen model for low carbon growth studies in Vietnam

For low carbon growth studies in Vietnam, an integrated approach with bottom – up and top – down model is recommended. In particular, EFFECT model is chosen for bottom – up model because is covers a number of sectors potentially to mitigate the emission in Vietnam such as:

(i) Power;

(ii) Industry;

(iii) Transport;

(iv) Household electricity use, and

(v) Non-residential energy use

In addition, a number of sectors which are particularly important for Vietnam will be added in the model such as:

(i) Land use change;

(ii) Forestry; and

(iii) Agriculture.

These will be added via the use of the FAO's Ex-Act model.

The output of EFFECT model will be used as exogenous inputs for general equilibrium model. The advantage is that we can use the current CGE model built for Vietnam. The assessment of low carbon growth scenarios is implemented by adding one component of energy and emission into current CGE model for Vietnam. The output of general equilibrium model is to provide economy-wide effects of low carbon growth scenarios with the amount of greenhouse gas mitigation and on the whole economy such as:

(i) GDP;

(ii) Employment;

(iii) Value added, and

(iv) Sectoral potential for GHG emission impact.

(v) Distributional impact (on sectors, regions, and income groups) of low carbon scenarios.

5.6. Data requirements and data gaps

Data requirements

The quantity and extent of the data needed will depend on the scope of the low carbon development study, government plans for low carbon development, and the ongoing programs or plans within each greenhouse gas intensive sector. In this case, the scope of the analysis defines that the data requirement will cover the whole economy.

Data requirements also depend on the type of modelling used. Bottom up models require many micro level variables and include engineering, sectoral, financial and economic indicators. Top-down modelling requires aggregated national level macro-economic, micro-economic and fiscal indicators.

First, data will need to be collected to create a list of GHG abatement measures in each sector, estimate their costs and benefits and calculate the net present value of each through bottom-up modelling. Next, a range of policy and macroeconomic level indicators such as production factors, public expenditure components and variables for each economic sector of the economy will be needed for the top-down work. In all cases a combination of qualitative and quantitative data is required to understand the institutional arrangement in each of the sectors included in the analysis, the policies, development goals and targets that are currently in place, and the composition of the stakeholder group.

Sourcing all of the data needed to construct these scenarios can be a challenge and it is not uncommon to experience issues with data availability, accessibility, reliability and consistency, fragmentation or even the lack of an adequate time series. There can also be issues of data transparency and limits on publicly sharable data.

Data gaps

In order to link bottom-up models with top-down model to assess the low carbon growth scenarios in Vietnam, it is first necessary to identify data gaps, which are available and not available at the moment but can be collected, to run models. For those which are available, sources would be shown. Details on data gaps are given in exel file attached with this report.

For general data, the only group of data which are unavailable is Energy Content and Emissions Factors for Fuels while other groups can be assessed mostly through GSO and SBV websites such as Exchange Rate, GDP, Population, Total Land Area, Price of Fuels (after tax), Ambient Temperature and Tax Rate for Fuels (Cost plus basis) from MOF.

Similarly, it is estimated by the team that 97% of data for power sector are available. These come from MOIT sources. There are only four indicators that data are not available. In particular, this is the percent CO2 emitted to atmosphere for new power plants. For existing units, this is the percent CO2 improvement emitted to atmosphere. In addition, for Fuels used for existing units, particularly for coals only, fuel-2 cost at Plant and total fuel cost at plant are not available and need to be collected.

Industrial data, however, are mostly not available at the moment and need to be collected by surveys. Data are available Finished Steel demand and production for Steel sector and Aluminium factors, Primary Aluminium demand and production, Alumina demand and production, Secondary Aluminium demand and production for Aluminium sector. All data for Cement, Fertilizer (Ammonia), Petroleum Product demand and production, Paper demand and production need to be collected by surveys.

For transport and vehicle class data, these are available at macro levels such as Vehicle Fuel Density, Vehicle Fuels, Fuel Prices (blended), Use mileage degradation factor. Data at micro levels such as Vehicle usage (km per year) by years of operation, Vehicle annual operating cost by years of operation, New Technology for fuel efficiency improvement, For Petrol, LPG, and CNG Vehicles, For Diesel Vehicles Only need to be collected by surveys.

For household data, data at macro level are available through GSO survey such as Household Electrification, Population per centile, Monthly Per Capita Expenditure per centile, Total

Electricity Usage per month. Data at micro level for household uses such as lighting (Lighting Unit Sales Mix by Technology, Average Operating Life of Light on Retirement, Historic Parc Configuration (Baseline), appliances and appliance usage like Radio Sales Mix by Size & Type, Radio Sales Mix by Technology, CD Sales Mix by Technology, TV Sales Mix by Technology, DVD Sales Mix by Size & Type, DVD Sales Mix by Technology, Computer Sales Mix by Size & Type, Washing Machine Sales Mix by Size & Type, Washing Machine Sales Mix by Technology, Electric Oven Sales Mix by Size & Type, Electric Oven Sales Mix by Technology need to be collected only by surveys in Vietnam.

Similarly, Non-resident data are available for Retail floor space, Office floor space, Hotels, Hospitals, Schools, SCHOOL Floor space, Others (Restaurants, Telecom, Warehouses, Others) and Total Energy in Base year which are collected from GSO. However, specific data for base year energy intensities for existing floor space and new construction, lighting and heating/cooling technology mix, data for lighting, cooling, fans and other appliances such as Average Operating Life, Percentage of Parc with each intensity improvement, Exogenous Efficiency Factor change are only available through surveys.

For other sectors such as land use, land use change, forest and agriculture, data can be collected and calculated. As 2007 SAM is available in Vietnam, outputs from bottom-up models can be exogenous inputs for CGE model to assess the economy-wide effects of low carbon growth scenarios. Technically, these require the consistency between the exogenous shock to CGE model and structure of the SAM we used.

VI. Detailed scopes for the Input Studies and main Study phases

6.1. Input Studies phase:

6.1.1. Background of the study

The quantity and extent of the data needed will depend on the scope of the low carbon development study, government plans for low carbon development, and the ongoing programs or plans within each greenhouse gas intensive sector. Data requirements also depend on the type of modelling used. Bottom up models require many micro level variables and include engineering, sectoral, financial and economic indicators. Top-down modelling requires aggregated national level macro-economic, micro-economic and fiscal indicators.

As analysed in the previous section, the hybrid models integrating two approaches, namely bottom up and top down are recommended for the case of Vietnam. The data requirements for these models are very extensive. The bottom up models requires many micro level variables and includes engineering, sectoral, financial and economic indicators, the top-down modelling

requires aggregated national level macro-economic, micro-economic and fiscal indicators. In fact, the data needed are not only lacking but also scattered throughout organizations. About 42% of total available data needs using for EFFECT model in Vietnam is scattered in different organizations that should be collected and calculated. 58% of data needed are not available and should be collected by surveys. The availability status of data needed is shown in the table bellows:

Table 11: The data status

No	Item	Data status		Data collection organizations
1.1	**Data needs for bottom up model (EFFECT)**	% available data (collection, analysis and calculation)	% unavailable data (pilot survey)	
1.1.1	***General data***	*70%*	*30%*	CIEM, GSO -MPI, Financial Economic Institute - MOF; NIAPP, IPSARD - MARD; IMHEN - MONRE
1.1.2	***Power sector***	*97%*	*3%*	IPSI, Energy Institute - MOIT; GSO - MPI
1.1.3	***Industrial data***	*27%*	*73%*	
	Steel	*22%*	*78%*	*IPSI - MOIT, CIEM, GSO - MPI*
	Aluminum	*18%*	*82%*	*IPSI - MOIT, CIEM, GSO - MPI*
	Cement	*22%*	*78%*	*IPSI - MOIT, CIEM, GSO - MPI*
	Fertilizer (Ammonia)	*27%*	*73%*	*IPSI - MOIT, CIEM, GSO - MPI,*
	Petroleum	*41%*	*59%*	*IPSI - MOIT, CIEM, GSO - MPI,*
	Paper demand and production	*28%*	*72%*	*IPSI - MOIT, CIEM - MPI*

1.2.4	***Transport, vehicle classes data***	*33%*	*67%*	Vietnam register; Institute of Institute for Development Strategy and Transport - MT; GSO - MPI
1.1.5	***Household sector***	*25%*	*75%*	CIEM, GSO - MPI; NIAPP - MARD
1.1.6	***Nonresidential data***	*20%*	*80%*	CIEM, GSO - MPI
1.2	**LULUCF**			
	Land use, land use change, forest and agriculture	*Land use, land use change and forest data for the whole country is available but GHG emissions from regional land use changes are not available and it should be estimated.* *Agriculture: most of data needed can be collected from GSO*		CIEM, GSO - MPI; MONRE; NIAPP - MARD
1.3	**IPCC guideline 2006**			
	GHG emission from waste	*The data is available for 1994 and 2000 only, it should be estimates the data updating following the 2006 IPCC guideline*		CIEM, GSO - MPI; IMHEN, VEA, DMHCC - MONRE; IPSI - MOIT
1.4	**Data needs for top down model (CGE model)**			
	Hybrid input – output extended (including environmental expenditure)or SAM: add rows showing pollution from manufacturing	*IO or SAM in 2007 or 2010*		CIEM, GSO - MPI

In Vietnam, the economics of low carbon and climate change resilient development issues are relatively new. There are not only lack of knowledge but also the skill for studying the costs and benefits of low carbon and climate change resilient development. Specially, the skills for using specific chosen models such as EFFECT, LULUCF, MAC-Tool, CGE on the issues of low carbon economy need to be provided and capacity building for Vietnamese staff on integrated low carbon

and climate change resilient development into the country's economic planning process should be completed.

Specifically, EFFECT and MAC-Tool models are very new in Vietnam, while CGE model is somehow accustomed to some Vietnamese researchers such as those in CIEM. However, they have never used CGE model for analysing different aspects of economics of low carbon and climate resilient development. There have not been any studies really utilising the LULUCF model although some provided selected figures on emissions from LULUCF by taking experts' opinions.

6.1.2. Objectives of the study

The objective of this phase are: i) to collect and fill the gaps of data, which are the input data for the designed models, such as EFFECT model (bottom up approach) and CGE, Land Use, Land Use Change, Forest model (LULUCF), GHG emissions from wastes (top down approach); ii) to start training Vietnamese staff on integrated low carbon and climate resilient development into the country's economic planning process, skills using the designed models.

6.1.3. Expected outputs of study

a) <u>Collected data</u>

In this phase, the main efforts will be made for completing the tasks of data collection. Two types of data needs are those using for bottom up and top down models.

✓ ***Bottom up models:*** The model collates national and sectoral information including the following national and sectoral level indicators. The data needs of bottom up (EFFECT model) such as:

The economy: i) Population and population growth by urban-rural areas, number of households by urban-rural areas, household income and its growth, access to power; ii) GDP growth and other macroeconomic data; iii) Power sector data: fuels, utility data, access data; iv) Parameters for modelling: inflation, discount rate, income and price elasticities; v) Fuel characteristics and utility characteristics; etc.

The power sector: i) Electricity demand from all sectors (households, transport, industry, non-residential) and load curve; ii) Electricity losses; iii) Prices and costs; iv) Type of plants; etc.

The transport sector: i) Private vehicle ownership and use, data for other on-road passenger transport and on-road freight transport; ii) Fuel prices divided into different fuel types and their

expected projections in the future, fuel taxes, etc.; iii) Fuel economy for all types of vehicles; iv) Annual operation cost – excluding fuel; etc.

Industry sector: i) Total production and import, export, domestic demand of steel, steel scrap, cement, fertilizer (ammonia), petroleum, paper, aluminium sector; ii) Efficiency Measures for Existing Plants; iii) Energy usage and efficiency of energy usage for exiting plants; iv) CO2 emissions in production process, such as those of cement, steel, paper, fertilizer; etc.

- ✓ ***Top down models***: three types of data needs of these models are:

- LULUCF model: the data needs are land use, land use change, forest and agriculture activities.
- IPCC guideline 2006: the data needs are total waste and typical wastes from different sectors to estimate the GHG emission.
- CGE model: the data needs are developing a Hybrid input – output extended table (including environmental expenditure, add rows showing pollution from manufacturing) or SAM.

In the data collection process, two kinds of works need to be completed:

a) If the data is available but scattered in different sources and institutions, the study team needs to collect, proceed and estimate the raw data to get the input data for the designed models.

b) If the data is unavailable, the study team needs to conduct specific surveys to get the required data.

The total data that need to be collected is very large and is shown in Appendix 9

b) <u>Trainings for Vietnamese staff</u>

In this study, the training need is focused only in some subjects bellows:

- Enhancing capacity for Vietnamese staff on integrated low carbon development and climate change resilient into the country's economic planning process.

- Enhancing skill for Vietnamese staff using some models, such as EFFECT, LULUCF, MAC-Tool, Computable General Equilibrium (CGE).

Training plan:

In phase 2 and based on the required skills, 5 training workshops for enhancing capacity of Vietnamese staff should be organized:

1) Training for trainers in second month of phase 2: organize a training workshop for enhancing capacity for Vietnamese staff on integrated low carbon and climate change resilient development into the country's economic planning process. It should be organized in 3 days with around 20 participants. The participant attending in the training workshop includes the Vietnamese staff working on annual planning in different ministries, such as Ministry of Planning and Investment (MPI); Ministry of Industry and Trade (MOIT); Ministry of Finance (MOF); Ministry of Natural Resource and Environment (MONRE); Ministry of Transport (MOT); Ministry of Construction (MOC); Ministry of Agriculture and Rural Development (MARD); Ministry of Science and Technology (MOST); Ministry of Health (MOH); Ministry of Education and Training (MOET),…

2) The MAC-Tool training in fourth month of phase 2: organize a training workshop for enhancing capacity for Vietnamese staff using the MAC-Tool in building low-emission development scenarios and is complementary to the other bottom-up tools. It should be organized in Ha Noi, in 5 days with 10 technical participants who involve in the program.

3) EFFECT model training in fifth month of phase 2: enhancing skill for Vietnamese staff using the EFFECT model, in 15 days in Ha Noi, 10 technical participants who involve in the program.

4) LULUCF model in sixth month of phase 2: for enhancing capacity for Vietnamese staff on LULUCF model, in 5 days, in Ha Noi, 10 technical participants who involve in the program.

5) Training workshop of the Computable General Equilibrium (CGE) in eighth month of phase 2: for enhancing skill for Vietnamese staff using CGE models, in 15 days, in Ha Noi, 10 technical participants who involve in the program.

Table 12: Training workshops and participants

No	Item	Participants from
1	*One training workshop enhancing capacity for Vietnamese staff on integrated low carbon and climate resilient development into the country's economic planning process (outside of Ha Noi)*	*MPI, MOIT, MONRE, MOT, MOF, MARD, MOH, MOET, ..*
2	*One training workshop enhancing capacity for Vietnamese staff on The MAC-Tool (5 days in Ha Noi, 10 technical staffs)*	*CIEM, GSO - MPI; IMHEN - MONRE; IPS - MOIT*
3	*One training workshop enhancing skill for Vietnamese staff using the EFFECT model (15 days in Ha Noi, 10 technical staffs)*	*CIEM, GSO - MPI; IMHEN - MONRE; IPSARD - MARD, IPS - MOIT, Vietnam register - MOST*
4	*One training workshop enhancing capacity for Vietnamese staff on LULUCF (5 days in Ha Noi, 10*	*CIEM, GSO - MPI; IMHEN - MONRE; NIAPP, IPSARD -*

	technical staffs)	*MARD,*
5	*One training workshop enhancing skill for Vietnamese staff using the Computable General Equilibrium (CGE), Dynamic Stochastic CGE (15 day in Ha Noi, 10 technical staffs)*	*CIEM, GSO – MPI,*

6.1.4. Budget of study

Total budget is designed to cover expenditures for three main tasks: data collection (66%), training the capacity and skill for Vietnamese staff (23%), and other tasks including organizing workshops and reporting.

6.1.5. Organization of the study

Many organizations and agencies from different ministries and organizations will be mobilised in this phase. As a general economic ministry which is assigned by the government to draft Socio-economic development Strategies and Plans and recently assigned by the Prime Minister of designing a "green development" (low carbon) strategy[12], the Ministry of Planning and Investment (MPI) is designed to be implementing agency for the overall project. The Central Institute for Economic Management (CIEM) of MPI, which has full capacity for running the project, is designed to be project coordinating organisation. This structure is designed for both phase 2 and phase 3 of this project.

A steering committee including representatives from MPI, MARD, MOIT, MONRE, MOF, MoT and donors could be an useful body for making concensus during the project implementation process. The project champions are CIEM, GSO and appropriate departments OR key research institutes of respective line ministries above. These institutions can be nominated by respective steering committee members of the proposed line ministries. While each "champion" can be responsible for its sectoral package, CIEM is designed to coordinate all these project partners and be the project leading institution/champion who is responsible for final report. A technical advisory group including both national and international specialists should be established to make technical advices for the study team as well as to review the completed works.

Specifically for phase 2 and in addition to CIEM, General Statistical Office (GSO); Agenda 21 Office and suggested nominated institutions such as the Institute of Policy and Strategy Industry (IPS), Energy Research Institute, Institute of Policy and Strategy for Agriculture and Rural Development (IPSARD - MARD), Vietnam register , Institute for Development Strategy and Transportation (MoT), The Vietnam Institute of Meteorology, Hydrology and Environment

[12] By the Notice No. 38 of the Prime Minister dated March 3, 2011

(IMHEN of MONRE), Department of Waste Management and Environment Promotion (DWMEP – VEA)

The specific tasks that the organizations can involve are shown in the table bellows

Table 13: The organization involves in the study

No	Item	Organization
I	**Data collections**	
1.1	**Data needs for bottom up model (EFFECT)**	
1.1.1	General data	CIEM, GSO (MPI)
1.1.2	Power sector	IPSI, Energy Research Institute (MOIT); GSO
1.1.3	Industrial data	
a1	Collecting and analysing data	IPSI (MOIT), CIEM, GSO (MPI)
a2	Pilot survey	IPSI (MOIT), CIEM, GSO (MPI)
a21	Developing questionnaire, data analysis	IPSI (MOIT), CIEM, GSO (MPI)
1.2.4	***Transport, vehicle class data***	
a1	Collecting and analysing data	Vietnam register; Institute of Institute for Development Strategy and Transport - (MoT); GSO (MPI)
a2	Pilot survey (combined with household survey)	combined in household survey
1.1.5	***Household sector (combined with transport survey)***	
a1	Collecting and analysis data	CIEM, GSO (MPI); IPSARD (MARD)
a2	Pilot survey	CIEM, GSO (MPI); IPSARD (MARD)
a21	Developing questionnaire, data analysis	CIEM, GSO (MPI); IPSARD (MARD)
1.1.6	***Nonresidential data***	
a1	Collecting and analysis data	CIEM, GSO (MPI)
a2	Pilot survey	CIEM, GSO (MPI); IPSARD (MARD)
a21	Developing questionnaire, data analysis	CIEM, GSO (MPI); IPSARD (MARD)

1.2	**LULUCF**	
	land use, land use change, forest and agriculture	*CIEM, GSO (MPI);* Department of Meteorology, Hydrology and Climate Change, IMHEN, General Department of Land Administration (MONRE)
1.3	**IPCC guideline 2006**	
	GHG emission from waste	*CIEM, GSO (MPI); IMHEN, DWMEP – VEA - MONRE; IPSI (MOIT)*
1.4	**Data needs for top down model (CGE model)**	
	Hybrid input – output extended (including environmental expenditure)or SAM: add rows showing pollution from manufacturing	*CIEM, GSO*
II	**Training**	CIEM
III	**Workshop of data needs**	CIEM, Agenda 21 Office
IV	**International consultant**	
V	**Reporting**	CIEM

6.1.6. Time schedule

The total implementation time for this phase is planned for 12 months. The time schedule is shown in the table bellows:

Table 14: Time schedule of phase 2

No	Item	Month											
		1	2	3	4	5	6	7	8	9	10	11	12
I	**Data collections**												
1.1	**Data needs for bottom up model (EFFECT)**												
1.1.1	***General data***												
1.1.2	***Power sector***												
1.1.3	***Industrial data***												

a1	Collecting and analysis data												
a2	Pilot survey												
a21	Developing questionnaire, data analysis												
a22	Southern provinces (HCM city and other)												
a23	Northern provinces												
1.2.4	***Transport, vehicle class data***												
a1	Collecting and analysing data												
a2	Pilot survey (combined with household survey)												
1.1.5	***Household sector (combined with transport survey)***												
a1	Collecting and analysing data												
a2	Pilot survey												
a21	Developing questionnaire, data analysis												
a22	Southern provinces (HCM city and other)												
a23	Northern provinces												
1.1.6	***Nonresidential data***												
a1	Collecting and analysing data												
a2	Pilot survey												
a21	Developing questionnaire, data analysis												
a22	Southern provinces (HCM city and other)												
a23	Northern provinces												
1.2	**LULUCF**												
	land use, land use change, forest and agriculture												
1.3	**IPCC guideline 2006**												
	GHG emission from waste												
1.4	**Data needs for top down model (CGE model)**												

	Hybrid input – output extended (including environmental expenditure)or SAM: add rows showing pollution from manufacturing												
II	**Training**												
2.1	**One training workshop enhancing capacity for Vietnamese staff on integrated low carbon development and climate resilience into the country's economic planning process** *(out side of Ha Noi)*												
2.2	**One training workshop enhancing capacity for Vietnamese staff on The MAC-Tool** *(5 days in Ha Noi, 10 technical staffs)*												
2.3	**One training workshop enhancing skill for Vietnamese staff using the EFFECT model** *(15 days in Ha Noi, 10 technical staffs)*												
2.2	**One training workshop enhancing capacity for Vietnamese staff on LULUCF** *(5 days in Ha Noi, 10 technical staffs)*												
2.4	**One training workshop enhancing skill for Vietnamese staff using the Computable General Equilibrium (CGE), Dynamic Stochastic CGE** *(15 day in Ha Noi, 10 technical staffs)*												
III	**Workshop of data needs**												
IV	**International consultant**												
V	**Reporting**												
5.1	**Data report**												
5.2	**Training report**												
5.3	**Final report of phase 2**												

6.2. Main Study phase:

6.2.1. Objectives of the study

The general objectives of this phase is to analyse low carbon portfolio and identify growth patterns that help the economy increase its resilience to climate impacts and reduce its carbon intensity.

Using the common economic evaluation methodologies to identify and assess a number of promising low-carbon interventions in Vietnam, in the short, medium and long term (5-10; 10 -20; 20 - 30 years). Low-carbon interventions would be selected on an integrated approach, with multiple sectors: i) having a good emissions reductions potential, low net financial and economic costs, and that are socially and politically feasible; ii) whose benefits are not jeopardized by potential climate change impacts; In this phase, the study will assess the impacts from different scenarios of low-carbon development within the National Target Program on Climate Change (NTPCC) and those of low carbon development on macroeconomic indicators such as investment, GDP, employment, and income distribution.

6.2.2. Expected outputs of the study

Portfolio of low-carbon interventions by key sector: Using a common cost-benefit analysis, the study will identify and assess promising low-carbon interventions in key sectors, such as power, industry, transport, agriculture, forestry, that could be implemented within the next 5-10, 10-20, and 20-30 years. The analysis will include an assessment of the costs (including investment requirements) and benefits of each intervention, in addition to the analysis of costs and benefits of the economic, social, and political feasibility of undertaking the interventions, and a set of policy recommendations that would be needed to implement the sectoral intervention programs. The study will not attempt to provide a comprehensive assessment of all possible interventions, but rather will provide a framework for the evaluation mitigation options in key sectors.

Economic, carbon emissions and climate-resilient modelling: The study will construct a series of baseline emission scenarios for the years 2020, 2030, and 2050 for key emission sectors, including power, industry, transport, agriculture and forestry. Compared to these baseline scenarios will be one or more low-carbon development scenarios constructed from the low-carbon portfolio analysis. The macro modelling exercise will also evaluate the impacts of implementing low-carbon programs on income, employment, and income distribution, etc.

A report of analysis of costs and financing, policy options, enabling environment: According to the results of running the models, the experts write a report on the analysis of cost and financing, policy options, enabling environment for Vietnam and it will be sent to the Government of Vietnam.

6.2.3. Budget

Total budget of this phase focuses in three main tasks, as developing the Portfolio of low-carbon climate-resilient development by sector (46%), Economic and carbon emissions modelling (27%),

Analysis of costs and financing, policy options, enabling environment (5%), workshops and technical meetings (19%), and writing report and publication (3%).

6.2.4. Organization of the study

In this phase, the number of project partners is more focused than in the Input phase (phase 2). There are not many organizations involving in the study, in contrast, high quality specialists in participating organisations are planned to be mobilised. Once again, MPI is designed to be the project implementing agency and CIEM is the coordinating institution. Other nominated organizations include:

- Ministry of Planning and Investment (MPI): General Statistical Office (GSO), AGENDA 21 Office
- Ministry of Industry and Trade (MOIT): Energy Research Institute
- Ministry of Agriculture and Rural Development (MARD): Institute of Policy and Strategy for Agriculture and Rural Development (IPSARD)
- Ministry of Natural Resource and Environment (MONRE): The Vietnam Institute of Meteorology, Hydrology and Environment (IMHEN), Institute for Policy and Strategy for Natural Resource and Environment (ISPONRE), General Department of Land Administration (GDLA)

The tasks that the organizations can involve is shown in the table bellows

Table 15: The organization involves in the study

No	Item	Organization
I	**Portfolio of low-carbon climate-resilient development by sector**	
1.1	**Developing MACCs using EFFECT model to develop low carbon scenarios for key sectors**	
	Power	CIEM; Energy Research Institute - MOIT
	Industry	CIEM; Energy Research Institute - MOIT
	Transport	CIEM; Energy Research Institute - MOIT
	Household	CIEM, GSO

	Nonresident	CIEM, GSO
1.2	**Developing MACCs using LULUCF model to develop low carbon scenarios for land use, land use change, forest and agriculture**	CIEM, IPSARD; ISPONRE
1.3	**Developing MACCs for waste**	CIEM; IMHEN
1.3	**International consultants**	
II	**Economic and carbon emissions modeling**	
2.1	**Construct a series of baseline emission scenarios for the years 2020, 2030, and 2050 for key emission sectors using CGE model**	CIEM,
2.2	**International consultants**	
III	**Analysis of costs and financing, policy options, enabling environment**	CIEM and international consultant
IV	**Workshop**	
4.1	**Workshop**	CIEM, Agenda 21 Office -MPI
4.2	**Consultation Meetings for result dissemination and awareness raising for relevant stakeholders, agencies and institutions** *(National Assembly Office, Party's Central Office, Government Office, Ministry of Justice, MPI, MOIT, MONRE, MOT, MOF, MARD, MOST, MOH, MOET, Ministry of Culture, Sports and Tourism, VTV, VOA,VCCI, Business Associations, NGOs, etc)*	CIEM, Agenda 21 Office
V	**Writing final report**	CIEM
VI	**Publication**	CIEM, Agenda 21 Office

6.2.5. Time schedule

The total implementation time for this phase is planned for 12 months. The time schedule is shown in the table bellows:

Table 16: Time schedule of phase 3

No	Item	2013 (month)											
		1	2	3	4	5	6	7	8	9	10	11	12
I	**Portfolio of low-carbon climate-resilient**												

	development by sector											
1.1	**Developing MACCs using EFFECT model to develop low carbon scenarios for key sectors**											
	Power											
	Industry											
	Transport											
	Household											
	Nonresident											
1.2	**Developing MACCs using LULUCF model to develop low carbon scenarios for land use, land use change, forest and agriculture**											
	Agriculture and forestry											
1.3	**Developing MACCs for waste**											
	Agriculture and forestry											
1.3	**International consultants**											
II	**Economic and carbon emissions modeling**											
2.1	**Construct a series of baseline emission scenarios for the years 2020, 2030, and 2050 for key emission sectors using CGE model**											
2.2	**International consultants**											
III	**Analysis of costs and financing, policy options, enabling environment**											
IV	**Workshop**											
4.1	**Workshop of finding out**											
4.2	**Launching workshop**											
4.3	**Meeting on result dissemination for relevant ministries**											
V	**Final report**											
VI	**Publication**											

Conclusion

Following increased awareness of the climate change challenges both internationally and nationally, Viet Nam formulated a national programme, the NTP-RCC approved in December 2008 by the Prime Minister, with activities focused on the period 2009-2015. The NTP-RCC

g*eneral objectives* are to assess climate change impacts on sectors and regions in specific periods and to develop feasible action plan to effectively respond to climate change in short-term and long-term periods to ensure sustainable development of Viet Nam, to take over opportunities to develop towards a low-carbon economy, and to joint international community's effort in mitigating climate change and protecting the climatic system.

The NTP-RCC aims to mainstream climate change concerns into the new Socioeconomic Development Strategy (SEDS 2011-2020) and Socio-economic Development Plan (SEDP 2011-2015), and into policies on DRR, coastal zone management, and energy supply and use. 40 Action plans to deal with climate change will be developed under the NTP-RCC in most sectors and all provinces, in several stages. This will include research and planning in the short term, and formulation and implementation of investment plans at later stages, requiring substantial technical assistance. Importantly, the NTP-RCC should help Viet Nam formulate an overall climate change strategy that includes long term goals on adaptation as well as GHG emissions mitigation. Also important but not covered explicitly under the NTP-RCC is climate change mainstreaming in public and private sector investment plans. This would include, for example, adapting coastal protection infrastructure and 'greening' energy production and manufacturing. Climate change-related policy development, research, and awareness raising all face coordination challenges, as climate change relates to so many sectors and other strategies, action plans and national target programmes.

Energy use in Vietnam has a large room for improvement. Beside the weak production management, it is backward technology that is main reason to consume more energy. Statistics pointed that, there are 50-60% of total enterprises using backward technology, including new purchase of equipment , but in fact, that is backward technology. The Vietnam's enterprises like to import Chinese equipment and technology of cheap price, but that are causing high pollution and energy consumption.

In addition, current regulation requires that all ODA-supported credits under the CDM accrue to the Viet Nam Environment Fund and not to the project owners. It is critical that Viet Nam addresses these barriers and takes full advantage of the CDM. Many investments in Viet Nam could benefit from the CDM. The CDM could also ensure the financial feasibility of hydropower investments.

All these grounds prove the rationale for a study on low carbon and climate-resilient development in Vietnam. It is even more pressing as the speed of industrialization and urbanization is high in the next decades. The government of Vietnam has also fully been aware of the importance of increasing quality of growth during economic development process. In the context of strong

international transforming into low carbon technology development, Vietnam should take the new opportunities so that it would not be left behind. The impact of climate change has also been evident in Vietnam and corresponding actions should be taken and prepared for the future impact as well. All these new development scenarios taken these two kinds of impact should be made clear from now on so that the government could have appropriate policy actions. The "Study into the Economics of Low Carbon, Climate-Resilient Development in Vietnam" is therefore really necessary to provide growth pattern options for the government to select especially at this time when 2011-2020 socio-economic development Strategy and fine year 2011-2015 socio-economic development Plan started to be implemented.

The results of this scoping study prove the feasibility of conducting the overall study especially in making plans for the next two phases of the Study. A broad picture of the "business as usual" scenarios for Vietnamese economy with the main macroeconomic indicators and climate conditions for the next 30-40 years was sketched. In addition, the government development strategies in crucial sectors related to low carbon and climate-resilient development were also analysed. In this scoping phase, an in-depth review of methodology for conducting the main study was completed taking into account the current capacities of domestic and international expertise. The hybrid-models classified as a combination of bottom-up and top-down models were chosen as appropriate approach for the study. This would help take the advantages of the complementarity of both kinds of models while minimizing their disadvantages. Specific implementing agencies with specific designed tasks ("role play") were also pointed out in the next two phases of the project implementation. The time schedule and proposed budget were estimated accordingly as well. It can be concluded that the plans for the next two phases of the study have already been made.

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Appendices

Appendix 1: Modelling framework for low carbon growth in Vietnam

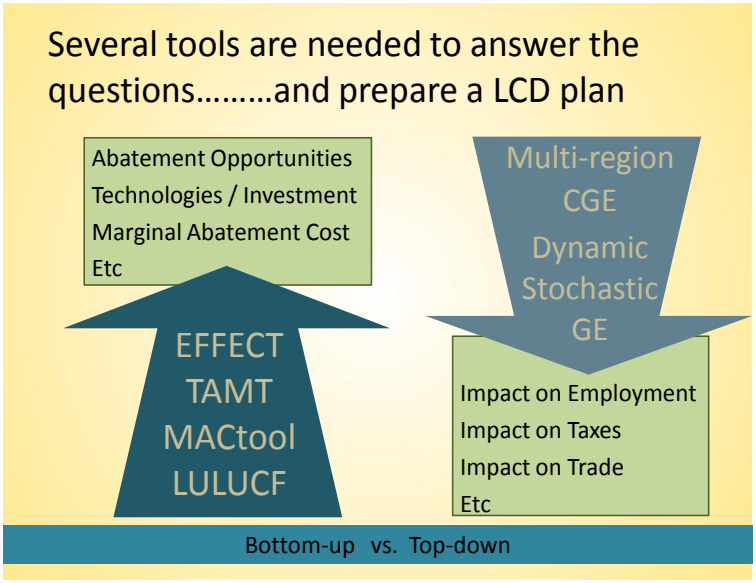
Low carbon development planning in Vietnam will require a consensus to be reached involving all Ministries and multiple other stakeholders[13] on an achievable long term development trajectory that will allow the country to maintain its growth targets while emitting less greenhouse gases to the atmosphere than could have been expected under previous development plans. Low carbon development planning requires that priorities be determined across sectors; deciding where investments should be made to reduce the future emission of GHGs, and the time frame in which each should best be made. This involves trade-offs and agreements across the entire economy.

Scenario modelling and sharing of data is an important part of this process. Modelling helps understand where a country and each sector – energy, transport, land use, agriculture, forestry and waste management – currently stand, the direction in which they are developing, the impact of this development on the level of GHG emissions, and resources that would be needed for abatement. There are various approaches to modelling low carbon pathways, typically grouped into top-down and bottom-up (see Figure 6). Top-down, macro-economic models are used to assess the economy-wide impacts of greenhouse gas policies and actions whilst bottom-up engineering style models can focus on, and quantify, the distinct impacts of a large number of specific abatement options. Whilst top-down models can take into account feedback effects from adjustment in prices by analyzing an energy-demand relationship through a reduced-form equation, bottom-up models examine the ownership and the use of energy-consuming devices and consider efficiency scenarios from an engineering point of view.

Vietnam would benefit from using different models to help understand and get answers to different questions and it is likely that several models will need to be selected and integrated in the low carbon analysis. A useful suite of models will include different models that approach the question of what might be a realistic low carbon development pathway from different angles illuminating important but different aspects of the economics of GHG mitigation and implementation strategies.

[13] Such as other stakeholders from the government, non-governmental institutions, academia, donors, investors, NGOs and other constituencies

Figure 6: Bottom-up and Top-down Modeling Tools



This low carbon development planning process presents an excellent opportunity for Vietnam to select those tools that will best serve its needs over the coming years, and obtain the international support needed to further develop its analytical capacity in this area.

Any modelling exercise for this study should be designed at the outset so that models can be maintained and updated in subsequent years. The ease of use of models and how much local capacity and resources needed to be developed to update the low-carbon scenarios are therefore an important consideration in selecting an approach. Over a period of decades –the scope of most low carbon studies –assumptions about efficiency improvements within sectors as well as how the development of one sector will affect other sectors as well as shifts towards less carbon-intensive activities as part of normal development will have a large impact on results. When this low carbon development planning study results in the implementation of a lower carbon development pathway for the country, these scenarios will need to be updated to reflect the changes that will occur and propose corrections as necessary to keep the process on track.

Adding the dimension of "climate resilience" adds an additional level of complexity to the low carbon development planning study. The study will need to evaluate not only what lower carbon options exist for electricity production, for example, but also where to locate them. Many technologies to generate electricity require water -- including some concentrated solar technologies -- and changes in the future availability of water for these power stations, due to climate change, greater frequency of extreme weather events, and competing uses for limited available water, will need to be taken into account in both the choice of technology and the location of the power stations. Policymakers will thus need to think carefully about long-term sectoral development in far more detail than is presently covered in most economy-wide models.

To achieve this, a suite of models needs to be selected that will develop these plausible longer-term scenarios and that can help answer a series of key questions about each particular sector and the economy as a whole:

- What are the specific development goals?
- Are there lower carbon options to achieve these goals?
- What and where are the greenhouse gas mitigation potentials?
- Do they make sense economically from a planning perspective?
- What would it take for the private sector to act?
- How much additional financing is needed?

Appendix 2 | The EFFECT Model Focuses on Sectors with Significant or Rising GHG Emissions

Electricity Generation is normally the biggest consumer of a country's primary energy resources since industry and households typically consume large amounts of electricity. In many countries, it is also the biggest contributor to global warming often being based on fossil fuels - like coal, oil, and natural gas – that lead to large quantities of CO_2 emissions. Various options exist to increase efficiency and lower CO_2 emissions from power generation – plant rehabilitation, use of high efficiency combustion technology, combined production of heat and power, coal gasification and combined cycle power production, switching to natural gas or biomass fuels, carbon capture and storage, increasing the share of renewable energy sources, and nuclear power.

Large-Scale Energy Intensive Industry, including pulp and paper, refineries and upstream oil and gas facilities, and the fertilizer, iron and steel, aluminium, and cement industries are covered in the EFFECT model. Most of these industries consume large amounts of power and heat, and generate process emissions. The electricity that they purchase from the Grid causes indirect GHG emissions. GHG emissions can be reduced by improving the efficiency of their power and heat generating (or conversion) processes, introducing energy efficiency measures in their industrial production processes, improving process integration (e.g., combined heat and power production), and substituting fuels.

On-Road Transport includes cars, buses, and trucks of all sizes plus motorized 2- and 3-wheelers (including mopeds scooters and motorcycles)... On-road transport is the largest contributor to GHG emissions in the transport sector given its continued reliance on fossil fuels and in many countries is the fastest growing source of CO2 emissions... The need for on-road passenger and freight transport is accelerating in most developing countries due to rising levels of urbanization and household income. Ways to reduce emissions include: improving vehicle fuel efficiency, shifting to travel modes that generate less GHG emissions per passenger and freight-tonne transported, and reducing the need to travel whilst to improving access to goods and services through urban redesign amongst other measures. The development and deployment of biofuels worldwide is a rapid area of growth despite concerns on their competition with food production for scarce water resources and agricultural land. Electric vehicles are also in sight.

Household Electricity Use consists of the energy used for lighting, refrigeration, heating, ventilation and air conditioning, kitchen appliances, entertainment systems, and cooking. The indirect CO_2 emissions from household electricity use are closely linked to how the power is being produced and how efficiently it is being used. Energy efficiency is the primary option for

lowering GHG emissions by households... Energy efficiency can be improved through the implementation of standards, changes in appliance technology and use, and improvements to building codes.

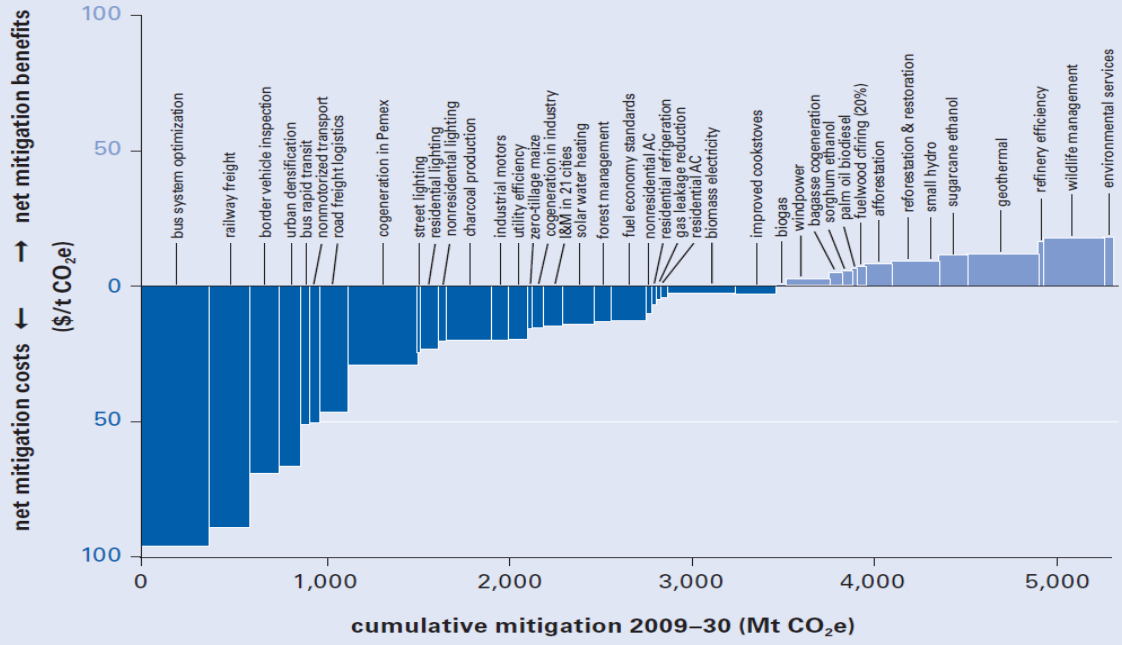
Non-residential Energy Use encompasses a mixed complex of buildings for: retail; offices; hotels; hospitals; schools; other public buildings and institutions, data warehouses etc. Lighting, power and air conditioning account for most of the energy consumed. Other energy needs include: space heating and liquefied petroleum gas etc used for water heating and cooking in schools, hotels and hospitals. As in the household sector, energy consumption can be reduced through the implementation of standards, changes in appliance technology and use, and improvements to building codes

Appendix 3 | Marginal Abatement Cost Curves*

The Marginal Abatement Cost Curve is a graphical representation of costs-benefit analysis of the GHG abatement options that could be employed in a particular country or sector. The curves are used by policy makers to select abatement options that are most beneficial for the economy - those that maximize GHG emission reduction per dollar of net present value of associated cost of abatement. The graph depicts abatement options sorted by cost, thus making a clear picture of comparative advantage of some options versus the others. The usual criticism of the MAC curves is the presence of the options with negative net present cost (or net profit), which should be attractive investment opportunities, yet not implemented by the private sector.

Various agencies have produced MAC curves. The most well known are created by McKinsey & Company and by Bloomberg New Energy Finance. ICF International created a MAC curve for California. The Wuppertal Institute for Climate, Environment and Energy from the perspective of end-user, utilities and society. The US Environmental Protection Agency produced a MAC curve for non carbon dioxide emissions. Enerdata and LEPII-CNRS (France) produce MAC curves with the POLES model for the 6 Kyoto Protocol gases, these curves have been used for various public and private actors either to assess carbon policies or through the use of a carbon market analysis tool.

Figure 2 Marginal Abatement Cost Curve



Source: Authors, based on MEDEC study results.

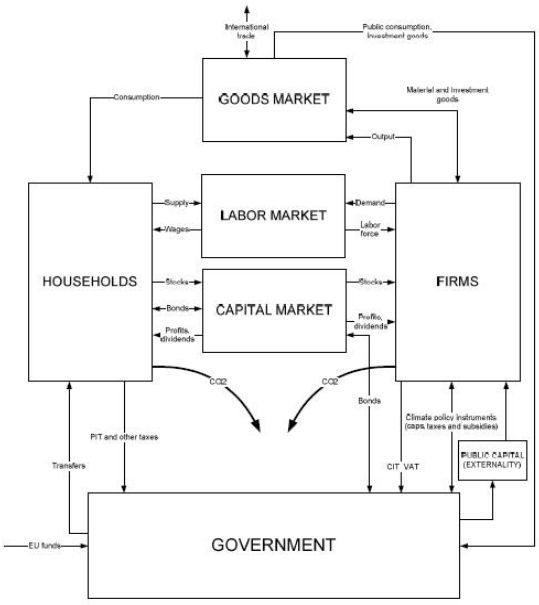
Appendix 4 | The Structure of the Poland DSGE model

The DSGE model is divided into three main blocks: (i) households, (ii) firms, and (iii) government. Those blocks are interconnected one with another on three separate markets: (i) labor, (ii) capital, and (iii) goods (see Figure). Both production and consumption evoke GHG emissions that are modeled on sectoral and household levels.

Households supply labor, decide on the level of their consumption as well as for government bonds and firm stocks. Households communicate with producers on labor market where wages are negotiated and vacancies filled. This market is operated by a special intermediate firm that buys labor from households and sells it to firms in eleven production sectors: (1) agriculture with food industry, (2) light industry, (3) heavy industry, (4) mining and fuels, (5) energy, (6) construction, (7) trade, (8) transport, (9) financial services, (10) public services, (11) other services.

In each sector there are firms producing basic goods using capital, labor and materials (including energy) as inputs. Goods that are later consumed by households, re-invested by producers or utilized by government. In the production process, firms employ labor, capital, intermediate goods and energy. As they are owners of capital, and have some monopolistic power their profits are positive allowing them to pay dividend for their shareholders. Apart from it they also pay income and value added taxes to government. Government divides its tax income into public investments, public consumption and social transfers to households for unemployed and retired.

In the goods market, prices for consumption, investment and intermediate goods are set. Firms purchase materials and investment goods from other companies and utilize them as inputs in the production process. Furthermore, the latter may be bought by the government to improve economical environment for the firms and households. In the labor market the wages are set to equalize labor market and supply. Labor market is non-Walrasian as a job search mechanism and centralized wage negotiations between employees and employers are implemented. Therefore, unemployment rate is higher than zero. Capital market allows borrowing through the issue of bonds. Furthermore, companies may share their profits with households paying out dividends and rise capital issuing stocks. Thus capital market allows for streaming sources of financing from households to firms and smoothing consumption over time of the former.



This DSGE modeling capacity has been built to make it portable to the economic impact assessment of climate policy strategies for individual countries in an international context paying special attention to the global nature of the climate problem and the increasing integration of national economies through international markets.

Appendix 5: Information on energy master plans of Vietnam

1). Master Plan VII on power energy

After two decades, total placement capacity of Electricity Plants has been increased significantly. That is about 2000MW in 1990, it was increased 8,500 MW in 2009, and as estimated in 2010 it is reached 20,600MW. In which, the Hydro power is 8,200MW, comprising 39.5%; Oil & gas Thermal Electricity are 7700MW, accounting for 37,7%, Coal Thermal Electricity is 3000MW – 14.8%; Small Hydropower and Renewable energy comprise 3.4%; and the rest of energy is 4.6% imported from China 4,6%. Despite having growth rate, but if compared with targets made in VI Master Plan for period up to 2025 (TSD-VI), the numbers of delay Generation Plants are so high.

+ *Hydro power:* It is capacity 1100MW in 1990 that has been increased 4100MW in 2004, because of large Hydropower Plant like Hoa Binh with 1920MW put into operation in 1994, Hàm Thuận-Đa My (300+175)MW in 2001, Yaly 720MW in 2002... It is building up total of 11 Plants. For 4 years from 2007 to 2010, Total of added new 23 Plants are put into operation, that contribute to total capacity with new 4000MW.

+ *Gas Thermal Power:* First GTP was made from 1997 since the pile line Cửu Long-Bạch Hổ, then Nam Côn Sơn and recently PM3-CAA to Cà Mau has been established. Gas thermal power has its first capacity of more 400MW in 1995, from 1996 up to now, Total of Gas & oil thermal power capacity in increased more than 7700MW (of which Oil thermal are ~550MW including Thủ Đức, Cần Thơ ~200MW, Amata 13.5MW, and #1 Ô Môn 330MW using FO).

+ *Coal thermal power:* After operation of Ninh Bình 100MW (1976), Uông bí 105MW (1977) and Phả Lại 1-440MW (1986) in the North, the coal generation development has been postponed during 15 years at total capacity 645MW. Up to 2002, Phả Lại 2 (its capacity 2x 300MW) was put in operation. Since 2004, its new added capacity 1800MW is made, of which there are more than 1000 MW in 2010. But some Plants as Hai Phong Quảng Ninh and Cẩm Phả with their total 300MW capacity have some problem.

It has been changed in electricity structure during 2 past decades. Hydro power continuously maintain high percentage 64% - 72% for period 1991 – 1997, especially in 1995 (72,3%), after that the ratio of hydro power is reduced, but it is still high 39.5% in 2010 (2007-36%). Oil &gas thermal power from 1995 to 2010, its ratio is increased from 10% up to 37,9% , in which the highest percentage is 2007-2008 (47.9%). At the same time, the ratio of coal thermal power is coming down from 32% in 1990 to 11-14% and now it consists of 14.8% of total generation capacity.

- *Electricity generation Projection up 2030*

According to Proposed Master Plan on electricity development for period 2011-2020, with its vision up to 2030 (TSĐ-VII), it is anticipated that the electrical demand (scenario baseline) is increased at rate 14.0%/year for period 2011-2015; and 11.1%/year for 2016-2020, it is proposed production in 2015 is 194 billion kWh, 2020 is 329 billion kWh, maximum capacity in 2015 is 30,803MW and 2020 is 52,040MW. Up to 2030, electrical production is 695 billion kWh, its maximum capacity is 110,215MW.

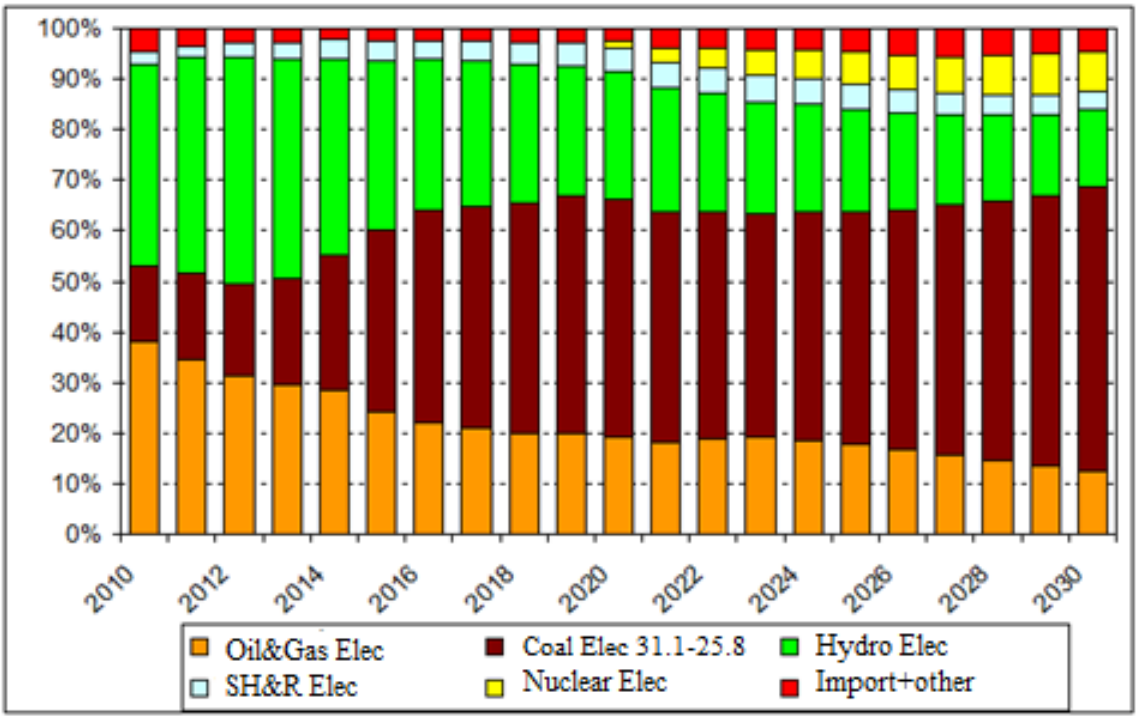
In total electrical generation capacity, Hydro power capacity (including water storage) is increased from 8,100MW at present up to 17,987MW in 2020 and 21,100MW in 2030; Oil & gas Thermal power come up from 7,700MW to 13,625MW in 2020 and 17,500MW in 2030, in which its 9,000MW capacity has to use LNG after 2027; Coal thermal power has its highest growth rate in term of capacity, from 3,000MW now up to 32,535MW in 2020 and 77,300MW in 2030 (in which about 43,000MW of its capacity should use imported coal, equivalent 80 million tones/year).

For the period up to 2030, Small hydro sources and Renewable energy come from 500MW at present to 3,100MW in 2020 (with its 1900MW of small hydro and 1,200MW renewable), and up to 4,800MW in 2030.

First Nuclear Power Plant is proposed to be run in 2020, and then its capacity is increased gradually up to 6,000MW in 2025 and 10,700MW in 2030; Imported electricity from Laos and China, and Cambodia come up 1,800MW in 2020 and 6,400MW in 2030.

Regarding to generation complex, Hydro would reduce its proportion to 25.7% in 2020 and 15.3% in 2030; oil & gas thermal would comprise 19.4% in 2020 and remain 12.7% in 2030; while coal thermal would increase its ratio up to 46.4% in 2020 and 56.1% in 2030; it forecast renewable energy would have its ratio 4,5% in 2020 and 5% in 2025, due to its potential have been not clarified, especially its wind power it has little change in renewable sources structure , after 2025 its proportion is coming down 3,5% -:- 4%; Nuclear power will be increased, comprising 6.1% in 2025 and 7.8% in 2030; other energy imported would comprise 2.6% and 4.6% relatively to year 2020 and 2030.

Figure 7: Generation Structure for 2011-2030



With minimum price target of Master Plan, it consider in Master Plan VII different scenario of generation replacement, of which there are scenario using high rate of renewable energy sources in order to reduce emission. It is suggested that maximum renewable energy sources would be mobilized, with its plan to build up 5,700MW in 2020 and more than 6,000MW in 2030 (haft of that is small hydro). But, due to low operation real time of its renewable energy (as wind power has 25% of year), so generation yield per designed capacity is low, its kWh produced is needed capacity 3 times higher than other. In other hand, and it is not clear whether it is feasible for renewable replacement, but the scenario if come with renewable rate up to 5.1% in 2020 and 5.8% in 2025, so it create only 2.1 billion kWh of replacement, while given accumulated expenditures added to budget for 20 years at 2.6 billion USD. In this connection, the emission reduction of CO_2 is only 2.3 Million tones in 2030.

2) Coal Exploitation Master Plan

Most of coal reserves are located in the North of Vietnam, of which Quang Ninh coal bay consist of 70%. According to geologist assessment, there 4 types of coal in Vietnam: antraxite, peat, bitium and sub-bitium. In recent years, coal sector has been developed quickly in term of investment size and growth rate. In 2005, the production of whole sector has been 35 Million tones, exceeding further than planned target at 20 Million tones for 2010.

Table 17: Forecast of coal demand up to 2025

	Coal demand (1000 tones)					Growth rate %		
Year	**2006**	**2007**	**2008**	**2009**	**2010**	**06-10**	**11-20**	**21-25**
Domestic demand	**18748**	**31837**	**50677**	**75412**	**118060**	**18.2**	**8.65**	**10.27**
1. Thermal electrical	5334	12322	23751	41642	78538	31.30	12.18	14.21
2. Cement	3650	5296	6401	7348	7877	1259	2.78	1.4
3. Construction materials	4590	5064	5899	6838	7928	4.77	3.08	3.0
4. Fertilizer, chemicals	766	1142	1832	2818	3429	10.51	9.45	4.0
5. Paper, wooden	220	294	415	574	732	7.55	6.88	5.0
6. Textile, Leather, Garment	193	269	403	590	827	8.69	8.11	7.0
7. Metallurgy	392	3264	6329	7830	9078	69.87	9.14	3.0
8. Other industry	230	310	433	606	773	7.76	6.92	5.0
9. Heating	2613	2925	2790	4791	5555	6,0	5,1	2,5
10. Peat	760	950	1425	2375	3325	6,0	9,0	10,0
Total	**18748**	**31837**	**50677**	**75412**	**118060**	**18.2**	**8.65**	**10.27**
Peat	760	950	1425	2375	3325	6.0	9.0	10.0
Bitium	392	3264	6329	7830	9078	69.87	9.14	3.0
Antraxite	17758	30577	48819	72432	113962	18.62	8.33	10.44

Source: Master Plan on Vietnam's coal Development 2006-2025

The coal production plan by end of 2010, in Quang Ninh Base and other mines are 48-50 Million tones; in 2015 it goes up to 60-65 Million tones; in 2020 it reach 70-75 Million tones and in 2025 it produce more than 80 Million tones. For Red River base, it strike to open mine after 2010, experiment made for exploitation with both gastification and underground technology. Beside this, due to increasing the domestic coal demand, especially for thermal electricity, it is needed to import coal to meet requirement.

In this Master Plan, it is anticipated that Vietnam has to import coke for metallurgical purpose. In 2010, it is to import 1.34 Million tones, in 2015: 4.2 Million tones, in 2020: 6.8 Million tones and by 2025: 7.8 Million tones. For meeting electricity production, after 2015, it has to import coal, and in 2030 Vietnam has to import 80 Million tones per year for electricity only.

3) Oil and Gas Exploitation Master Plan

According to Master Plan, it is to develop new mine and invest to widen current mines, invest to develop pile line infrastructure to supply gas to industry customer, electricity producers and build Master Plan on gas use network in Mekong River Delta and East-North region, develop oil and gas processing technology.

Oil and gas processing and fuels import are to meet country demand, that increase every years. The forecast of domestic fuels demand up 2025 are as followings.

Table 18: Petrolimex Forecast of Fuels demand

Units: 1000 tones

Products	Year			
	2010	**2015**	**2020**	**2025**
LPG	1,588	2,362	3,633	5,590
Gasoline	3,987	5,016	6,311	7,940
Jet oil	541	794	1,167	1,716
Kerosene	482	526	576	630
Diesel	7,600	9,561	12,030	15,136
Mazut	3,035	3,966	5,062	6,461
Total	**17,180**	**22,228**	**28,782**	**37,475**
Bitum	687	1009	1,483	1,938
Grant Total	**17,867**	**23,238**	**30,265**	**39,413**

Sources: Petrolimex

There is another forecast made by JICA. It is reliable forecast according to suggestion of specialist.

Table 19: JICA's Forecast of fuels demand to 2025

Units: 1000 tones

TT	Products	2010	2015	2020	2025
1	LPG	1,900	3,600	6,400	10,000
2	Gasoline	3,850	4,400	5,500	6,700

3	Jet Fuel	750	1,050	1,400	1,800
4	Kerosene	380	400	430	510
5	Diesel	7,300	10,150	13,850	18,950
6	Mazut	1,900	2,750	4,300	6,100
	Total	**16,080**	**22,350**	**31,880**	**44,060**

Sources: Jica

4) Nuclear Power Master Plan

On 17/June/2010, the Decision 906/QĐ-TTg has been made by Prime Minister regarding to Master Plan on Nuclear power development up to 2030, targeted at gradually building and developing Nuclear power sector in Viet Nam.

Projection of Master Plan: According to Nuclear Power Development Master Plan, the Nuclear Power development in Vietnam has been divided into 3 periods.

- Period from now to 2015 (Preparation Period)

The first period up to 2015 will prepare all documents and decide Plant location Selection. They are implementation of projects documentation, approval of location, selection of EPC vender, human resources preparation.

It is including preparation of supporting policy, financial partner, improving domestic capacity to involve in construction and providing materials, equipment, and other consultant services. In this period, it is to finalize location selection for first Nuclear Plant.

- Second Period from 2016 to -2025 (Run of First Nuclear Power Plant)

In 2020: First Unit of First Vietnamese Nuclear Power Plant, with its capacity 1000 MW put to run. In 2025: total capacity of Nuclear power in Vietnam will be about 8,000 MW, comprise 7% of total electricity generation capacity.

- Third Period up 2030: Run 13 reactors

There will be 13 Nuclear power Plants in Vietnam in 2030, with their capacity of 15,000 MW, comprising 10% of total electrical capacity. The list of Vietnamese Nuclear Reactors by the Master Plan is given in the following table

Table 20: List of Vietnamese Nuclear Reactors

STT	Reactors	Capacity (MW)	Year of run
1	First Phuoc Dinh Reactor	1000	2020
2	Second Phuoc Dinh	1000	2021
3	First Vinh Hai Reactor	1000	2021
4	Second Vinh Hai Reactor	1000	2022
5	Third Phuoc Dinh Reactor	1000	2023
6	Forth Phuoc Dinh	1000	2024
7	Third Vinh Hai	1000	2024
8	Forth Vinh Hai	1000	2025
9	Central 1 and 2	2 x 1000	2026
10	Central 3	1,300 – 1,500	2027
11	Central 4	1,300 – 1,500	2028
12	Central 5	1,300 – 1,500	2029
13	Central 6	1,300 – 1,500	2030
	Total capacity	**15,000 – 16,000**	

Source: Decision 906/QĐ-TTg dated 17/06/2010

Appendix 6: Comparison of ICES and ENVISAGE

	ICES	**ENVISAGE**
No. Sectors / Regions	Variable	Variable
Dynamics	Recursive	Recursive
Solving software	GEMPACK	GAMS
SAM Data Base	GTAP	GTAP
Extended calibration	No	Yes
Endogenous Climate	No	Yes
End Year	2100	2100
Steps	Annual	Variable
Income effects	No (limited)	Yes (flexible)
Macroec. scenario	Econometric / other m.	Econometric
Sticky capital stock	No	Yes
Saving rate	Exogenous	Endogenous
International capital f.	Yes	No
GHG gases	CO2, N2O, CH4	CO2, N2O, CH4, F-g
Sea level impacts	Yes	Yes
Agriculture impacts	Yes (linear)	Yes (non-linear)
Water impacts	No	Yes
Human health impacts	Yes	Yes
Tourism impacts	Yes	Yes
Energy demand	Yes	Yes
Labor productivity impact	Yes	Yes

Appendix 7: Projects and studies on climate change

No	Nam of project	Start	End	Donor(s)	Objectives and Activities
I	**Completed projects and studies on climate change**				
1		1995	1997	UNDP, ADB	The overall objective of the study is to enhance the existing national and regional capacity to develop least-cost greenhouse abatement strategies that promote environmentally sustainable economic development in twelve countries including Viet Nam.
2	Economics of GHG Limitation - Phase I	1996	1999	GEF	The project aims to assist countries with economic analysis of climate change mitigation strategies by establishing, applying and testing a consistent methodological framework. The long term results of the project will contribute to CC mitigation by providing input to the process of integrating environmental and specially CC concerns with national and regional development priorities.
3	Forest Protection and Rural Development Project	1997	2006	WB, the Gov. of Netherlands	The overall objective of the Forest Protection and Rural Development Project is to assist Vietnam to protect and manage natural forests with high biodiversity. More specifically, the main development objectives are: 1) to effectively protect Cat Tien National Park (CTNP) and to effectively protect and manage the Chu Mom Ray Nature Reserve (CMRNR); 2) to effectively manage the remaining natural forests outside the protected areas (PA) but within the buffer zone of CTNP and CMRNR; 3) to reduce dependency on CTNP and CMRNR for subsistence and cash income; and 4) to strengthen capacity of the government to effectively design, implement, and monitor Integrated Conservation Development Projects (ICDPs).

4	Green Corridor	2006	2010	GEF, WWF, WB, Netherlands Development Organization	The Green Corridor project's purpose aims to protect and maintain the Green Corridor landscape by strengthening management and capacity building. The project applies a landscape-level approach, identify areas of biodiversity and forest conservation importance. Project results include: High biodiversity in project area as well as in Thua Thien Hue province is nationally and internationally confirmed through various reports and workshops; based on scientific foundation on biodiversity research, earth observation and geographical information tools: conservation zoning on biodiversity, habitats of some species with considerably high conservation; new species project area were discovered and release internationally; establishing endemic species and flagship monitoring system; monitoring system of Ho Chi Minh highway; establishing strategy on raising conservation awareness and environmental education; provincial strategy on forest fire fight; strategy - action plan for combating illegal wildlife trade; officers and people at all levels' awareness on biodiversity, importance of forest landscape are raised; capacity in forest fire fight and prevention of rangers and communities is raised; supporting conservation based training on small grant schemes; community forest management; ecotourism models with community management; integration between conservation and poverty reduction; integrating 661-forest restoration programme into the project
5	Vietnam PARC - Creating Protected Areas for Resources Conservation (PARC) in Vietnam Using a Landscape Ecology Approach	1998	2004	GEF, UNDP	Project to conserve Vietnam's globally significant biodiversity through implementation of a landscape ecology approach to protected areas management which will seek to find a fair balance between the provision of ecologically sound livelihoods and the conservation of biodiversity in Vietnam's unique socioeconomic conditions. The project will introduce, develop and implement the Protected Areas for Resources Conservation concept which is based on participatory approach, an open consultative process, and the appropriate integration of conservation and development. Objectives include provision of sustainable livelihoods and generation of employment, protection of endemic genetic resources and preservation of distinctive ethno-biological forms and values of global significance, and the mitigation of fragmentation effects
6	Rural Energy 1 Project	2000	2006	WB	The Rural Energy Project (RE) for Vietnam aims to 1) expand rural access to electricity in communes located in 32 provinces through grid extension, where economically justified, to improve welfare, enhance income-earning capacity and help alleviate poverty; 2) to define and establish institutional mechanisms and strategy for rural electrification; and 3) promote the application of renewable energy sources in areas

					inaccessible to the national grid and to supplement grid power supply.
7	Viet Nam National Strategy Study on Clean Development Mechanism (NSS CDM)	2001	2005	AusAid, WB	The NSS CDM final report was completed in 2004. The report indicated benefits for Vietnam from participating in CDM including direct economic advantages, environmentally-friendly technology transfer, the mitigation of harmful effects on the local environment and population (through GHG abatement projects), and the preparation of national institutions and private organizations for opportunities that will arise under post-Kyoto legislation
8	Benefits on Climate Change adaptation from Small and medium scale hydropower plants: Synergies and trade offs with rural development	2006	2009	DANIDA	Project results show that: (i) CC would have positive impacts on small and medium scale hydropower plants as the increase of precipitation; (ii) In the aspect of environment, building small and medium scale hydropower plants would have bad impacts on local ecosystem of the project areas and vicinity such as change the use of land, dry up river and affect the migration and residence of aquatic species etc. (iii) Small and medium scale hydropower projects have significant potential to mitigate GHG emissions. (iv) Building and operating small and medium scale hydropower projects would have positive impacts on safety and economic security of local people.
9	Promotion of Renewable Energy, Energy Efficiency and Greenhouse Gas Abatement (PREGA)	2002	2004	ADB	This project focuses mainly on (i) preparing a portfolio of renewable energy, energy efficiency and greenhouse gas abatement (REGA) projects for financing by diverse sources, including the private and public sectors, multilateral and bilateral agencies, and using specialized mechanisms such as GEF and CDM, (ii) preparing the country studies on policy and institutional aspects relevant to dissemination of REGA technologies, (iii) developing the financial models suited to the needs of the country, for REGA technologies, and (iv) setting up the pilot projects for REGA options and evaluating the performance of such projects. Project output: (i) A policy and strategy report on Institutional and Policy Barriers for Renewable Energy and Greenhouse Gas Reduction Technologies; (ii) Implementation of rural electrification program, with grid expansion, construction and development of new power plants are being strongly implemented by EVN. The Renewable Energy Action Plan is an effort of EVN in rural electrification to help people in rural areas improve their living standards and increase incomes

10	Energy Conservation and Efficient in Small and Medium Scale Enterprise	2005	2009	GEF	This project is intended to reduce the GHG emissions from small- and medium-sized enterprises (SMEs) by removing existing policy, institutional, technical, informational, and financial barriers to adoption of more energy efficient technologies and practices. The energy management schemes that will be replicated after the project are expected to result in positive impacts to the country's SME sector. This project will cover SMEs of different ownership, e.g., state-owned enterprises (SOEs), private entities, cooperatives and household-based enterprises.The project is expected to bring about the following outcomes: 1) the policy and institutional capacities of the Government of Vietnam (GVN) in facilitating the adoption of energy efficiency (EE) technologies and practices in SMEs are improves; 2) "One-stop shop" for serving the Energy Conservation and Energy Efficiency (EC&EE) needs of SMEs are established.; 3) the operations of ESCOs (Energy Service Companies" are promoted to, and are utilized by, SMEs in their EC&EE activities; 4) public participation in implementing and monitoring EC&EE as well as environmental performance of SMEs is enhanced; 5) EC&EE techniques and technologies are demonstrated to, and are adopted by, SMEs in the brick making, ceramic, textile, paper and food processing sectors; 6) small- and micro-credits are made available, affordable and accessible for SMEs for use in their EC&EE activities.Capacity Building for Clean Development Mechanism (CD4CDM) in Vietnam (2003 - 2006) (funded by the Gov. of Netherlands)The project is intended to help to establish GHG emission reduction projects that are consistent with national sustainable development goals, particularly projects in the energy sector. The project aims at 1) generating in participating developing countries a broad understanding of the opportunities offered by the Clean Development Mechanism, and 2) developing the necessary institutional and human capabilities that allows them to formulate and implement projects under the CDM
11	Capacity Development for National Climate Change Focal Point	2006	2009	DANIDA	The overall objective of the project is to have the International Cooperation Department (ICD) under MONRE to act as National Climate Change Focal Point (NCCFP) that will address key problems arising from the interaction of climate change and sustainable development for a better co-ordination & integration of national climate policies with sustainable development policies.Immediate Objectives: This project is aimed at immediately building the human and institutional capacity of the NCCFP under MONRE in Viet Nam. The project’s immediate objectives are: 1) to develop the capacity of ICD of MONRE as a National Climate Change Focal Point (NCCFP) that collects and provides

					information to decision makers and concerned ministries on Climate Change adaptation activities that address the current and anticipated adverse effects of climate change, including extreme events in sustainable development programmes; 2) NCCFP strengthens its role in cooperation with the international community in eliminating/mitigating threats from climate change to sustainable development
12	Preparation of 1st National Communication to the UNFCCC	1999	2002	GEF	The project enabled Vietnam to publish its 1st National communication under the UNFCCC in 2003, as required by Article 12.1 (a), (b) and (c) of the UNFCCC, based on the recommended COP2 guidelines and format for non-Annex 1 Parties
13	Vietnam: Preparation of the 2nd National Communication to UNFCCC	2006	2009	UNEP	The project enabled Vietnam to publish its 2nd National Communication to UNFCCC in 2010, based on guidelines approved on COP8. It provided information on the National Greenhouse Gas Inventory in 2000, analyses and assesses impacts of climate change, and recommended a number of feasible options for the adaptation to climate change and the mitigation of greenhouse gas emission in some major economic sectors in the near future.
II	**Ongoing projects and studies on climate change**				
1	Rural energy 2	2005	2011	WB, GEF	The development objective of the Rural Energy (RE) II project is to provide rural communities with access to good quality, affordably priced electricity services in an efficient and sustainable manner. Its global environmental objective is to achieve major GHG reductions by removing the barriers to achieving and sustaining much higher efficiency levels in rural power distribution
2	Forest Sector Development Project	2004	2011	GEF, WB	The Forest Sector Development Project will achieve sustainable management of plantation forests, and conservation of biodiversity in special forests uses. The project components are as follows: 1) strengthening forest management and biodiversity conservation; 2) based on different cropping systems, forest plantations will be established, including fast-growing plantations, mixed forestry-agriculture crops, and fruit trees, as well as promoting small-scale tree growing by rural communities; 3) conservation, and sustainable use of biodiversity resources will be provided through a new Vietnam Conservation Fund (VCF) to administer a competitive small grants program, including monitoring and reporting, and, implementing conservation needs assessments

3	Vietnam Renewable Energy Development Project	2009	2014	WB, AusAid	The objective of the Renewable Energy Development Project for Vietnam is to increase the supply of electricity to the national grid from renewable energy sources on a commercially, environmentally, and socially sustainable basis
4	System Efficiency Improvement, Equitization & Renewables Project	2002	2012	WB	The objective of the Project is to improve the overall efficiency of power system services, particularly to the poor in rural areas, by optimizing the transmission systems, and upgrading sub-transmissions, and medium voltage distribution lines for rural electrification. The project components are as follows: 1) power system efficiency will be improved by upgrading the 500 KV, and 200 KV transmission networks, and associated substations, which includes the installation of capacitors to selected substations; 2) rural electricity access will be improved by upgrading, and strengthening the 110 KV sub-transmission line, and substations, restoring five existing hydropower plants, and, construction of a small-scale hybrid wind-diesel power plant at Phu Quoc Island; and 3) sector reform and institutional development will be pursued, through improvements in the management information system, the creation of one District, and several commune-level joint-stock distribution companies, and, by strengthening the regulation, planning, and implementation capacity for renewable electricity. To this end, operational training, and technical assistance will be provided
5	VN-Priority Infrastructure Investment Project	2008	2013	WB	Long-term objectives of Project: 1) urban poverty alleviation through upgrading of technical infrastructure, environmental condition and improvement in living condition of the urban poor; 2) improvement of environmental condition in polluted areas relating to waste water, sewerage issues; 3) enhancement of economic growth through investment in development of strategic infrastructure, implementation of improvements and technical assistance to create an attractive investment climate; 4) gradual adaptation to urban development planning; 5) socialization in process of planning, programming and implementing investment in urban infrastructure upgrading through participatory technical solutions, human resources and fund contribution; 6) promotion in participatory project preparation, implementation and management in order to satisfactorily meet people' demand; 7) provision of support to institution and enhancement in management capacity to City's administration authorities.Short-term objectives: 1) improving flooding status, environmental sanitation condition at urban Low Income Ares (LIAs); 2)

					providing infrastructure services for poverty community
6	Demand-Side Management & Energy Efficiency Project	2003	2010	WB, GEF	The objectives of the Demand-Side Management and Energy Efficiency Project are to: (a) develop and expand demand-side management (DSM) business programs and test new market transformation efforts within the national electric utility, Electricity of Vietnam (EVN); and (b) develop sustainable business models and mechanisms to support energy efficiency (EE) retrofit investments in commercial and industrial facilities
7	Hanoi Urban Transport Development	2007	2013	WB, GEF	The development objectives of the HUTDP are to help Hanoi City to (a) increase the efficiency and cost-effectiveness of its transport system, and (b) develop public transport-compatible urban growth plans. Its GEF strategic objectives are to promote a shift to more environmentally-sustainable transport modes and urban development plans, and to promote the replication of these approaches in the country and region. Its global environment objective is to lower Hanoi's transport-related greenhouse gas emissions, relative to a business-as-usual scenario
8	National Action Framework for Reduction of Emission from Deforestation and Degradation (REDD	2008	2010	UNDP	The Objective of the UN-REDD Viet Nam Programme is to assist the Government of Viet Nam in developing an effective REDD regime in Viet Nam and to contribute to reduction of regional displacement of emissions. This will contribute to the broader Goal of ensuring that ―By the end of 2012 Viet Nam is REDD-ready and able to contribute to reducing emissions from deforestation and forest degradation nationally and regionally
9	Energy Efficiency Public Lighting (VEEPL) Project	2006	2010	GEF	VEEPL is aimed at building both technical and policy support for transition to more energy efficient public lighting in Vietnam. By increasing the energy efficiency of public lighting installed over the next 10 years, the project will significantly reduce electricity consumption by the public lighting sector in Vietnam compared to what it otherwise would have been. Reducing electricity consumption will reduce emissions of GHG from the Vietnamese electricity generation sector. Although VEEPL specifically targets public lighting (street lighting, public spaces and public buildings), the technical capacity and policies established through the project will support lighting efficiency efforts in other sectors as well

10	Strengthening national capacities to respond to climate change in Vietnam and controlling GHG emissions	2009	2012	UNDP	Frameworks, mechanisms and capacities in place to inform, guide and coordinate (i) analysis of climate change related risks and formulation of climate change adaptation policy responses and investment plans; and (ii) analysis of Green House Gas emissions, and formulation of investment plans and ways to change consumer behaviour for low-carbon economic development. Project expected outcomes: Climate change policy formulated and mainstreamed into the National Target Program to respond to Climate Change, related action plans formulated, and policy and management capacities for roll out strengthened. Improved knowledge base, and national research capacity strengthened to deliver analysis for evidence-based planning and policy development, and implementation of climate change related measures to support sectors and provinces in rolling out the National Target Programme to respond to climate change (NTP-RCC). Build capacities for regulation, guidance, local policy measures, and project management, and formulate concrete regulations, policy measures and investment plans for CC adaptation and GHG emissions control
11	Phasing out Incandescent Lamps through Lighting Market Transformation in Vietnam	2010	2014	GEF	The object of the project is to phase-out of Incandescent Lamps (ILs) production and sale through the transformation of the lighting products market as well as the promotion of high quality Energy Saving Lamps (ESLs) in Vietnam
12	Promoting Energy Conservation in Small and Medium Scale Enterprises (PECSME)	2005	2011	GEF	The goal of the project is the reduction in the annual growth rate of GHG emissions from the five selected SME sectors through widespread and sustained improvement in energy utilization. The project purpose is the removal of barriers to the widespread uptake of energy conservation technologies, improved management focus on reducing energy costs, enhanced technician training in energy conservation practices and improved operation of energy using equipment

13	Renewable Energy Enterprise Development - Seed Capital Access Facility	2008	2013	UNEP, ADB	The near term objectives of the project are to, first, increase in developing countries the flow of seed capital to sustainable energy enterprises and, second, to convince the energy finance community that early stage seed capital investing is a viable and cost effective strategy for building long term commercial energy investment portfolios
14	Vietnam Clean Production and Energy Efficiency Project	2010	2015	GEF, WB	The overall objective is to reduce greenhouse gas (GHG) emissions through market-based mechanisms to scale-up the adoption of energy-efficient technologies in new and existing industrial facilities, and support energy-efficiency improvement in the large commercial and residential sectors, including promotion of more efficient electrical appliances
15	Barrier Removal to the Cost-Effective Development and Implementation of Energy Standards and Labeling Project (BRESL)	2006	2011	GEF	Considering the envisioned alternative scenario, it is expected that the improved capacity of Asian countries to develop and implement effective ES&L programs would contribute ultimately to the goal of reducing greenhouse gas (GHG) emissions from the major energy consuming sectors in the participating Asian economies. To realize this, the envisioned regional project is expected to result in the following: increased capacity of Asian countries to develop and implement ES&L programs; enhanced awareness on ES&L programs and in the use of EE products in the countries in the region; facilitation of the development and implementation of ES&L programs, with the participation of the relevant government agencies, manufacturers/suppliers, retailers, and consumers; increased financing and access to financing for ES&L initiatives; establishment of a regional network of standards and labeling activities that will facilitate harmonization of standards; and, successful demonstration of the design, development, financing, institutionalization, implementation of ES&L programs and the resulting benefits from such programs.

16	Strengthening Sustainable Development and Climate Planning	2009	2011	UNDEP	The Project Objective is: To improve mechanisms, knowledge and tools, capacity and coordination for sustainable development (SD), especially on climate change (CC) for policy development, planning and investment in Viet Nam.The Project focuses on strengthening knowledge, coordination and mechanisms for sustainable development (SD) and climate change (CC) planning. Mainstreaming SD & CC into socio-economic development planning processes is of paramount importance if Viet Nam is to develop low carbon economic development solutions whilst ensuring the climate resilience of most vulnerable populations including children and the poor and marginalized
III	**Research on low carbon economy at MOIT**				
1	Survey, investigate and assess the impact of industrial clusters in coastal areas and propose solutions to respond	2010			
2	Investigate and assess potential damage of climate change to chemical industry bases in affected areas in Vietnam	2010			
3	Assess the impact of climate change and rising sea level to production activities of industries sensitive to climate change	201			

4	Assess the impact of climate change to trade and propose appropriate measures for Vietnam's trade industry to respond	2010			
5	Assess the impact and propose solutions to respond to climate change and rising sea level for Vietnam's steel industry.	2010			
6	Integrate the issue of climate change response into the formulation of financial mechanism to support renewable energy development.	2010			
7	Investigate and assess the potential development of low carbon industry in Vietnam to respond to climate change	2010			

Appendix 8: Vietnam CDM projects registered by ED (as of 10/2010)

No	Project name	Duration	Total mitigation potential (T CO2 e)
1	Rang Dong Oil Field Associated Gas Recovery and Utilization Project (Ba Ria - Vung Tau province)	10 years (2001 - 2011)	6,770,000
2	Song Muc Hydro Power Station Regeneration Project in Viet Nam (Thanh Hoa province)	07 years (2007 - 2013)	29,066
3	Dong Thanh Landfill gas CDM Project in Ho Chi Minh City	07 years (2008 - 2014)	1,033,328
4	Wind power plant No 1 - Binh Thuan 30 MW (Binh Thuan province)	07 years (2009 - 2015)	405,921
5	Cao Phong Reforestation Project (Hoa Binh province)	16 years (2008 - 2023)	42,645
6	Phu Mau Hydropower Project (Lao Cai province)	07 years (2009 - 2015)	95,438
7	Muong Sang Hydropower Project (Son La province)	07 years (2009 - 2015)	35,056
8	Suoi Tan Hydropower Project (Son La province)	07 years (2009 - 2016)	102,487
9	So Lo Hydropower Project (Hoa Binh province)	07 years (2009 - 2015)	114,422
10	Nam Pia Hydropower Project (Son La province)	10 years (2009 - 2016)	348,940
11	Wastewater treatment with Anaerobic Digester at Viet Ma starch processing plant (Tay Ninh province)	10 years (2009 - 2019)	398,140
12	Wastewater treatment with Anaerobic Digester at Truong Thinh starch processing plant (Tay Ninh province)	10 years (2009 - 2019)	423,890

13	Ta Niet Hydropower Project (Son La province)	07 years (2009 - 2016)	71,232
14	Phuoc Hiep I sanitary Landfill gas CDM project, Ho Chi Minh city	07 years (2009 - 2015)	926,454
15	An Diem III Hydropower Project (Lao Cai province)	07 years (2009 - 2016)	276,878
16	AVN08-S-01, Methane Recovery and Biogas Utilization Project, Nghe An province,Viet Nam	07 years (2009 - 2016)	360,222
17	AVN08-S-02, Methane Recovery and Biogas Utilization Project, Nghe An province, Viet Nam	07 years (2009 - 2016)	217,077
18	VN08-WWS-04, Methane Recovery and Biogas Utilization Project, Lao Cai province,Viet Nam	07 years (2009 - 2016)	317,474
19	VN08-WWS-03, Methane Recovery and Biogas Utilization Project, Yen Bai province, Viet Nam	07 years (2009 - 2016)	277,329
20	VN08-WWS-05, Methane Recovery and Biogas Utilization Project, Quang Tri province, Viet Nam	07 years (2009 - 2016)	285,771
21	Nam Gion Hydropower Project (Son La province)	07 years (2011 - 2018)	288,092
22	Nam Khoa 3 Hydropower Project (Lao Cai province)	07 years (2010 - 2016)	324,030
23	Nam Khot Hydropower Project (Son La province)	07 years (2010 - 2017)	195,471
24	Yam Tann Sien Hydropower Project (Lam Dong province)	07 years (2011 - 2018)	278,257
25	Ha Rao Quan Hydropower Project (Quang Tri Province)	07 years (2010 - 2017)	85,596
26	Coc Dam Hydropower Project (Lao Cai province)	07 years (2010 - 2017)	115,304

27	Lap Vo Rice Husk Biomass Power Plant (Dong Thap Province)	07 years (2011 - 2017)	276,545
28	Chieng Cong Hydropower Project (Son La Province)	07 years (2010 - 2017)	162,725
29	Pa Khoang Hydropower Project (Dien Bien Province)	07 years (2010 - 2017)	49,560
30	Dak Ne Hydropower Project (Kon Tum Province)	07 years (2010 - 2017)	144,158
31	Ea Drang 2 Hydropower Project (Dak Lak Province)	07 years (2010 - 2017)	96,383
32	Dak Rung Hydropower Project (Dak Nong Province)	07 years (2010 - 2016)	120,799
33	Suoi Sap 3 Hydro Power Project (Son La Province)	07 years (2010 - 2017)	194,417
34	Landfill gas recovery and utilization in Nam Son, Tay Mo landfills in Hanoi	07 years (2010 - 2017)	2,615,870

Source: Viet Nam's second national communication to the UNFCCC, 2010.

Appendix 9: The data needs

No	Item	Data status		Note
I	**Data collections**	**Available**	**Unavailable**	
1.1	**Data needs for bottom up model (EFFECT)**			
1.1.1	***General data***			
	Data indicators			
	Exchange Rate	√		*Data collection, analysis and calculation*
	GDP	√		*Data collection, analysis and calculation*
	Population	√		*Data collection, analysis and calculation*
	Total Land Area	√		*Data collection, analysis and calculation*
	Price of Fuels (after tax)	√		*Data collection, analysis and calculation*
	Tax Rate for Fuels (Cost plus basis)	√		*Data collection, analysis and calculation*
	Energy Content and Emissions Factors for Fuels		√	*Data collection, analysis and calculation*
	Ambient Temperature	√		*Data collection, analysis and calculation*
1.1.2	***Power sector***			

	Electrical Energy Demand	√		*Data collection, analysis and calculation*
	Electrical Energy Demand by type of Consumer	√		*Data collection, analysis and calculation*
	Electricity Price Change in Constant L.C.	√		*Data collection, analysis and calculation*
	Transmission and Distribution Losses	√		*Data collection, analysis and calculation*
	Supplied Demand	√		*Data collection, analysis and calculation*
	Load Duration Curve	√		*Data collection, analysis and calculation*
	Typical Specifications for New Plants	√		*Data collection, analysis and calculation*
	For each existing and currently planned power producing unit	√		*Data collection, analysis and calculation*
	Existing Plant Heat Rate Default Data	√		*Data collection, analysis and calculation*
	Long Run Income Elasticities for Electrical Appliances by Sector in Country	√		*Data collection, analysis and calculation*
1.1.3	***Industrial data***			
	Steel			Data collection, calculation and survey
	Finished Steel demand and production	√		*Data collection, analysis and calculation*
	Steel Scrap		√	*Survey*

	Production by type of plant		√	*Survey*
	Steel - Integrated Steel Producers Total production		√	*Survey*
	Energy Usage in production (Status Quo)		√	*Survey*
	Efficiency Measures for Existing Plants		√	*Survey*
	Efficiency Measures for New Plants		√	*Survey*
	Steel - Small Scale Producers Total production		√	*Survey*
	Energy Usage in production (Status Quo)		√	*Survey*
	Efficiency Measures for Existing Plants		√	*Survey*
	Efficiency Measures for New Plants		√	*Survey*
	Aluminium Total production			Data collection, calculation and survey
	Aluminium factors	√		*Data collection, analysis and calculation*
	Primary Aluminium demand and production	√		*Data collection, analysis and calculation*
	Alumina demand and production	√		*Data collection, analysis and calculation*
	Secondary Aluminium demand and production	√		*Data collection, analysis and calculation*
	Energy Usage in Primary Aluminium production (Status Quo)		√	*Survey*

	Energy Usage in Alumina production (Status Quo)		√	*Survey*
	Energy Usage in Secondary Aluminium production (Status Quo)		√	*Survey*
	Electricity Supply		√	*Survey*
	CO2e emissions in Aluminium current production (Status Quo)		√	*Survey*
	Efficiency Measures for Existing Plants		√	*Survey*
	Efficiency Measures for New Plants		√	*Survey*
	Cement			
	Cement Emissions from industrial process		√	*Survey*
	Cement demand and production		√	*Survey*
	Cement variety		√	*Survey*
	Energy Usage in Cement production (Status Quo)		√	*Survey*
	Efficiency Measures for Existing Plants		√	*Survey*
	Efficiency Measures for New Plants		√	*Survey*
	Fertilizer (Ammonia)			
	Energy Usage in Ammonia production (Status Quo)		√	*Survey*
	CO2 emissions in Ammonia production (Status Quo)		√	*Survey*

	Efficiency Measures for Existing Plants		√	*Survey*
	Efficiency Measures for New Plants		√	*Survey*
	Petroleum Product demand and production			
	Energy Usage in Refining (Status Quo)		√	*Survey*
	Efficiency Measures		√	*Survey*
	Conversion of Electricity Savings into Primary Fuel savings			*Survey*
	Paper demand and production			
	Energy Usage in Pulp Production (Status Quo)		√	*Survey*
	Efficiency Measures		√	*Survey*
1.2.4	***Transport, vehicle class data***			
	Vehicle Fuel Density	√		*Data collection, analysis and calculation*
	Vehicle Fuels	√		*Data collection, analysis and calculation*
	Fuel Prices (blended)	√		*Data collection, analysis and calculation*
	Use mileage degradation factor	√		*Data collection, analysis and calculation*
	in calculating emissions	√		*Data collection, analysis and calculation*

	Households that own Cars		√	Survey
	Number per Household		√	Survey
	Car Ownership	√		*Data collection, analysis and calculation*
	MC Ownership		√	Survey
	3W Ownership		√	Survey
	LCV (Goods) and Truck Ownership	√		*Data collection, analysis and calculation*
	Active Vehicle Population and use		√	Survey
	Two Wheelers	√		*Data collection, analysis and calculation*
	Vehicle usage (km per year) by years of operation		√	Survey
	Vehicle annual operating cost by years of operation		√	Survey
	New Technology for fuel efficiency improvement		√	Survey
	For Petrol, LPG, and CNG Vehicles		√	Survey
	For Diesel Vehicles Only		√	Survey
1.1.5	***Household sector***			
	Household Electrification	√		*Data collection, analysis and calculation*
	Population per centile	√		*Data collection, analysis and calculation*

	Monthly Per Capita Expenditure per centile	√		*Data collection, analysis and calculation*
	Total Electricity Usage per month	√		*Data collection, analysis and calculation*
	Lighting Unit Sales Mix by Technology		√	Survey
	Average Operating Life of Light on Retirement		√	Survey
	Historic Parc Configuration (Baseline)		√	Survey
	Appliances		√	Survey
	Number per Household		√	Survey
	Average Age of Appliance on Retirement		√	Survey
	Historic Parc Configuration (Baseline)		√	Survey
	Appliance Usage		√	Survey
	Radio Sales Mix by Size & Type		√	Survey
	Radio Sales Mix by Technology		√	Survey
	CD Sales Mix by Technology		√	Survey
	TV Sales Mix by Technology		√	Survey
	DVD Sales Mix by Size & Type		√	Survey
	DVD Sales Mix by Technology		√	Survey

	Computer Sales Mix by Size & Type		√	Survey
	Washing Machine Sales Mix by Size & Type		√	Survey
	Washing Machine Sales Mix by Technology		√	Survey
	Electric Oven Sales Mix by Size & Type		√	Survey
	Electric Oven Sales Mix by Technology		√	Survey
	Toaster Sales Mix by Size & Type		√	Survey
	Toaster Sales Mix by Technology		√	Survey
	Microwave Sales Mix by Size & Type		√	Survey
	Cooler Sales Mix by Size & Type		√	Survey
	Cooler Sales Mix by Technology		√	Survey
	AC Sales Mix by Size & Type		√	Survey
	AC Sales Mix by Technology		√	Survey
1.1.6	***Non-resident data***			
	Retail floor space	√		*Data collection, analysis and calculation*
	Office floor space	√		*Data collection, analysis and calculation*
	Hotels	√		*Data collection, analysis and calculation*

	Hospitals	√		*Data collection, analysis and calculation*
	Schools	√		*Data collection, analysis and calculation*
	SCHOOL Floor space	√		*Data collection, analysis and calculation*
	Others (Restaurants, Telecom, Warehouses, Others)	√		*Data collection, analysis and calculation*
	Total Energy in Base year	√		*Data collection, analysis and calculation*
	Base year Energy Intensities for Existing floor space		√	Survey
	Base year Energy Intensities for New Construction		√	Survey
	Base year lighting technology mix		√	Survey
	Base year heating/cooling technology mix		√	Survey
	Lighting		√	Survey
	Average Operating Life of Lights		√	Survey
	Percentage of Parc with each intensity improvement		√	Survey
	Exogenous Efficiency Factor change in lighting		√	Survey
	Cooling		√	Survey
	Average Operating Life of Cooling appliances		√	Survey
	Percentage of Parc with each intensity improvement		√	Survey

	Exogenous Efficiency Factor change in Cooling		√	Survey
	Fans		√	Survey
	Percentage of Parc with each intensity improvement		√	Survey
	Exogenous Efficiency Factor change in Fans		√	Survey
	Other Appliances		√	Survey
	Percentage of Parc with each intensity improvement		√	Survey
	Exogenous Efficiency Factor change in Other Appliances		√	Survey
1.2	**LULUCF**			
	land use, land use change, forest and agriculture	√		*Data collection, analysis and calculation*
1.3	**IPCC guideline 2006**			
	GHG emission from waste	√		*Data collection, analysis and calculation*
1.4	**Data needs for top down model (CGE model)**			
	Hybrid input – output extended (including environmental expenditure)or SAM: add rows showing pollution from manufacturing	√		*Data collection, analysis and calculation*