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THE VIETNAM EC-LEDS DATA NEEDS ASSESSMENT

THE AILEG PROJECT

CONTRACT NO. EEM-I-00-07-00004-00
TASK ORDER: AID-OAA-TO-11-00041

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Prepared For

Office of Economic Policy
Global Climate Change Office
Bureau of Economic Growth, Education, and Environment
U.S. Agency for International Development

Prepared by

Abt Associates

October 2012

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Photo Credits: Rice fields, industry, landfill. Ministry of Natural Resources and Environment, *Viet Nam's Second National Communication under the United Nations Framework Convention on Climate Change*,

Hanoi, Vietnam, 2010. ***Monitoring***. Ministry of Natural Resources and Environment, *Viet Nam Initial National Communication under the Framework Convention on Climate Change*. Hanoi, Vietnam, 2003.

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ACRONYMS

ADB	Asian Development Bank
AFD	Agence Francaise de Developpement
AILEG	Analysis and Investment for Low-Emission Growth
AusAID	Australian Agency for International Development
ALU	Agriculture and Land Use Greenhouse Gas Inventory (ALU) Software
BAU	Business-as-Usual
CDM	Clean Development Mechanism
CGE	Computable General Equilibrium
CIEM	Central Institute of Economic Management
CLUE	Conversion of Land Use and Its Effects Model
CNAM	CIEM-NIAS Analytical Model
CNG	Compressed natural gas
CO_2	Carbon dioxide
CO_2e	Carbon dioxide emission equivalents
COMAP	Comprehensive Mitigation Assessment Process
CPC	City People's Committees
DAYCENT	Daily Century Model
DFID	Department for International Development
DMHCCC	Department of Meteorology and Hydrology and Climate Change of MONRE
DNDC	DeNitrification-DeComposition model
DOC	Department of Construction
DONRE	Department of Natural Resources and Environment
DSI	Development Strategy Institute
DSO	Districts Statistics Office
EC-LEDS	Enhancing Capacity in Low Emission Development Strategies
EFFECT	Energy Forecasting Framework and Emission Consensus Tool
EFOM	Energy Flow Optimization Model
ESMAP	Energy Sector Management Assistance Program
EVN	Electricity of Vietnam
EX-ACT	Ex-ante Appraisal Carbon Balance Tool
GAMS	General Algebraic Modeling System

GDP	Gross Domestic Product
GEMPACK	General Equilibrium Modeling Package
GGS	Green Growth Strategy
GHG	Greenhouse Gas
GSO	General Statistics Office
GTAP	Global Trade Analysis Project
GVN	Government of Vietnam
IAE	Institute of Agricultural Environment
IARD	Institute of Agriculture and Rural Development
ICES	Inter-temporal Computable Equilibrium System
ICT	Information and Communications Technology
IE	Institute of Energy
IFC	International Finance Corporation
IFPRI	International Food Policy Research Institute
IMHEN	Institute of Meteorology, Hydrology and Environment
IMPACT	International Model for Policy Analysis of Agricultural Commodities and Trade
IPCC	Intergovernmental Panel on Climate Change
IPSI	Institute for Industry Policy and Strategy
ISPONRE	Institute of Strategy and Policy on Natural Resources and Environment
JICA	Japan International Cooperation Agency
LEAD	Low-Emissions Asian Development Program
LEAP	Long-Range Energy Alternatives Planning System
LEDS	Low-Emission Development Strategies
LEI	Landbouw-Economisch Instituut
LUCF	Land Use, Land Use Change, and Forestry (sometimes abbreviated as LULUCF)
MAC	Marginal Abatement Cost
MAGNET	Modular Applied GeNeral Equilibrium Tool
MARD	Ministry of Agriculture and Rural Development
MARKAL	MARKet Allocation Model
MEDEE	*Modèle d'Evolution de la Demande d'Energie*
MESSAGE	Model for Energy Supply Strategy Alternatives and Their General Environmental Impact
MOC	Ministry of Construction
MOF	Ministry of Finance
MOH	Ministry of Health

MOIT	Ministry of Industry and Trade
MONRE	Ministry of Natural Resources and Environment
MOST	Ministry of Science and Technology
MOT	Ministry of Transport
MOU	Memorandum of Understanding
MPI	Ministry of Planning and Investment
NAMA	Nationally Appropriate Mitigation Action
NCCC	National Committee on Climate Change
NIAPP	National Institute for Agricultural Planning and Projecting
NIAS	Nordic Institute of Asian Studies
NPV	Net Present Value
NREL	National Renewable Energy Laboratory
NSIS	National Statistics Indicator System
NTP-RCC	National Target Program to Respond to Climate Change
PPC	Provincial People's Committees
PSO	Provincial Statistics Office
REDD+	Reducing Emission in Deforestation and Degradation Plus
SAM	Social Accounting Matrix
SIDA	Swedish International Cooperation and Development Agency
SME	Small and medium-sized enterprises
SP-RCC	Support Program to Respond to Climate Change
UN	United Nations
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
URENCO	Urban Environment Company
USAID	United States Agency for International Development
USEPA	United States Environmental Protection Agency
USG	United States Government
VCEP	Vietnam/USAID Clean Energy Program
VEA	Vietnam Environment Administration
VHLSS	Vietnam Household Living Standard Survey (formerly the Vietnam Living Standard Survey, VLSS)
VINACOMIN	Vietnam National Coal–Mineral Industries Holding Corporation Limited
VIPAG	Vietnam Policy Advisory Group

VLCRP	Vietnam Low Carbon Rice Pilot Project
VNEEP	Vietnam National Energy Efficiency Program
WASP	Wien Automatic System Planning
WEPA	Waste Management and Promotion Agency
WITCH	World Induced Technical Change Hybrid

1. EXECUTIVE SUMMARY

Responding to its high vulnerability to climate change, Vietnam is moving to transform its development pathway toward sustainable growth with low greenhouse gas (GHG) emissions and climate-resilient practices. Having launched extensive climate change programs throughout the past decade, in November 2011 the Government of Vietnam (GVN) joined a strategic partnership with the United States Government (USG) on Enhancing Capacity for Low Emission Development Strategies (EC-LEDS). In March 2012, the Analysis and Investment for Low-Emission Growth (AILEG) Project, funded by the United States Agency for International Development (USAID), began assisting the GVN to strengthen national and provincial capacity in the collection, management, and analysis of data for low-emission development strategies (LEDS). Because the General Statistics Office (GSO), housed within the Ministry of Planning and Investment (MPI), is mandated to supervise all national data collection and statistics, it is the focal point for the AILEG activity in Vietnam.

This report comprises (1) the findings of the in-country assessments and (2) GVN priorities for AILEG assistance. Working with GSO, AILEG solicited input from key ministry representatives and other stakeholders responsible for data collection, management, and analyses through extensive interviews and workshops (Annex A). AILEG concentrated on LEDS data needs for the agriculture, energy, and solid waste sectors as directed by USAID, given existing technical support by other programs for the forestry, industry, and transport sectors.

1.1. AILEG AND THE LEDS PROCESS

Section 2 of this document presents an overview of the AILEG Project and Memorandum of Understanding (MOU) on EC-LEDS that forms the strategic partnership between Vietnam and the United States. Section 3 describes the LEDS history, concept, and analytical approaches used by USAID as developed by the National Renewable Energy Laboratory (NREL) and other USG agencies. It presents the concepts, tools, and data inputs needed for each step in analyzing LEDS. The three components in analyzing LEDS are to (1) prepare a baseline emissions trajectory, called the Business-as-Usual (BAU) scenario, against which the projected emissions from alternative low-emission scenarios can be compared; (2) assess the low-emission development options for reducing emissions; and (3) evaluate low-emission development pathways.

Vietnam uses a variety of analytical methods and tools, described in Section 3, to determine the above steps in a LEDS analysis. Most assessment methods and tools need a combination of some—though not necessarily all—of the following data for a specified time period: GHG emission factors for emitting sources (e.g., tonnes of carbon-dioxide equivalents per tonne of rice produced); activity data on the annual production of the emitting sources (e.g., tonnes of rice per year); demand and supply for the emitting sources from all sectors; product prices (financial) and economic values (e.g., co-benefits, environmental benefits); and socioeconomic variables, such as gross domestic product (GDP), GDP growth, population, and population growth. In Vietnam, AILEG focused on the gaps and needs in data collection, management, and analysis for preparing each of these steps, looking at both economy-wide and sector-based needs.

1.2. NATIONAL DATA ASSESSMENT NEEDS

Vietnam has made a strong commitment to LEDS through its national climate change policies and initiatives. The Ministry of Natural Resources and Environment (MONRE) has submitted two National Communications to the United Nations Framework Convention on Climate Change (UNFCCC).[1] Some of the key initiatives are the 2008 **National Target Program to Respond to Climate Change (NTP-RCC**) to develop "feasible action plans" that respond to climate change; the 2009 **Support Program to Respond to Climate Change, 2011–2016 (SP-RCC)** to scale up and mainstream climate change adaptation and mitigation activities; the **Social Economic Development Plan** to integrate climate change considerations into national planning; the **Action Plan to Respond to Climate Change 2011–2015;** the 2011 **National Climate Change Strategy 2012-2050** that sets clear strategies for undertaking actions to build resilience and reduce long-term GHG emissions; and the **Green Growth Strategy (GGS**) currently under development that will support LEDS with a 20% national emissions reduction target and doubling of GDP per capita over its 2010 level by 2020.[2]

The GVN recognizes that the data collection and management systems required to support these LEDS initiatives are spread across many agencies. Although GSO is responsible for all the data collected, there is a need for line-ministry coordination and central reporting transparency to streamline LEDS initiatives. Currently, MONRE is the lead agency for national GHG inventory development, given its mandate to prepare the country's National Communications. In addition, the Ministry of Agriculture and Rural Development (MARD), Ministry of Industry and Trade (MOIT), and Ministry of Construction (MOC) are also responsible for collecting and managing LEDS programs.

To develop Vietnam's GHG emissions inventory and prepare BAU emission scenarios, the GVN employs internationally acceptable practices for emission accounting and data set forth by the Intergovernmental Panel on Climate Change (IPCC). The United States Environmental Protection Agency (USEPA) and Japan International Cooperation Agency (JICA) are currently assisting Vietnam in the development of its GHG emission inventory. The GVN requests additional capacity-building support to expand and customize its emission assessment approaches to prepare robust BAU projections. The GVN also noted the continuing need to have country-specific emission factors and finer-scale activity data for several key production and high-emitting sources (rice, livestock production, wastes) in order to customize their national inventory. In addition to these data, the GVN also voiced a need for supporting data management systems for ministerial reporting to GSO, identification of legal and data management requirements for creating standardized GHG performance indicators, and LEDS awareness training within and outside the government.

For economic assessments of economy-wide climate change, Vietnam employs a range of macroeconomic models, often started with donor assistance. MPI does economy-wide modeling, together with its affiliated Central Institute of Economic Management (CIEM), to support country-wide policy planning. For general economic planning, MPI uses various computable general equilibrium (CGE) models, which can be modified for LEDS analysis. These assessment tools include the CGE model of the Vietnam Policy Advisory Group (VIPAG); versions of the Global Trade Analysis Project (GTAP) model; and the Inter-temporal Computable Equilibrium System (ICES) model of the Asian Development Bank. Given the numerous donors providing such modeling assistance, AILEG's focus will be on improving data

[1] UNFCCC, "Non-Annex I National Communications," http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php, 2012.

[2] The GGS will be finalized by the Ministry of Planning and Investment for release during the summer of 2012.

management systems, line ministry reporting processes, national GHG indicators, and legal frameworks for LEDS data collection and sharing.

1.3. DATA ASSESSMENT NEEDS IN THE AGRICULTURE AND WASTE SECTORS

In 2000, agriculture was the leading source of GHG emissions in the country (43%), with the majority coming from methane emissions from rice production and livestock management. Yet Vietnam's ministries report that they do not yet have robust country-specific emission factors for rice cropping, and there are limited activity (annual production) data for rice, livestock, and waste production. Strengthening data collection and modeling needs for the agriculture and waste sectors, hence, are important priorities for the GVN.

To date, relatively limited LEDS economic modeling exists for the agriculture sector in Vietnam, although a few efforts are ongoing or have supported the development of an emission inventory, mitigation options, and marginal abatement costs (MACs) for this sector. In addition, both the International Food Policy Research Institute (IFPRI) and a group from Wageningen University in the Netherlands (LEI - Landbouw-Economisch Instituut) are using the International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) and MAGNET (Modular Applied GeNeral Equilibrium Tool), respectively, to assess the impacts of agricultural policies on land use change and GHG emissions. Data quality is a concern for both these efforts. The efforts to develop an emission inventory by JICA and to construct "quick and dirty" MAC curves by MPI and Institute for Agricultural Environment (IAE) with support from the United Nations Development Programme (UNDP) underscore the lack of detailed activity data and the inconsistency in datasets between MARD and MONRE. Recognizing these data gaps, the GVN expressed the need for AILEG to help build capacity in gathering better emission and production data for the agriculture sector. In addition, the GVN also expressed a need for AILEG to assist in the preparation of MAC curves and the analysis of mitigation actions for the agriculture sector, building on MPI's effort as part of the Green Growth Strategy.

Likewise, little work has been done to assess waste-related emissions or mitigation potential. This is largely attributable to the sector's relatively small contribution to overall GHG emissions—although from 1994 to 2000, the sector had the highest percentage increase in GHG emissions of any sector in Vietnam (over 200%). Accordingly, AILEG is planning to conduct a feasibility study for a data collection and management system in the solid waste sector.

1.4. DATA ASSESSMENT NEEDS IN THE ENERGY SECTOR

LEDS data availability is the strongest for the energy sector, where the GHG emissions data are the most robust and the economic assessment tools are the most advanced. Currently, MOIT has used or is considering using a number of energy models: the Model for Energy Supply Strategy Alternatives and Their General Environmental Impact (MESSAGE); the World Bank's Energy Forecasting Framework and Emission Consensus Tool (EFFECT); MARKet Allocation Model (MARKAL); the Long-Range Energy Alternatives Planning System (LEAP); the Energy Flow Optimization Model (EFOM); the *Modèle d'Evolution de la Demande d'Energie* (MEDEE); the Wien Automatic System Planning (WASP) model; and Energy Outlook Models.

With the higher reliability of data in the energy sector and because of other USAID projects, such as the bilateral Vietnam/USAID Clean Energy Program (VCEP), and donor engagement, AILEG is not supporting data collection and management for this sector.

1.5. RECOMMENDATIONS AND NEXT STEPS

During the extensive interviews conducted by AILEG and GSO with key GVN ministry, donor, and other LEDS stakeholders in the spring of 2012, the GVN expressed the need for assistance in LEDS data collection and management and analysis (Table 1).

In terms of economy-wide LEDS data collection, management and analysis, there is a need for: clearer ministerial mandates for data collection and sharing, more GSO oversight of LEDS data collection and reporting, standardization of GHG estimation methods and assumptions, more coordination among ministries to identify and address data needs, increased access to publicly available LEDS data repositories, the avoidance of duplication among donors and an emphasis on collecting better sectoral data. For agriculture, recommendations include: the development of a system to collect, store and manage activity data; the generation of Vietnam-specific emission factors for rice and livestock; further refinement of MAC curves for agriculture and an analysis of the feasibility of mitigation actions; a financial analysis of the potential for methane capture; and an enhanced legal mandate for MARD to collect LEDS-related data. The waste sector is a small but growing source of emissions in Vietnam. Mitigation planning is in a more incipient stage. Needs in this sector include: waste sector activity data, including waste volume and composition data from each landfill; clarified roles and responsibilities of MONRE and MOC; the development of a low-emission waste policy and support for the decree on waste policy for MOC; the incorporation of GHG indicators into MOC's legal mandates and monitoring; and MAC curve analysis of mitigation options. Lastly, priorities for the energy sector include: an annual process for developing national electricity generation emission factors, improved emission factors for coal, exploration of options for updating energy sector data and standardizing the use of these data in national plans, the development of a full energy system model, the generation of benchmark activity data for large and medium-sized buildings, and the design of a public database and/or website housing the results of existing energy sector studies.

AILEG in collaboration with the GVN plans to focus the next phase of AILEG support in Vietnam on improving data collection and management in the agriculture and waste sectors, exploring the expansion of legal mandates to make sure the requisite LEDS data are collected and shared, and providing training on LEDS. Specifically, AILEG plans to provide capacity-building assistance to the GVN in:

- **Data Collection and Management and Economic Analysis for the Agriculture Sector**
- **A Feasibility Study for Municipal Solid Waste Data Collection and Management**
- **Legal and Technical Support for the Incorporation of GHG Indicators and LEDS Data Collection in GVN Mandates**

AILEG expects to launch this technical assistance in August 2012 through July 2013 with USAID funding and GVN collaboration. This activity will work closely with GVN ministries, local institutes, USAID, and the donor community to support LEDS assessment, preparation, and implementation in Vietnam.

TABLE 1: RECOMMENDATIONS FOR LEDS DATA COLLECTION, MANAGEMENT, AND ANALYSIS IN VIETNAM

LEDS Component	Sector/Recommendations			
	Economy-Wide	**Agriculture**	**Energy**	**Waste**
Data Collection and Management	• Clearer ministerial mandates and GSO oversight of LEDS data collection and reporting • A strengthened legal framework and mandate for data collection and sharing • Standardization of GHG estimation methods and assumptions • Coordination among ministries to identify and address data needs • Increased access to publicly available LEDS data repositories	• Conduct a granular review of what, when, and how data are currently being collected in the agricultural sector • Design a system to collect and manage activity data • Derive Vietnam-specific emission factors and gather more precise data on agricultural activity and how rice and livestock management systems vary across the country	• An annual process for developing national electricity generation emission factors • Improve emission factors for coal • Recommend options for updating energy sector data and standardizing the use of these data in national plans	• More robust waste sector activity data, including waste volume and composition data from each landfill • Clarified roles and responsibilities of MONRE and MOC

LEDS Component	Sector/Recommendations			
	Economy-Wide	**Agriculture**	**Energy**	**Waste**
Analysis	• Avoid duplicating the efforts of multiple donors already supporting economy-wide economic assessments • Provide support for improved sector data rather than CGE modeling, according to GVN priorities	• Build on MPI's ongoing work to refine a MAC curve for the agriculture sector • Analyze the potential for mitigation options in the rice cultivation and livestock management sectors using the MAC curves generated above • Conduct financial analysis for methane capture • Review the legal framework to provide recommendations to expand the mandate of MARD for collecting LEDS data	• Develop a full energy system model • Develop benchmark activity data for large and medium-sized buildings • Design a public database and/or website housing results of existing energy sector studies	• Develop a low-emission waste policy and support for the decree on waste policy for MOC • Incorporate GHG indicators into MOC's legal mandates and monitoring • Develop a MAC curve for the waste sector reflecting technical mitigation potential and analyze the potential for mitigation options in the sector

2. BACKGROUND

2.1. AILEG AND EC-LEDS IN VIETNAM

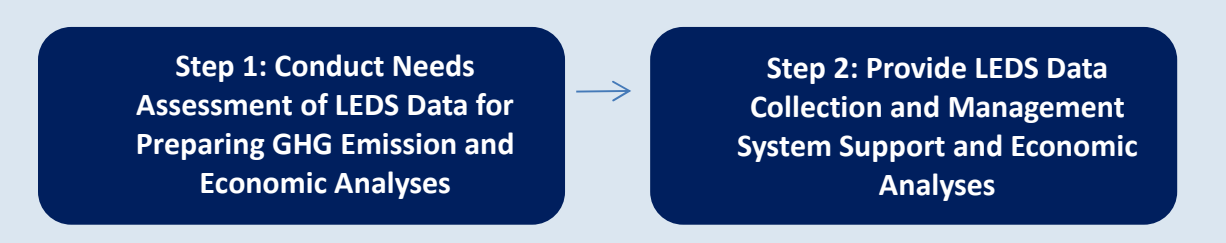
USAID's AILEG Project assists developing countries in elaborating and strengthening LEDS. The primary goal of LEDS is to pursue and accelerate long-term transformative and sustainable development while slowing or reversing the rate of growth of GHG emissions through mitigation.

On March 21, 2012, the U.S. Government and the Government of Vietnam signed a Memorandum of Understanding (MOU) as part of the EC-LEDS effort. The MOU covers collaboration in a number of LEDS areas: (1) enhanced coordination, (2) national GHG inventory system; (3) systems to collect, archive, and distribute economic and emissions data; (4) agriculture, land use, land use planning, and forestry emissions modeling; and (5) energy, industry, construction, or transport modeling and policy analysis.

In March 2012, AILEG launched a joint USG-GVN effort to determine the highest priority EC-LEDS data assessment needs, with particular focus on economy-wide and sector-level models and data. As other USAID projects in Vietnam address the forestry and industry sectors, AILEG concentrated on LEDS needs for the energy, agriculture, and solid waste sectors. Specifically, AILEG supports the MOU objective to advance the development of "systems to collect, archive, and distribute economic and emission data." To pursue this objective, the MOU foresees:

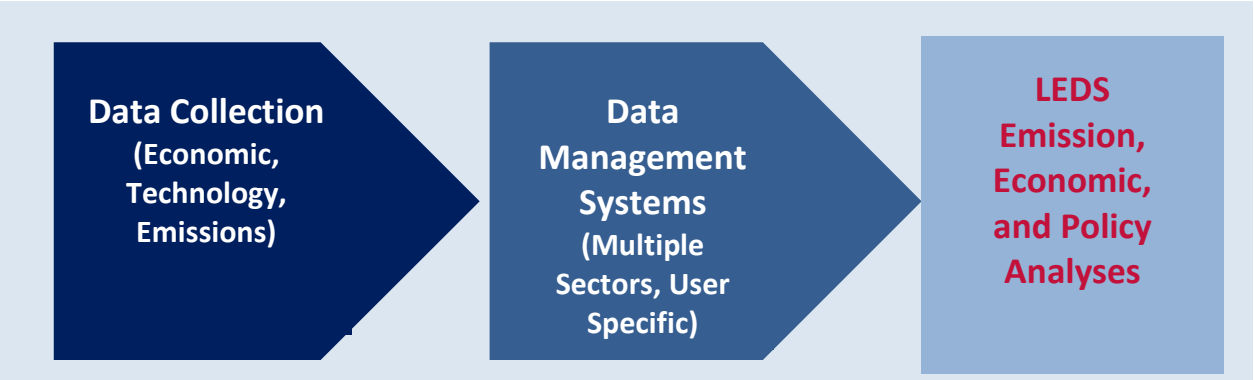
- Completing an in-depth assessment of the current capacities, systems, and needs of the GVN with regard to economic and emission data collection, archiving, and distribution, and the capacities of the non-profit, business, and academic sectors to generate and use these data
- Identifying options for designing a system or multiple systems to address the needs of data collection, management, integration, and distribution (Figure 1).

FIGURE 1: AILEG EC-LEDS TECHNICAL SUPPORT IN VIETNAM



Developing robust, sustainable data systems is not an end in itself, but it is essential for rigorous GHG inventories and to carry out economic analyses needed to develop sound LEDS policies and programs. Figure 2 illustrates the scope of the AILEG technical assistance in Vietnam's LEDS data collection and management systems, which are needed to prepare economic modeling analyses that contribute to LEDS programs, policies, and projects.

FIGURE 2: AILEG DATA COLLECTION AND MANAGEMENT FOCUS



2.2. STUDY PURPOSE AND STRUCTURE

AILEG's data assessment examines the informational gaps, needs, and capacity-building opportunities expressed by the GVN that are required for the development of LEDS in Vietnam. The development of any LEDS program necessitates economy-wide and sector-level data on GHG emission inventories, economic impacts, environmental sustainability, and societal net benefits. This report explores the data availability and management systems in Vietnam for LEDS. Based on feedback from the GVN and other stakeholders, specific recommendations on economy-wide needs related to LEDs data collection and management and analysis, as well as those in the energy, agriculture, and waste sectors are presented.[3]

The assessment involved background research, extensive in-country missions and stakeholder interviews, and two consultative workshops in collaboration with the GVN. The AILEG team carried out in-country missions during March 21–April 6, 2012, and again during June 10–16, 2012. In addition, the AILEG needs assessment builds on: (1) a 2010 pre-scoping mission by the USAID Global Climate Change Office's LEDS program that identified the need for improved data collection and management systems for low-emission development[4]; and (2) the United Kingdom's Department for International Development (DFID) *Study into the Economics of Low Carbon, Climate-Resilient Development in Vietnam – Scoping Phase*.[5]

The report is structured as follows. It first presents a general overview of the LEDS concept and framework, standard analytical approaches (models and tools), and their related data needs (Section 3). Section 4 includes a country-wide overview of Vietnam's GHG and economic trends, LEDS initiatives and stakeholders, economy-wide analytical efforts, and data collection and management, finally finishing with the GVN's expressed priorities for improvement with regard to LEDS data collection and management. The report then follows the same structure regarding detailing GHG emissions, analytical efforts, and data needs ending with recommendations for the selected sectors in Vietnam—agriculture

[3] Other USAID and donor programs are covering LEDS needs in the industry, transport, and forestry and land use sectors, and thus will not be covered in this report.

[4] International Resources Group, *Low Emission Development Strategy Pre-Scoping Mission Assessment – Vietnam*, prepared for USAID, Washington, DC, October 2010.

[5] Nguyen Manh Hai, John A. Rogers, Le Minh Duc, Ho Cong Hoa, Tran Trung Hieu, Huynh Thi Lan Huong, and Nguyen Thi Hien Thuan, *Study into the Economics of Low-Carbon, Climate Resilient Development in Vietnam—Scoping Phase*, prepared by the Central Institute of Economic Management for DFID, Hanoi, Vietnam, March 2011.

(Section 5), energy (Section 6), and solid waste (Section 7). The conclusions (Section 8) recap the assessment recommendations initially presented in the Executive Summary.

3. OVERVIEW OF LEDS ANALYSES AND DATA NEEDS

This section introduces the concept of low-emission development strategies (LEDS) and the types of analyses that undergird them. The LEDS history and concept are first presented in Section 3.1, followed by a discussion of the LEDS framework (Section 3.2) and LEDS models and tools (Section 3.3).

3.1. THE LEDS HISTORY AND CONCEPT

The term "low-carbon development strategy" emerged from international climate negotiations in April 2009 with a European Commission submission to the United Nations Framework Convention on Climate Change (UNFCCC).[6] By July 2009, the concept was discussed under the name "Low-Carbon Growth Plans" at the Major Economies Forum on energy and climate in L'Aquila, Italy, where the leaders of 17 major economies pledged that their countries would prepare low-carbon growth plans.[7] The subsequent Copenhagen Accord refers to low-emission development strategies as "indispensable to sustainable development."[8] After the 2010 Conference of Parties, the Cancun Agreements proposed that low-carbon, or low-emission, development strategies[9] should be mandatory for developed countries and encouraged for developing countries.[10] The concept of LEDS is a close

> LEDS "will enable countries to transition to low carbon economic development resulting in sustained growth in employment and investment, increased financial flows through carbon markets, reduced greenhouse gas (GHG) emissions, and other social, economic, and environmental benefits. As communicated in the Copenhagen Accord, development priorities of partner countries will remain paramount in the evaluation of opportunities through LEDS."
>
> —U.S. Department of Energy, National Renewable Energy Laboratory, "Introduction," http://en.openei.org/wiki/Introduction_to_Framework

[6] European Commission, *Communication from the Commission to the European Parliament*, the Council, The European Economic and Social Committee and the Committees of the Regions - Stepping up International Climate Finance: A European Blueprint for the Copenhagen Deal, {SEC(2009) 1172}, Brussels, 2009.

[7] White House – Office of the Press Secretary, *Declaration of the Leaders – The Major Economies Forum on Energy and Climate*. July 2009, http://www.whitehouse.gov/the_press_office/Declaration-of-the-Leaders-the-Major-Economies-Forum-on-Energy-and-Climate/.

[8] UNFCCC, *The Copenhagen Accord*, FCCC/CP/2009/11/Add.1, 2009.

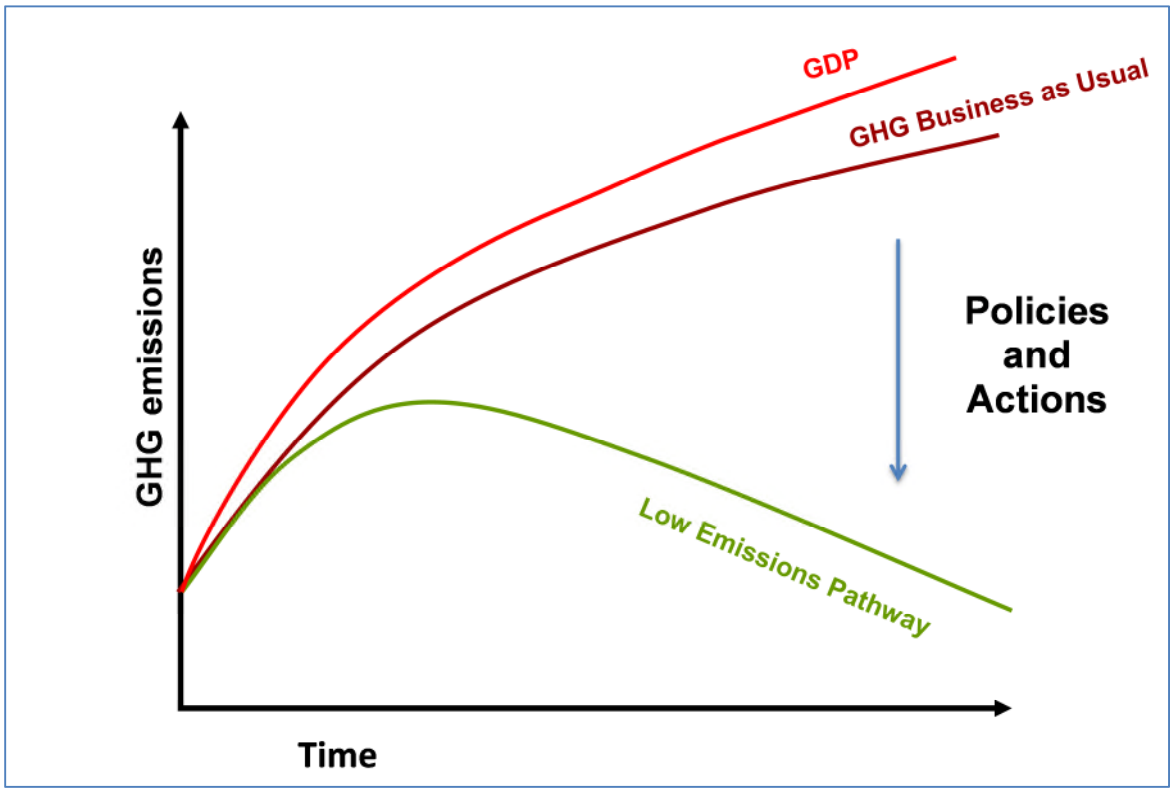
[9] "Low carbon" and "low emission" are used synonymously.

[10] UNFCCC (2011): *The Cancun Agreements*, Outcome of the work of the Ad-Hoc Working Group on Long Term Cooperative Action under the Convention. Decision 1/CP.16, UNFCCC document FCCC/CP/2010/7/Add.1.; X. van Tilburg, L. Würtenberger, H. de Coninck, and S. Bakker. 2011. *Paving the way for low-carbon development strategies*. Energy Research Centre of the Netherlands. www.ecn.nl.

cognate of Nationally Appropriate Mitigation Actions (NAMAs), first mentioned in the Bali Action Plan.[11] Though definitions vary, LEDS are generally used to describe forward-looking national economic development plans or strategies that focus on low-emission or climate-resilient growth. The key concept is maintaining economic growth and development goals over time, while decoupling that growth from rising GHG emissions.

Figure 3 demonstrates how GHG emissions continue to increase over time along with economic growth under a "Business-as-Usual" scenario. The low-emission pathway involves "bending" the GHG curve; GHG emissions decline over time, while economic growth continues. The low-emission pathway would involve a combination of both low-carbon technologies and policies related to renewable energy, energy efficiency, and sustainable landscape management, *inter alia*.

FIGURE 3: EMISSIONS AND ECONOMIC GROWTH WITH LEDS

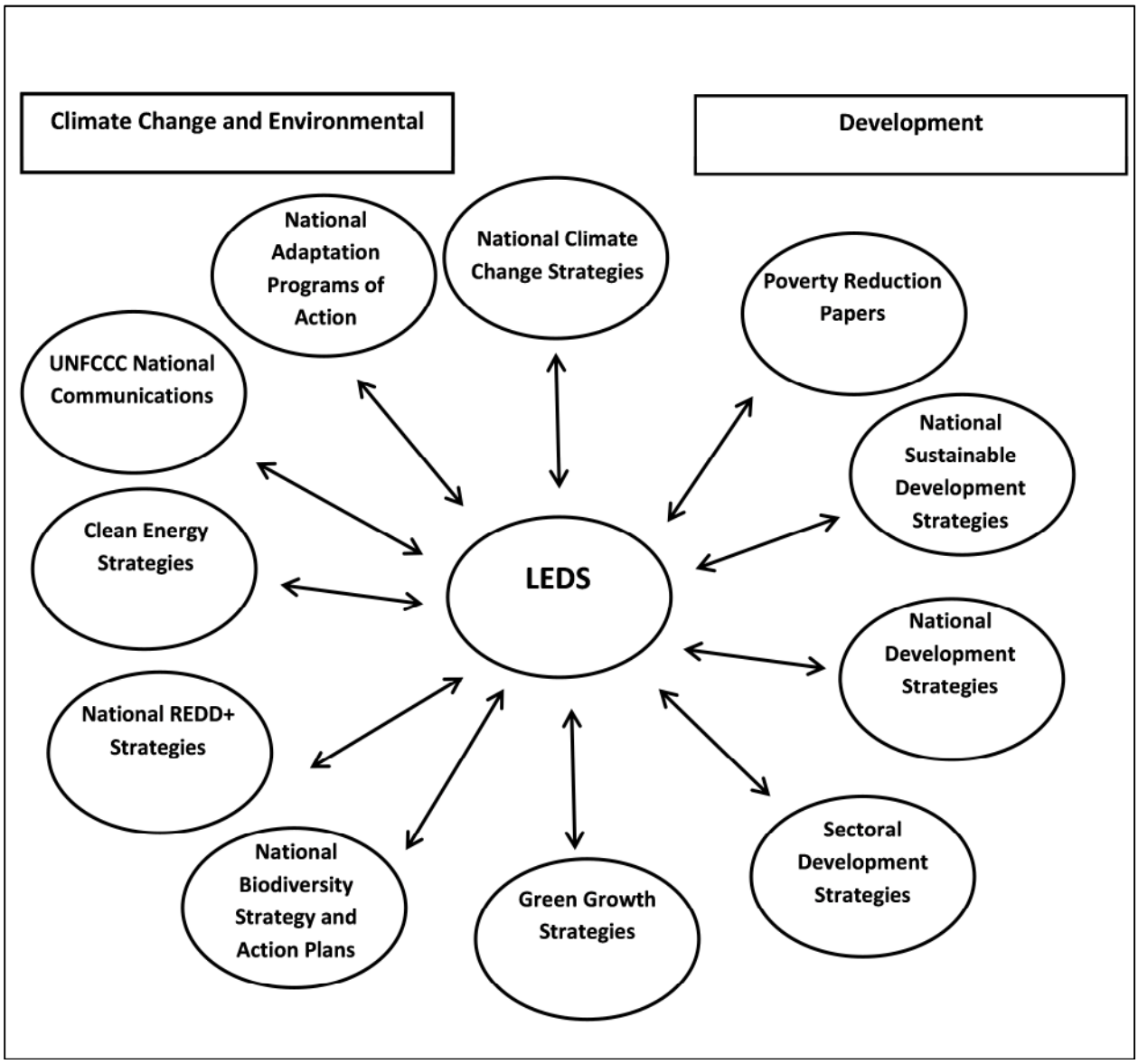


Source: USAID Global Climate Change Office communications.

Countries around the world can formulate a variety of climate change, environmental, and development strategies (Figure 4). All of these other strategies inform the development and implementation of LEDS, which incorporate both climate change and development concerns. LEDS are most successful when they are country owned and directed, consonant with development goals, implementable, economy-wide, long term and forward looking (decadal scale), inclusive of all stakeholders, and monitored for impact, as well as iterative and adaptive.

[11] X. van Tilburg, L. Würtenberger, H. de Coninck, S. Bakker, *Paving the way for low-carbon development strategies.* Energy Research Centre of the Netherlands, 2011, www.ecn.nl.

FIGURE 4: POTENTIAL NATIONAL CLIMATE CHANGE, ENVIRONMENTAL, AND DEVELOPMENT STRATEGIES AND RELEVANCE TO LEDS



3.2. THE LEDS FRAMEWORK

USAID and the National Renewable Energy Laboratory, in partnership, lead the EC-LEDS initiative for the U.S. Government and coordinate efforts across agencies and countries. The LEDS process as formulated by NREL includes the following steps: [12]

1. *Organizing the LEDS process*
2. *Assessing the current situation*

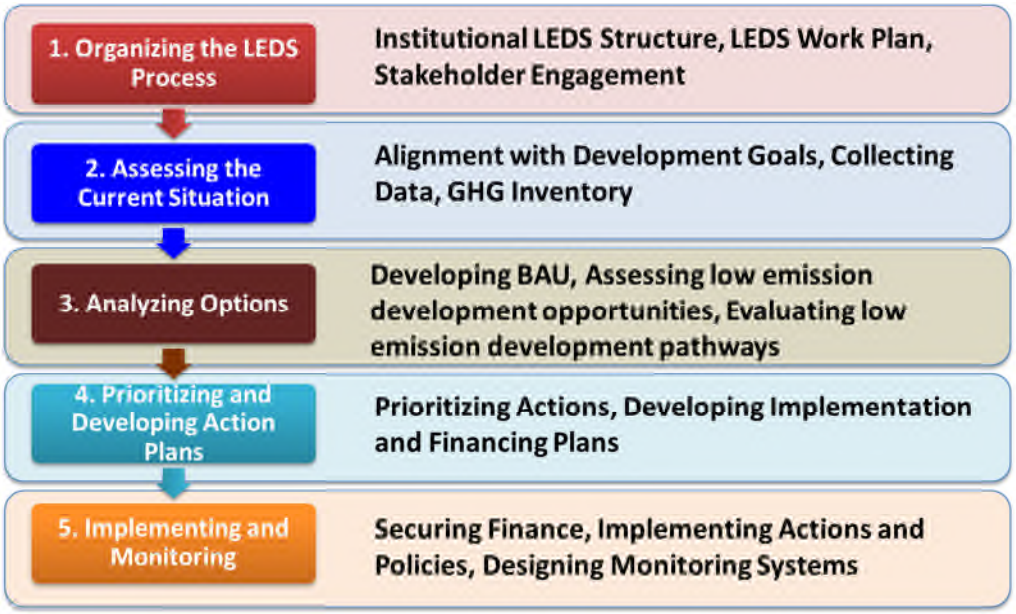
[12] U.S. Department of Energy, National Renewable Energy Laboratory, "Low Emission Development Strategies (LEDS) Gateway," http://en.openei.org/wiki/Gateway:Low_Emission_Development_Strategies.

3. *Analyzing options*
4. *Prioritizing actions*
5. *Implementing and monitoring*

Figure 5 presents the components in each step. AILEG focuses on supporting Step 3, *Analyzing Options*. The components (described below) are:

- Developing the Business-as-Usual (BAU) scenarios
- Assessing low-emission development opportunities
- Evaluating low-emission development pathways.

FIGURE 5: STEPS IN THE LEDS PROCESS



3.2.1. DEVELOPING THE BAU SCENARIOS

To begin any LEDS options analysis, a country needs to (1) assess its historical emissions for a particular year and (2) create projections of GHG emissions for a policy-relevant future timeframe. An assessment of historical emissions consists of developing an **emission inventory** for a past year. The Intergovernmental Panel on Climate Change (IPCC) has prepared and periodically updates the Guidelines for National Greenhouse Gas Inventory to be used by all parties to the UNFCCC.[13] National Communications submitted by all parties to the Convention include their country's emission inventories for a specific year in the past.

A **Business-as-Usual** GHG emission scenario, also referred to as the baseline or reference case scenario, represents **future emissions** projected for the

The **Business-as-Usual** emission scenario is the projected emission trajectory for the economy *in the absence of any mitigation or adaptation actions* over a specified timeframe. Data needs include emission factors and projected annual activity levels for all emitting sources in a country or locale.

[13] UNFCCC, "National Reports," 2012, http://unfccc.int/national_reports/items/1408.php.

economy, or a sector, without the introduction of any climate change policies or actions over a specified time period. The BAU scenario takes into account underlying changes in population, GDP, sector production, and land use, for example.

Mathematically, an emission scenario is generated by summing the projected annual GHGs across all emission sources for each year within the timeframe of analysis. The data needed for quantifying the emission scenario include:

1. **GHG emission factor (EF_z)** expressed as the amount of GHG emitted (in carbon-dioxide equivalents or CO_2e) per unit of activity *z* (t CO_2e/unit *z*)
2. **Activity data (A_{zs}),** the annual amount of human activity *z* in year *s*. For example, **A_{zs}** could be the amount of fuel consumed by households or the tonnage of rice produced in a given future year.

Using these two data elements, the total emissions projection for a future year *s* is obtained by summing the emissions from all human activities across sectors:

$$\textbf{Emissions}_s = \sum \textbf{A}_{zs} * \textbf{EF}_z \qquad \textbf{(Equation 1)}$$

where:

z	= type of activity
CO_2e	= carbon dioxide equivalents
A_{zs}	= amount of activity *z* in year *s* in metric tonnes (t)
s	= year

Note that CO_2-equivalents are used because one type of activity can produce different types of GHGs (e.g., carbon dioxide, methane).

An emission scenario is a set of emission projections for all years in the analysis timeframe. Equation 1 above can be used to create any type of emission scenario, including those that incorporate mitigation actions. The BAU scenario relies on the sector-specific activity (and, thus, emission) projections and assumes that no mitigation actions are introduced during the analysis timeframe.

A number of tools are used to help estimate GHG emissions and consequently can be used to help compile GHG inventories. For example, the USEPA **Agriculture and Land Use (ALU)** software tool calculates GHG emission/sequestration estimates (which are consistent with the IPCC National Greenhouse Gas Inventory Guidelines) based on the user-provided agriculture and land use activity data (e.g., nitrogen fertilizer application; crop residue, livestock, and rice management; grassland burning). [14] Similarly, the **Ex-ante Appraisal Carbon Balance Tool (Ex-ACT)**, developed by the UN Food and Agriculture Organisation, calculates projected GHG emissions that result from climate change impacts or changes in land use (e.g., deforestation, reforestation, forest degradation, area of annual/perennial crops, irrigated rice) and agricultural practices (e.g., tillage, nutrient, water, and residue management).

The emission factors and methodologies used to develop a BAU scenario often come from a country's national GHG emission inventory. Two major issues often limit the ability of a country to compile comprehensive GHG emission inventories and develop BAU scenarios to support LEDS analysis. First,

[14] Colorado State University, National Resource Ecology Laboratory, "Agriculture and Land Use National Greenhouse Gas Inventory Software," http://www.nrel.colostate.edu/projects/ALUsoftware/.

activity data are often lacking in critical sectors. Second, while international default emission factors are available (so-called Tier I emissions factors), in an ideal situation it is more accurate to use country-specific emission factors for the activity data. Unfortunately, in some countries, these emission factors are not readily available for all emission sources.

MONRE compiled and submitted Vietnam's Second National Communication to the UNFCCC, which contains the national GHG emission inventory for 2000, and the Japan International Cooperation Agency is providing support for the development of Vietnam's inventories for the years 2008 and 2010.

3.2.2. ASSESSING LOW-EMISSION DEVELOPMENT OPPORTUNITIES

After preparing the BAU scenario, the next step in LEDS analysis is to determine viable low-emission (mitigation) opportunities. These opportunities involve the use of low-emission technologies that are feasible for large-scale implementation, given the associated financial, economic, environmental, social, and regulatory impacts in a country. Assessment of low-emission opportunities involves the following actions:

- Identification of development and climate (emission) goals
- Evaluation of the technical, economic, and financial potential as well as non-cost barriers of specific mitigation (abatement) options
- Analysis of the GHG emission and socioeconomic impacts of specific LEDS technologies and policies.

A variety of approaches are used to analyze the GHG and economic impacts of LEDS technologies and policies. **Marginal abatement cost (MAC) curves** are one economic assessment methodology for determining the potential financial implications from the adoption of mitigation technologies and actions.[15] MAC curves have gained traction among climate change analysts and decision makers as a financial tool to compare the cost-effectiveness of mitigation options. The term "marginal" cost refers to the cost of avoiding an *additional unit of (CO_2e) emissions*.

Figure 6 shows a MAC curve for Poland, prepared as part of the World Bank's Energy Sector Management Assistance Program's (ESMAP's) low-carbon country studies in 2010.[16] MAC curves present the GHG abatement potential, or amount of GHG emissions avoided (generally in tons of CO_2e), associated with different technologies—or more broadly, mitigation actions—in increasing order of cost on the x-axis. The abatement cost is the net incremental cost of this new technology or action with regard to some conventional technology or action,[17] divided by the reduction in emissions (CO_2e) that results from adopting the alternate abatement technology of action. The cost typically includes both the capital and operating costs of the technology, amortized over its lifetime.[18] MAC curves are often displayed as histograms, where the width of each bar is the abatement potential, and the height is the

[15] As defined in the U.S. Environmental Protection Agency's "Glossary of Climate Change Terms," co-benefits are benefits of policies that are implemented for various reasons at the same time—including climate change mitigation—acknowledging that most policies designed to address GHG mitigation also have other, often at least equally important, rationales (e.g., those related to objectives of development, sustainability, and equity).

[16] Energy Sector Management and Assistance Program, "Transition to a Low Carbon Economy in Poland," Briefing Note 009/11, 2011, http://www.esmap.org/esmap/sites/esmap.org/files/ESMAP-LCCGP_POLAND%20_Web.pdf.

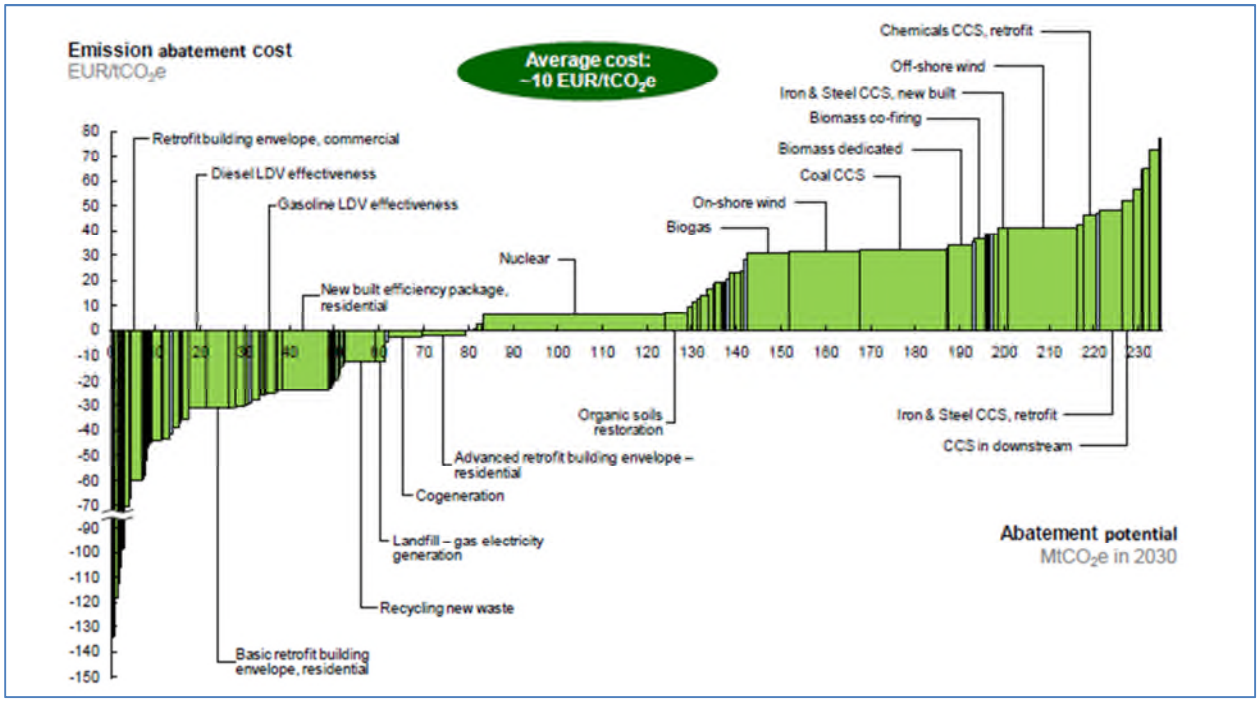
[17] Or the change in net present value (NPV) of between the two technologies or actions.

[18] For further explanation of the MAC methodology, see: Bloomberg New Energy Finance, "A Fresh Look at the Costs of Reducing US Carbon Emissions, January 2010, https://www.bnef.com/WhitePapers/view/25; P. Enkvist, T. Naucler, J. Rosander, "A Cost Curve for Greenhouse Gas Reduction," *McKinsey Quarterly,* No. 1, 2007.

average unit cost of the technology or action. MAC curves enable a visual comparison between different mitigation technologies and actions, looking at the cost to implement them and the amount of carbon reduced. Moreover, they are also useful for determining the break-even price of carbon for a technology or action to become financially viable, and the combination of technologies and actions to be employed to reach a specific carbon reduction goal.

As a result, MAC curves help governments or other institutions make informed decisions on how to best meet their carbon reduction targets or obligations. There are a number of tools that help generate MAC curves, such as ESMAP's **MACTool**.[19] Because MACs only account for the financial or engineering costs of abatement, they are sometimes referred to as "MicroMACs."

FIGURE 6: MARGINAL ABATEMENT COST CURVE FOR POLAND IN 2030



Source: Energy Sector Management and Assistance Program, "Transition to a Low Carbon Economy in Poland," Briefing Note 009/11, 2011, http://www.esmap.org/esmap/sites/esmap.org/files/ESMAP-LCCGP_POLAND%20_Web.pdf.. See source for a full description of the technologies displayed in the MAC curve.

There are, however, many limitations to the use of MAC curves. Often they do not include total programmatic costs, nor the full co-benefits[20] or social opportunity costs of using specific technologies. In addition, MAC curve estimation fails to capture the interactions and economic feedbacks from the adoption of alternative technologies. Additional economic assessment methods for analyzing LEDS options include **environmental valuation** and **co-benefit analysis**. Environmental valuations

[19] ESMAP, "Modeling Tools and E-Learning: MACTool," 2012, http://esmap.org/esmap/MACTool.

[20] As defined in the U.S. Environmental Protection Agency's "Glossary of Climate Change Terms," co-benefits are benefits of policies that are implemented for various reasons at the same time—including climate change mitigation—acknowledging that most policies designed to address greenhouse gas mitigation also have other, often at least equally important, rationales (e.g., those related to objectives of development, sustainability, and equity).

calculate the ecosystem benefits and costs of a conventional or low-carbon option. A variety of environmental valuation methods exist and are increasingly used by national governments to more completely internalize into any net benefits analysis the social opportunity costs from environmental use; for example, measuring the damages from deforestation, mining, and energy production or the benefits from reforestation and watershed management. Co-benefit analysis may include environmental costs and benefits along with the health and other economic impacts from adopting a clean energy, energy efficiency, or sustainable landscape management mitigation option. USEPA has a portal with risk assessment methods, a guidance manual, and tools to analyze and manage environmental risks.[21] NREL has extended the typical MAC analysis by scoring mitigation options by their social, environmental, and economic benefits, as well as ease of implementation.

3.2.3. EVALUATING LOW-EMISSION PATHWAYS

The last step, **evaluating low-emission development pathways**, involves the analysis of a *portfolio* of low-carbon technologies and practices to be deployed over time that will enable a country to meet its development and climate goals at the least social cost. This analysis then feeds into an overall low-emission development strategy, which would specify prioritization of actions and a plan for financing.

An evaluation of low-emission pathways builds on the assessment of low-emission opportunities for specific mitigation technologies or actions. Its objective is to determine whether and how a set of mitigation technologies or actions helps a country achieve its development goals by reducing GHG emissions compared to those projected for the BAU scenario.

An analysis of future projections necessitates the use of models.[22] Generally speaking, LEDS models can be classified into two categories:[23]

- **Sector-specific models** assess the impacts of the portfolio of mitigation options on one or more sectors, but not the whole economy, such as the LEAP or EFFECT models discussed in Section 3.3.1 (both used in Vietnam). They are often detailed, technology-rich models. These allow the exploration of sector-level abatement costs and emissions reductions.
- **Economy-wide models**, such as computable general equilibrium models, assess the macroeconomic impacts of the portfolio of mitigation across all sectors of the economy. They typically use aggregated data to look at costs and benefits of certain policies that are usually not technology-specific, such as carbon taxes, in order to assess impacts on output, GDP, employment and other macroeconomic factors. They capture feedback and interactions between sectors and often assume efficient markets. Specific types of CGE models of relevance to Vietnam and LEDS policy formation are provided in more detail in Annex B.

[21] USEPA, "Guidance & Tools," 2012, http://www.epa.gov/risk/guidance.htm.

[22] Models are simplified representations or caricatures of reality for some systems. They allow one to explore how changes scenarios or inputs to a system translate into changes in outputs; they often project, or simulate, into the future. Tools are more broadly decision aids. They can be computational and software-based, or qualitative and heuristic. All models are tools, but the converse is not true.

[23] Climate change modeling literature generally distinguishes between *top-down* and *bottom-up* models. Although this distinction is useful in characterizing a specific model, in practice, many LEDS models are hybrids. In addition, not all sector models are bottom-up. For example, top-down energy models can explore how energy service demands in other sectors of the economy affect the need for power generation, or how changes in fuel prices, fuel substitution, or policies (e.g., feed-in tariffs) might in turn affect demand. In top-down energy models, though, technology is abstracted within the production functions, and detailed descriptions of energy supply, end-use, and energy conversion technologies are generally omitted.

These two types of analyses are complementary, with aggregate sector-level impact estimates serving as inputs to a CGE model in order to assess impacts on the entire economic system.

3.3. LEDS MODELS AND ANALYSES

3.3.1. SECTOR-BASED MODELS

Sector-based models typically include very detailed, granular data on specific technologies, fuels, and related sector or multi-sector policies, such as the costs, adoption and diffusion rate, and total abatement potential (i.e., tCO_2e) in order to analyze the costs and benefits of each technology and policy. These tools rarely include the social opportunity (economic) or environmental costs; rather, they more often look at only the engineering or financial costs for a technology or policy. They do not assume efficient markets, nor do they typically capture interactions (feedbacks) between the different technology and policy choices or externalities. The outputs from these models are sometimes fed into economy-wide models to generate economy-wide impacts.

There are a large number of models in the energy sector, in particular. For example, the **Long-Range Energy Alternatives Planning (LEAP) System**[24] model, developed by the Stockholm Environment Institute, is an indicative energy model used by the Ministry of Energy in Vietnam. The model starts with current and future inputs on energy demand (e.g., household, transport, industry, commercial), energy supply, and conversion (including production and importation), which allows one to generate a BAU scenario. The model then allows exploration of the costs and benefits of various supply- and demand-side technologies and the generation of alternative scenarios of energy use and tCO_2e emissions. The model requires technology-specific information on technology penetration, performance (e.g., energy use), and cost. Examples of technologies and policies that can be considered include more energy-efficient lighting or appliances, compressed natural gas (CNG) buses instead of traditional diesel buses, natural gas turbines and renewable energy, or policies such as improved fuel economy standards for passenger automobiles. LEAP can also do least-cost optimization for power generation expansion, subject to a number of user-specified constraints, such as maximum annual levels of emissions for any given pollutant (e.g., CO_2, SO_x, NO_x, PM_{10}) and minimum or maximum capacities for certain plant types.

Another example of a commonly deployed multi-sector model just now being used for LEDS analysis in Vietnam is ESMAP's **Energy Forecasting Framework and Emissions Consensus Tool (EFFECT).**[25] This is a Microsoft® Excel-based spreadsheet tool used for projecting GHG emissions under a range of technology and policy scenarios introduced in the energy, industry, and transport sectors. EFFECT covers power generation, on-road transport, household and non-residential energy use, and large-scale intensive industry, and it will in the future contain modules for the agriculture, land use, and solid waste sectors. Like LEAP, EFFECT requires fine-scale information on energy and service demands (e.g., number of passenger cars required) and the costs (capital and operation), diffusion, lifetime, and performance of specific technologies. Annex C summarizes the sector-based models used in Vietnam.

[24] Stockholm Environment Institute, "An Introduction to LEAP," 2012, http://www.energycommunity.org/default.asp?action=47. LEAP also calculates non-energy sector GHG emissions, and it can track other pollutants, such as nitrogen oxides (NO_x), carbon monoxide (CO), and particulate matter of size less than 10 microns (PM_{10}).

[25] ESMAP, "Energy Forecasting Framework and Emissions Consensus Tool (EFFECT)," 2012, http://esmap.org/esmap/EFFECT.

3.3.2. ECONOMY-WIDE MODELS

Computable general equilibrium models are a major category of economy-wide models. CGE models are *general* because they model all economic activity and sectors in a country simultaneously, including production, consumption, taxes, savings, and trade. They are *computable* in the sense that they quantify the impacts of "shocks" on an economy, and they are in *equilibrium*, meaning that supply and demand are in balance for a particular set of prices and assumptions.[26] CGE models require many data, such as information on existing monetary flows in an economy (Social Accounting Matrix), and perhaps the inputs and outputs of production (Input-Output table), as well as sophisticated software to run the model (e.g., General Algebraic Modeling System). CGE models capture feedback impacts of policies, which is quite critical to developing optimal national LEDS policies and programs.

In a LEDS context, the introduction of mitigation policies are treated in CGE models like "shocks" to the rest of the economy. CGEs can be used to evaluate such policies as: carbon taxes, Renewable Portfolio Standards, fuel subsidies or energy price reform, feed-in tariffs, and Reducing Emissions from Deforestation and Degradation Plus (REDD+) mechanisms. CGEs quantify the economy-wide impacts of these, and can help generate macro-MAC curves, which show the impact on GDP per unit of emission reduction of various mitigation policies. (Under the World Bank ESMAP's low-carbon development activities these are known as "Macro MACs"). Specific types of CGE models of relevance to Vietnam and LEDS policy formation are provided in more detail in Annex B.

[26] M. E. Burfisher, *Introduction to Computable General Equilibrium Models* (Cambridge University Press, Cambridge, United Kingdom, 2011).

4. ECONOMY-WIDE LEDS ASSESSMENTS IN VIETNAM

Recognizing the importance of decoupling GHG emissions from economic growth and responding to domestic initiatives to incentivize low-emission planning, the Vietnamese government has engaged in an increasing number of efforts to analyze strategies to address GHG emissions. Many of these have been supported by the international donor community. Along with the implementation of these efforts, the institutional capacity of the Vietnamese government to conduct LEDS assessments has grown, and more and more government stakeholders have become involved in the process. MONRE acts as the focal point between the international community and the government, and coordinates the GVN's interaction with the UNFCCC. Meanwhile, MPI and the line ministries provide data and analytical input for national- and sector-based planning efforts. As many of the GVN's LEDS analyses are new, they have yet to be incorporated into permanent GVN institutions and decision-making processes.

Past low-emission studies by the GVN have highlighted a number of general areas where the capacity for low-emission analysis can be strengthened and expanded. This includes the need for development of more detailed activity data and country-specific GHG emission factors, stronger legal mandates and institutional setups for data management and analysis, and improved analytic capabilities and data management procedures. A number of donor efforts are underway to respond to some of these needs and help institutionalize the LEDS process, while others remain to be addressed. The GVN is also continuing to strengthen its environmental regulations and adjust its institutions to support a more liberalized economy. As a result, there are several opportunities to add and emphasize LEDS processes in the emerging legal and institutional framework for economic growth in the GVN.

Section 4.1 gives a summary of economic and GHG emission trends in Vietnam. Section 4.2 presents the institutional framework and stakeholders for this sector. Section 4.3 goes on to describe Vietnam's current planning initiatives, including those focusing on the energy, agriculture and waste sectors, as well as the stakeholders involved in formulating these. Section 4.3 presents analytical efforts to assess new LEDS strategies while Section 4.5 reviews the GVN's data management processes available for supporting LEDS. Finally, Section 4.6 presents the general government-wide opportunities for strengthening the institutional and data management systems for LEDS analysis.

4.1. ECONOMIC AND GHG EMISSION TRENDS

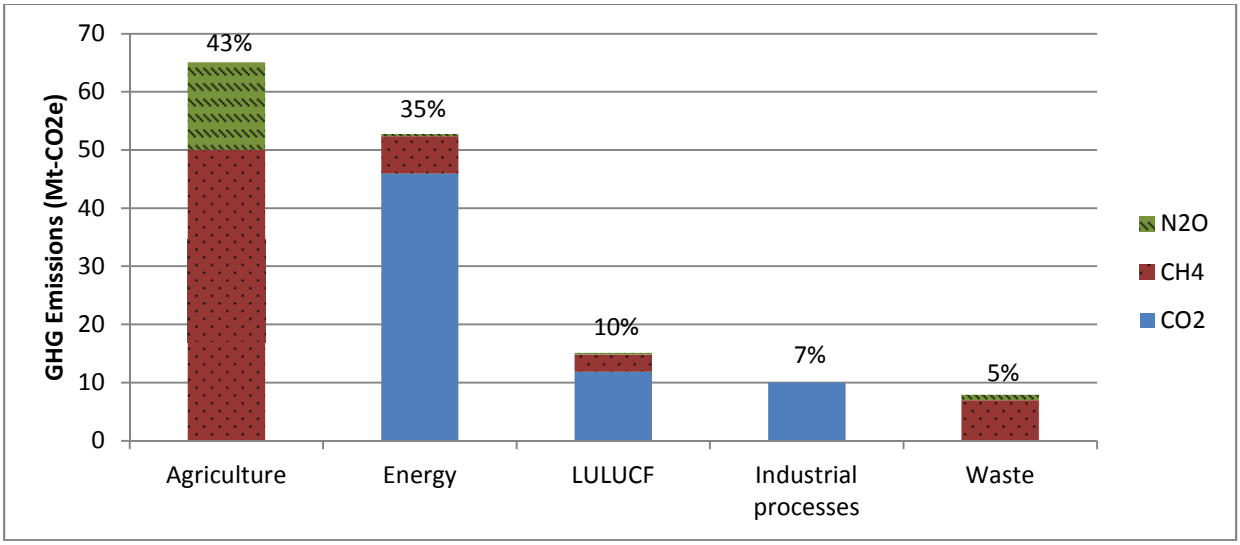
Between 2000 and 2010, Vietnam's economy grew at an annual average rate of 7.2% per year.[27] Since then, GDP has continued to grow, although at a slower pace. Similarly, Vietnam's GHG emissions have increased significantly over the last decade. For example, energy-related emissions are estimated to have more than doubled between 2000 and 2010.[28]

[27] World Bank, "World Development Indicators," 2012, http://data.worldbank.org/data-catalog/world-development-indicators.

[28] Ministry of Natural Resources and Environment, *Viet Nam's Second National Communication under the United Nations Framework Convention on Climate Change,* Hanoi, Vietnam, 2010.

In 2000, the year of Vietnam's most recent GHG inventory, the country's GHG emissions amounted to more than 150 million tonnes of CO_2e per year. The agricultural sector was the leading source of GHG emissions (43%), followed by the energy sector at 35%, and Land Use, Land Use Change, and Forestry (LUCF[29]) at10% (Figure 7).[30]

FIGURE 7: VIETNAM'S GHG EMISSIONS BY SECTOR (2000)



Sources: Based on Nguyen Manh Hai, John A. Rogers, Le Minh Duc, Ho Cong Hoa, Tran Trung Hieu, Huynh Thi Lan Huong, and Nguyen Thi Hien Thuan, *Study into the Economics of Low-Carbon, Climate Resilient Development in Vietnam—Scoping Phase*, prepared by the Central Institute of Economic Management for DFID, Hanoi, Vietnam, March 2011, and derived from the Ministry of Natural Resources and Environment, *Viet Nam's Second National Communication under the United Nations Framework Convention on Climate Change,* Hanoi, Vietnam, 2010.

Going forward, GHG emissions are expected to continue to increase, driven mostly by rising incomes and energy use in the industrial, transportation, residential, and power sectors. Energy-related emissions are estimated to have doubled to more than 100 million tCO_2e between 2000 and 2010, and are projected to more than double again to reach over 250 million tCO_2e by 2020. By contrast, agricultural emissions are projected to rise only moderately, while LUCF emissions are expected to slightly decline.[31] Of all the sectors, waste experienced the highest emission growth during 1994 to 2000, more than doubling over the period (Table 2).

[29] The abbreviations LUCF and LULUCF are both commonly used.

[30] Ministry of Natural Resources and Environment, *Viet Nam's Second National Communication*.

[31] Ibid.

TABLE 2: GHG EMISSIONS BY SECTOR, 1994 AND 2000

Sector	1994		2000		Percent Change (1994 – 2000)
	Emissions (thousand tCO_2e)	Percent	Emissions (thousand tCO_2e)	Percent	
Energy	25,637	24.7	52,773	35.0	105.8
Industrial Processes	3,807	3.7	10,006	6.6	162.8
Agriculture	52,450	50.5	65,091	43.1	24.1
LUCF	19,380	18.6	15,105	10.0	-22.1
Waste	2,565	2.5	7,925	5.3	209.0
Total	103,839	100	150,900	100	

Sources: Ministry of Natural Resources and Environment, *Viet Nam Initial National Communication.* Ministry of Natural Resources and the Environment, *Viet Nam's Second National Communication.*

4.2. KEY LEDS STAKEHOLDERS

The national structure to address climate change in Vietnam was reformed in early 2012 with the formation of the National Committee on Climate Change (NCCC) by Prime Ministerial Decision No. 43/QD-TTg (dated 9 January 2012). The NCCC is chaired by the Prime Minister and is at the ministerial level; vice chairs include the Vice PM, the Minister of MONRE, and a Vice Minister of MARD. Members of the NCCC include ministers of line ministries such as the Ministry of Planning and Investment (MPI), Ministry of Finance, Ministry of Science and Technology (MOST), Ministry of Foreign Affairs, MARD, Ministry of Defense, Ministry of Construction (MOC), Ministry of Police, Ministry of Transport (MOT), Ministry of Health (MOH), Ministry of Industry and Trade (MOIT), and the heads of other important organizations. According to the new system, the National Steering Committee of NTP-RCC has been replaced by the NCCC**.** However, in this transitional period, the new system is still being formulated and the existing responsibilities thus far remain the same.

Several ministries are involved in the planning, analysis, and implementation of low-emission development in Vietnam. The specific responsibilities of MPI, MONRE, and other ministries for implementing and monitoring climate change-related strategies under the GGS, including potentially developing and managing a tracking system, have not yet been clarified. The development of a monitoring, reporting, and verification system is planned as part of a JICA project on capacity building for national GHG inventories with MONRE. However, the details of the system have not yet emerged. It is also uncertain who will be responsible for the development and implementation of NAMAs in the future. Currently, NAMA activities are coordinated by MONRE's Department of Meteorology and Hydrology and Climate Change (DMHCC), and in the near future this role may be transferred to the Office of NCCC.

According to the new system, the supporting organizations for the NCCC are described below.

4.2.1. MONRE

MONRE is the primary body for the development of the NCCC's work program. At the same time, MONRE is Vietnam's National Focal Point for coordinating the implementation of the UNFCCC and its Kyoto Protocol. The ministry is responsible for preparing Vietnam's National Communications to the UNFCCC, including developing national GHG inventories. For the development of the national inventory, MONRE obtains sector-specific data from individual ministry studies and publications, but the

coordination of data is not optimal, as several line ministries have information and data that are not publicly available or that can only be accessed by MONRE (for a fee).

MONRE also coordinates all activities related to climate change in Vietnam under the National Climate Change Strategy, SP-RCC, and NTP-RCC, and is the focal point for GHG offset projects approved under the Clean Development Mechanism (CDM). It therefore collects and reviews a range of studies on the potential for GHG mitigation projects and LEDS in the country. Figure 8 describes the functions and coordinating responsibilities of MONRE under the NTP-RCC.

The **Office of NCCC** is the supporting body for the NCCC and is based at MONRE. The Director General of the Department of Meteorology and Hydrology and Climate Change (DMHCC) is the head of the Office. The duties and functions of the Office will be decided by the Minister of MONRE, who is at the same time the Vice Chairman of the NCCC.

The **National Steering Committee** for the UNFCCC and the Kyoto Protocol, which is housed in the DMHCC, is the lead organization on climate change within MONRE. Its tasks are to:

- Develop policies and strategies and manage activities related to climate change in all sectors and localities in Vietnam
- Guide sectors and provinces in setting up action plans to deal with climate change
- Monitor and evaluate the progress of the implementation of sector and provincial action plans
- Coordinate efforts on public awareness, policy dialogue, and international dialogue
- Set up climate change (e.g., sea level rise) scenarios for Vietnam
- Coordinate climate-related overseas development assistance and climate financing
- Work with line ministries and provinces responsible for implementing specific climate change activities.

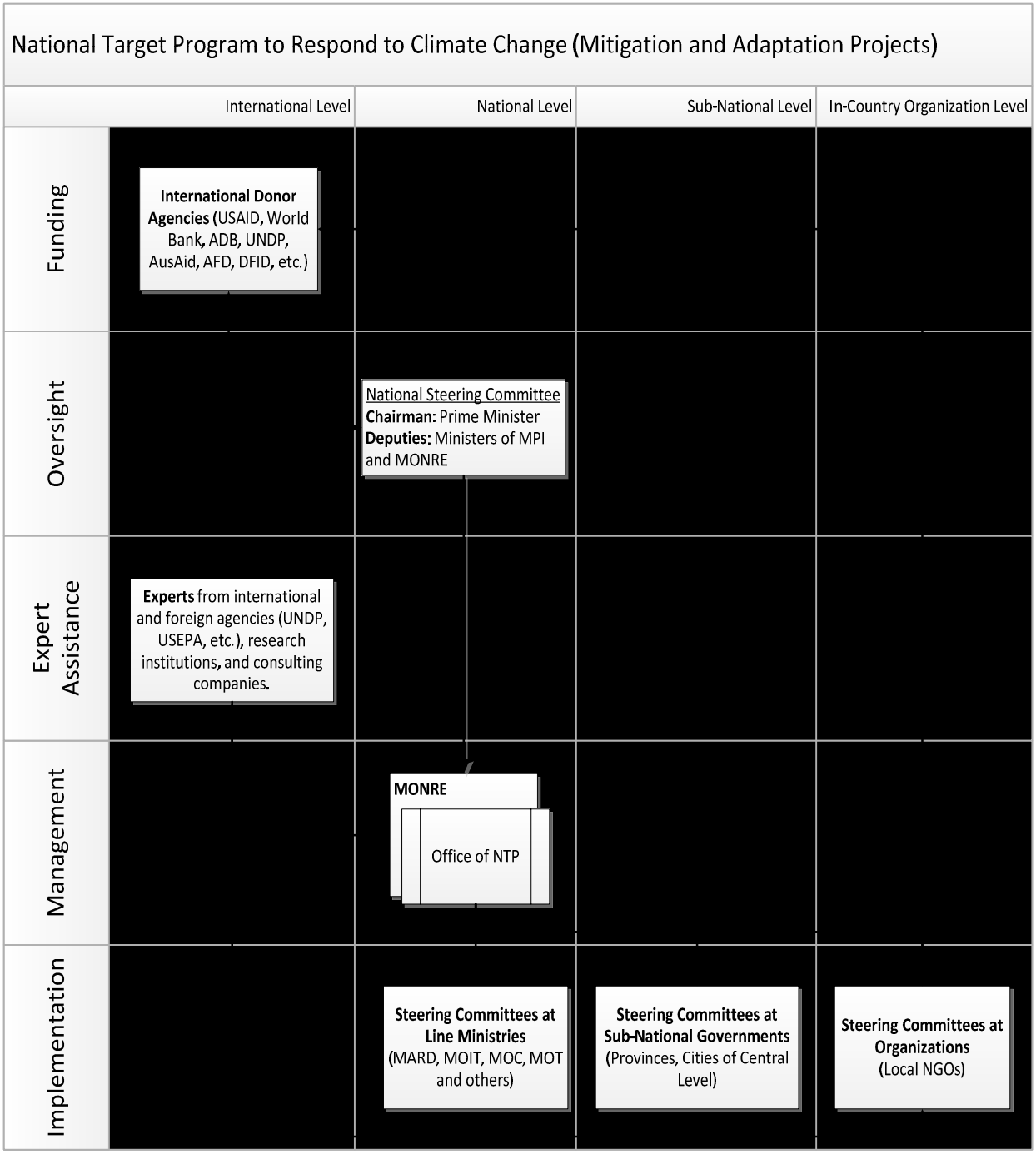
4.2.2. LINE MINISTRIES, INSTITUTES, AND PROVINCES

Line ministries such as MARD, MOIT, MOC, and MOT, their relevant institutes, and provinces are responsible under the SP-RCC and NTP-RCC for implementing sector- and province-specific climate change activities; integrating climate change activities into socioeconomic development plans; and mobilizing participation from non-governmental organizations, civil society, and the private sector to implement climate change activities. MARD, MOIT, MOT, MPI, and their institutes are typically also engaged in the climate change planning process. For example, MPI and MOIT use their in-house models to generate emission scenarios for the National Communications.

4.2.3. MPI

MPI is a key umbrella ministry responsible for overall economic planning and budgeting. As such, it has an important role to play in the development of LEDS. MPI was tasked with developing the GGS and integrating climate change into Vietnam's social and economic development plans. Pending the finalization of GGS, MPI may also become responsible for monitoring and reporting upon its implementation. The General Statistics Office (GSO) within MPI is responsible for collecting data on important indicators, including some that are relevant to tracking low-emission development. This includes the 26 environmental indicators listed in Annex D, of which only one, expressed in terms of GHG emissions per capita, is based directly on GHG emissions. MONRE must report this indicator every two years.

FIGURE 8: MONRE RESPONSIBILITIES UNDER THE NTP-RCC



Definitions: ADB – Asian Development Bank, AFD - Agence Francaise de Developpement, AusAID - Australian Agency for International Development, DFID – United Kingdom Department for International Development, MARD - Ministry of Agriculture and Rural Development, MOC – Ministry of Construction, MOIT – Ministry of Industry and Trade, MONRE – Ministry of Natural Resources and Environment, MPI - Ministry of Planning and Investment, NTP – National Target Program, UNDP – United Nations Development Programme, USEPA – United States Environmental Protection Agency
Source: Ministry of Natural Resources and Environment, Government of Vietnam.

4.2.4. INTERNATIONAL DONORS

A number of international donors are conducting LEDS-related work in Vietnam, including:

- The **World Bank** has extended Vietnam a $70 million climate change development policy credit to increase the GVN's capacity to respond to climate change and enhance Vietnam's preparedness to engage in international climate partnerships. The World Bank is preparing to implement capacity-building activities for LEDS modeling and analysis of abatement measures in the energy, transportation, agriculture, and waste sectors.
- **Australian Agency for International Development (AusAid)** is supporting Vietnam's efforts to achieve low-carbon growth by backing World Bank efforts to promote energy efficiency, and establish a Climate Innovation Center to support small and medium-sized enterprises (SMEs) in developing climate technologies. At the request of MARD, AusAid is focusing on agriculture, and is starting up a pilot life-cycle assessment of rice and tea production in three provinces in the North, Center, and South to determine the feasibility of using a value chain approach to assessing and reducing emissions in the agriculture sector.
- **JICA** is assisting MONRE with the development of inventories of GHG emissions for 2005 and 2010. JICA is working with MONRE to analyze options for a low-carbon society in Vietnam, including funding joint research and modeling by Japanese and Vietnamese research institutes and universities.
- The **Swedish International Development Agency (SIDA)** supported MPI's GSO of Vietnam with statistics management, environmental and climate change statistics, and data dissemination. This included a project to help GSO and MONRE assess methods for calculating GHG emissions from agriculture activities.
- The **United Nations Development Programme** (**UNDP)** has supported MONRE in developing Vietnam's National Communications to the UNFCCC. In addition, UNDP is providing support to MPI on the GGS and is generating initial development of MAC curves to assess agriculture, energy, and forestry measures for the GGS.
- The **Asian Development Bank (ADB)** is supporting the implementation of the NTP-RCC 2011-2015. In general, the ADB is supporting low-emission development in Vietnam through model and software development, LEDS analysis, and training. The ADB focuses on energy (power generation, transport, household/residential, industry) and land use change and forestry.
- The **World Bank** and the **Asian Development Bank** are working jointly on supporting Vietnam in taking part in carbon markets through their Partnership for Market Readiness.
- The **United Kingdom's Department for International Development (DFID)** implemented a project to assess macroeconomic modeling capabilities for low-carbon, climate-resilient development within Vietnam's ministries and government-affiliated think tanks and provided recommendations for models and approaches to strengthen LEDS analysis within these agencies.[32]
- The **Agence Française de Développement (AFD)** and **JICA** supported the development of the SP-RCC and NTP-RCC through a EUR20 million budget support loan.
- **USEPA** is providing targeted technical support for specific inventory areas in the land use change and forestry sector.
- **USAID**, through the regional Low-Emissions Asian Development (LEAD) Program, may also help

[32] Hai et al., *Economics of Low-Carbon, Climate-Resilient Development.*

with GHG inventories at the city level and the development of a GHG registry for entity-level reporting

4.3. KEY LOW-EMISSION POLICY INITIATIVES

Over the last decade, the GVN has demonstrated a growing commitment to addressing climate change through a number of policy initiatives. The reasons for this include a strong concern for the potentially serious impacts of sea level rise and other expected consequences of climate change as well as an interest in taking advantage of the many international support activities that are tied to low-emission development.[33] In addition, Vietnam recently became a middle-income country, and the GVN is therefore taking on a more active role in managing its resources for long-term sustainability while continuing to encourage rapid economic development.

Key policy documents of relevance to economy-wide low-emission development in Vietnam include the following:

- **Vietnam's Draft Green Growth Strategy** (GGS), to be finalized by the MPI by the end of 2012,[34] aims to achieve a 10% to 15% reduction in BAU GHG emissions by 2020, as well as reducing Vietnam's energy intensity (energy use per GDP dollar) by 2.5% to 3% per year while doubling GDP per capita over its 2010 level by 2020. It foresees achieving this by: (1) greening production, (2) reducing GHG emission intensity and increasing the use of clean and renewable energy, and (3) greening lifestyle and promoting sustainable consumption. The strategy lays out a large number of measures under each of these pillars, targeting sustainable growth in the power, industrial, agricultural, land use and forestry, transportation, commercial, and residential sectors.[35]
- The **National Climate Change Strategy 2012–2050,** spearheaded by MONRE and approved by the Prime Minister in December 2011 sets strategies for both climate change adaptation and mitigation. The goals for GHG abatement include: (1) ensure sustainable development and protection of forests to increase GHG sinks and (2) mitigate GHG emissions by developing new renewable energy sources, increasing energy efficiency and conservation in industry, transportation, and construction, and reducing emissions from the agriculture and waste sectors.[36]
- The **Support Program to Respond to Climate Change, 2011–2016 (SP-RCC)**, adopted in 2009, aims to scale up and mainstream climate change adaptation and mitigation activities within national and sub-national development plans, and implement the 2008 National Target Program to Respond to Climate Change.
- The 2008 **National Target Program to Respond to Climate Change (NTP-RCC**) is meant to lead to the development of "feasible action plans" to respond to climate change in both the short-term and long-term, "to ensure the sustainable development of Vietnam," and "to develop a low carbon economy."[37]
- Vietnam's **Social Economic Development Plan** integrates climate change considerations and is a

[33] Trung Duc Tri, "National Strategy on Climate Change," Department of Meteorology and Hydrology and Climate Change, Ministry of Natural Resources and Environment, presented at the "Analysis and Investment for Low-Emission Growth (AILEG) in Viet Nam Introductory Workshop," Hanoi, March 29, 2012.

[34] In-person Nguyen Thi Dieu Trinh, Ministry of Planning and Investment, September 2012.

[35] Ministry of Planning and Investment, "Viet Nam Green Growth Strategy for the Period 2011–2020 and Vision to 2050," February 2012, Unpublished Draft.

[36] Decision on approval of the National Climate Change Strategy, Decision No. 2139/QD-TTg, December 5, 2011.

[37] Ministry of Natural Resources and Environment, *Viet Nam Initial National Communication*.

testament to efforts by the MPI to mainstream climate change issues into development planning.

- **Action Plan to Respond to Climate Change 2011–2015** developed by MONRE also explicitly mentions low-emission development. Task 5 calls for "researching and proposing mechanisms, policies and technology direction toward mitigating GHGs; and exploring opportunities to implement low carbon development."
- **Vietnam's Second National Communication**, submitted to the UNFCCC in 2010, designates energy, agriculture, and LUCF as priority sectors for mitigation and lays out sector-specific mitigation options through 2030.[38]
- In December 2011, the GVN signed **Decision No. 3119/QD-BNN-KHCH—**an ambitious strategy of reducing emissions from agriculture by 20%, while reducing poverty by 20% and increasing agricultural GDP by 20% ("20-20-20 Plan").

4.4. TECHNICAL ASSESSMENTS TO SUPPORT LEDS

4.4.1. INVENTORIES OF GHG EMISSIONS

This section describes the analytical or technical activities underway in Vietnam regarding the development of emission and economic assessments for LEDS. National GHG emission inventories provide a snapshot of emission sources during a given year, and highlight the sectors where emissions are significant and could be managed better. Based on the IPCC's international GHG accounting guidelines, national inventories also provide a recognized standard for calculating emissions given available activity data and emission factors. Countries use these established inventory methods as a reference point for developing emission scenarios and analyzing low-emission strategies in order to obtain comparable emission estimates.

Vietnam has compiled four GHG inventories to date, two of which were developed as part of official National Communications to the UNFCCC, while others were developed as part of various regional efforts to assess emissions. These are presented in Table 3. Vietnam is working on two forthcoming national inventories with support from JICA. As the focal point for UNFCCC reporting, MONRE was charged with the responsibility for developing these inventories.

The past inventory efforts were mostly donor funded and involved the hiring of short-term technical experts to help with data collection and analysis. The process for developing and compiling the inventories was therefore not institutionalized within the government, and most of the data sources and methods used were left undocumented. In many ways, the current inventory efforts therefore have to start from fresh, and an established procedure for inventory development must still be defined. As a result, there is also less guidance available for which benchmark data and GHG accounting methods to use when projecting future emissions and analyzing LEDS strategies for Vietnam.

[38] Ministry of Natural Resources and Environment, *Viet Nam's Second National Communication.*

TABLE 3: GHG INVENTORIES IN VIETNAM

Inventory Data Year	Compiling Agency	Study
1990	MONRE, with support from ADB	*Climate Change in Asia: Vietnam,* 1994
1993	MONRE, with support from ADB	*Asia Least-Cost Greenhouse Gas Abatement Strategy,* 1997
1994	MONRE, with support from the Global Environment Facility/United Nations Environment Programme	*Viet Nam Initial National Communication to the UNFCCC,* 2003
2000	MONRE, with support from the Global Environment Facility/United Nations Environment Programme	*Viet Nam's Second National Communication to the UNFCCC,* 2010
2005	MONRE, with support from JICA (to be completed in 2013)	
2010	MONRE, with support from JICA (to be completed in 2014)	

Sources: DFID; UNDP, "Climate Change Fact Sheet: Greenhouse Gas Emissions and Options for Mitigation in Viet Nam, and the UN's Responses," April 2011; Ministry of Natural Resources and Environment, *Viet Nam's Second National Communication*; and Nguyen Mong Cuong, *Vietnam – National Communication Report,* presented at the 9th Workshop on GHG Inventories in Asia (WGIA9), July 13-15, 2011, Phnom Penh, Cambodia.

In addition, the GVN identified a number of gaps in country-specific activity data and emission factors that prevent development of a complete and verifiable national inventory for Vietnam. Because of these data gaps, MONRE is not yet able to apply the most recent inventory guidance developed by the IPCC as part of the *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. Instead, MONRE is using the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories,* as these have less stringent and detailed requirements for estimating emissions. Indeed, even when using the revised 1996 methods, MONRE reports having difficulties obtaining activity data that satisfy all of the IPCC's requirements and quality assurance steps. The gaps span across all emitting sectors, with many of the specific data issues for the agriculture, energy, and waste sectors outlined in Sections 5, 6, and 7.

Other challenges that MONRE has raised concerning the GHG inventory process include:

- The GVN uses the IPCC inventory guidance for preparing its inventory but has not yet established a formal procedure for completing the inventory, including which emission factors and activity data to use, which ministries should provide the data, and where to standardize and improve datasets. The establishment of an internal GVN working group to select and standardize inventory methods would facilitate this process.
- The legal basis for inventory development in Vietnam is lacking, which means that the process and effectiveness of the inventory depends on the stakeholders involved and available donor support. Without such a legal basis, it is possible that MONRE will halt work on future inventories once JICA completes its inventory support.
- MONRE does not have permanent staff for the preparation of regular inventories. In the past, technical experts were hired from outside to support inventory development, which means the institutional knowledge was lost upon project completion. The creation of a legal mandate and institutional process for inventory development would facilitate hiring of permanent staff.
- There is currently no data management system for tracking data used for past inventories and incorporating data for new inventory years. The development of an inventory software tool will facilitate data verification, documentation, and comparison with future year inventories, and would serve as a basis for planning future improvements in the process since changes in methodology

across data years must be reported to the UNFCCC.

- In the past, the GVN has not had a plan in place for improving future year inventories and standardizing methodologies across reporting years and government agencies. JICA is supporting MONRE with the development of such a plan. Creating a legal mandate for inventory development, planning, and standardization would support this process.

4.4.2. LOW-EMISSION ECONOMIC AND POLICY ANALYSIS

Analytical efforts leading to the development of economic planning and policy making in Vietnam are largely concentrated in the research institutes that support each ministry. These institutes serve as think tanks to support sector planning efforts, such as the elaboration of sector strategies, policies, laws, and regulations. Economy-wide economic assessment modeling is conducted within MPI, together with its affiliated Central Institute of Economic Management (CIEM) and the Development Strategy Institute (DSI) to support country-wide policy planning.

CIEM is the lead for analyzing LEDS within MPI, and has used a variety of CGE models for analytical purposes, including the General Equilibrium Modeling PACKage (GEMPACK), the General Algebraic Modeling System (GAMS), the Inter-temporal Computable Equilibrium System (ICES), and the IFPRI IMPACT model. CIEM has indicated that it is exploring the use of the Vietnam Policy Advisory Group (VIPAG) model, which incorporates Vietnam's Social Accounting Matrix (SAM). DSI formerly conducted all economic policy analysis using VIPAG. However, it ceased to do so in 1995 due to the inadequacy of the available data. DSI is now responsible for developing socioeconomic scenarios pertaining to inflation, investment, growth, and labor, mainly for use in the development of Social Development Strategies. For this, it relies on an in-house econometric model, and data collected from GSO or directly from the provinces. DSI is generally not involved in LEDS analysis. Annex B contains a summary of economy-wide models used in Vietnam.

A comprehensive, macro-level study examining the overall economic impacts of alternative, low-emission development trajectories has not been carried out in Vietnam. The ADB is using EFFECT and the regional CGE model, ICES, to explore the impacts of various LEDS-related policies for Southeast Asia, including Vietnam. In addition, a number of recent and ongoing analytical efforts are strengthening Vietnam's capacity to inform low-emission development policy making. Most of these efforts focus on bottom-up analyses, especially in the energy, transportation, and agriculture sectors. The major LEDS economic modeling and policy analysis efforts to date include:

- **Low-Carbon Study:** MONRE launched a multi-year effort to design and assess LEDS with support from JICA in 2011. This work builds on the national inventory of GHG emissions and involves the development of emission projections through 2030 and the analysis of mitigation options for the energy, agriculture and LUCF sectors. In an initial phase of the 2011 effort, the Ministry started gathering and validating data, selecting an appropriate suite of models, and designing low-carbon growth scenarios. In a subsequent phase, it plans to assess the impacts and costs of alternative low-emission scenarios. To support the study, MONRE created a low-carbon strategy working group made up of researchers from Kyoto University, Institute for Environmental Studies (NIES) in Japan, Institute of Strategy and Policy on Natural Resources and Environment (ISPONRE), the Vietnam Institute of Meteorology, Hydrology and Environment (IMHEN), the Water Resources University (WRU), MARD, and Hanoi Science and Technology University (HUST). The results of the first phase

of this study were published in the spring of 2012,[39] and MONRE and JICA are in the process of designing a follow-on study.

- **CGE Training for LEDS:** CIEM has explored low-emission development in cooperation with some Nordic Research counterparts with support from the United Nations Industrial Development Organization (UNIDO) and UNDP. Some preliminary results have been announced recently, and CIEM has also been organizing training sessions on CGE modeling, as well as on data gathering and validation.
- **EFFECT Model and MACTool Training:** With support from the World Bank, GVN ministries, and affiliated research institutes—including the Institute of Energy (IE), CIEM, and the Transport Development Strategy Institute—are working to design a study for analyzing low-emission development strategies in Vietnam focusing on the energy, transportation, and waste sectors. It is envisioned that this study will rely on the EFFECT model. The World Bank is focusing on coordinating the various actors and building capacity for LEDS. The MACTool, under development by World Bank's ESMAP division, was recently used to prepare a preliminary marginal abatement cost curve for Vietnam as part of the World Bank's assistance in providing the $70 million development policy loan for climate change.
- **EFFECT, Ex-ante Appraisal Carbon Balance Tool (Ex-ACT), and VIPAG Analysis**: In a separate study, DFID reviewed the availability of data needed to run multi-sector models identified as being well suited to Vietnam's analytic needs and capacity; these include the EFFECT and Ex-ACT models, as well as the VIPAG model.[40]
- **Multi-Country Southeast Asian LEDS Analysis:** The Asian Development Bank is carrying out LEDS analysis in five Southeast Asian countries, including Vietnam, in an attempt to help governments assess the macroeconomic impact of various climate change-related policy bundles (e.g., taxes, fuel subsidies, energy price reform, REDD+ mechanisms, feed-in tariffs, and emission quotas).[41] The ADB is examining the energy (power generation, transport, household/residential, industry) and land use change and forestry sectors. For this analysis, the ADB is drawing on three models: EFFECT, ICES (a regional CGE model), and World Induced Technical Change Hybrid (WITCH)—an integrated assessment model. The first two are "soft-coupled": policy assumptions are entered into ICES, and its outputs are fed into EFFECT. WITCH is used to look at regional interaction and cooperation through a game-theoretic perspective.
- **Economics of Adaptation for Climate Change:** Vietnam was included in a 2010 World Bank country case study on the economics of climate change adaptation that focused on climate change impacts and adaptation, rather than on the impacts of low-emission pathways on the economy. Some of the study's analytics, however, may be useful for the economic analysis of low-emission growth scenarios and, in particular, for the elaboration of baselines. The study establishes a baseline scenario consisting of projections of land use, production, value-added, population growth, urbanization, and other variables without climate change. This serves as a reference scenario against which the impacts of climate change with and without adaptation are then measured.[42]

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[39] Nguyen Thai Hoa, Kei Gomi, Yuzuru Matsuoka, Tran Thanh Tu, Junichi Fujino, Mikiko Kainuma, and Ram Manohar Shrestha, *Preliminary Study on Low-Carbon Development Towards 2030 In Vietnam,* Asia-Pacific Integrated Model Team, Kyoto University, and NIES, 2012.

[40] Hai et al., *Economics of Low-Carbon, Climate-Resilient Development.*

[41] Asian Development Bank, "Strengthening Planning Capacity for Low Carbon Growth in Developing Asia," Project Description, http://www.adb.org/projects/44158-092/main.

[42] World Bank, *Economics of Adaptation to Climate Change – Vietnam Country Study,* 2010.

See Annexes B and C for more detailed information on the models above.

4.5. LEDS DATA COLLECTION AND MANAGEMENT

The collection and management of data that can be used for LEDS analysis in Vietnam takes place at many levels of the government and depends on the type of activity being tracked. MPI and several line ministries, such as MARD, MOIT, MOC, and MONRE, are involved in the collection and reporting of data that can be used for LEDS analysis, with specific responsibilities tied to the sector for which these ministries are responsible. In some cases, such as for solid waste, multiple ministries are involved (see Section 7.3). As a result, organizations working on LEDS analysis have to reach out to several ministries and institutes in order to obtain the requisite data. In some cases, these organizations must pay a fee to get the data.

Most data collection and reporting occur at the province and city government level, after which the data are submitted to the central ministries. In some cases, the ministries also collect data directly from enterprises, as is the case with MOIT. The line ministries collect data through their provincial offices. In some cases, these ministries have direct lines of communication with the target entities, in which case the data are reported directly to their provincial departments, otherwise they use an intermediary, such as the Provincial People's Committees (PPCs) or City People's Committees (CPCs). For example, MARD has a direct line of communication to farmers, and can collect data through the Department of Rural and Agricultural Development in each province.

However, to collect information on air pollutants and waste handling, MONRE designed a questionnaire and then contacted the PPC through its provincial-level Department of Natural Resources and Environment (DONRE) to implement the survey. DONRE is housed within the PPC and can therefore coordinate such requests on behalf of the central ministry. Similarly, MOC must go through its provincial level Department of Construction to the PPC to collect data on wastewater utilities, since these are under the authority of the PPCs or CPCs. In this case, the line ministry must train PPC staff on how to correctly conduct the survey and manage the resulting data, and the success rate depends on the technical capacity of PPC staff to understand and explain the specific subject matter to the survey respondents. When developing new surveys or reporting requirements, it may therefore be more effective to go through GSO, whose staff is already trained in implementing diverse surveys.

Past efforts to develop new sector- and technology-level GHG activity data for use in LEDS analyses have taken place on an *ad hoc* basis as part of individual donor-funded projects. The resulting data are therefore not being tracked centrally and are often not made publicly available for other analyses. Rather, the data reside within the ministries or are kept by the technical experts that performed the analyses, and can be accessed through connections or payment of a fee. Because of the *ad hoc* nature of these data efforts, the data inputs have not yet been incorporated into the GVN's data collection system.

Along with the line ministries that produce sector-specific data, MONRE and GSO play key roles in the collection and management of LEDS-related data. GSO collects province- and district-level data through its Provincial Statistics Offices (PSOs) and Districts Statistics Offices (DSOs), which have dedicated staff for handling data and conducting surveys. GSO is ultimately responsible for the census and data related to households and farms, while the line ministries are responsible for sector-specific data collection.

MONRE is the lead on data collection for Vietnam's national GHG inventory and for tracking environmental performance of all other sectors in the economy. As such, it is responsible for identifying the data to be collected for the inventory and for coordinating with other ministries to determine data availability and obtain the requisite data. However, MONRE is faced with several challenges when preparing these inventories, including data gaps, inconsistent datasets, or requirements that data must be purchased. For example, when MONRE analyzed the availability of activity data and emission factors for completing the energy component of the national GHG inventory, it found that out of 48 required data inputs, only 8 were available for free. Out of the remaining 40 inputs, 8 did not exist, while 32 could be obtained from other agencies at a fee (Table 4). Even data collected by the country's national statistical agency, GSO, is not always free and publicly available. MONRE found that more than half of the energy data inputs that it would obtain from GSO would have to be purchased.

MONRE does not yet have a systemized process for collecting, tracking, storing, and sharing the collected inventory data with other organizations, and has asked JICA and other donors for support in designing and implementing such a system. It has also not yet developed a formal list of data required from other ministries, and alerted these ministries that the data will be needed on a regular basis.

TABLE 4: DATA INPUTS AND SOURCES FOR THE ENERGY SECTOR GHG INVENTORY

Data Status	Total Number of Data Inputs Needed	Number of Data Inputs Generated by GSO	Other Data Sources
Not Free	32	4	Electricity of Vietnam, MARD, MOIT, GSO, General Department of Geology and Minerals, Vietnam Airlines, and Petro Vietnam
Free	8	N/A	
Does Not Exist	8	3	
Total	**48**	**7**	

Source: Vietnam Institute of Meteorology, Hydrology and Environment, MONRE, March 2012.

GSO is mandated to supervise data collection and manage national statistics and, as such, could play a key role in LEDS analyses by providing official activity data that can be used for the development and verification of GHG emission estimates and LEDS analyses. Stakeholders within and outside the government have therefore suggested that GSO should play a greater role in collecting, storing, and publicizing GHG inventory and other LEDS-related data. [43]

The data tracked by GSO include national income and public accounts data; information on population; population growth, GDP, and GDP growth; household data; and data for Vietnam's Social Accounting Matrix, which represents flows of all economic transactions that take place within the economy (regional or national). GSO also manages a National Statistics Indicator System (NSIS) that has 350 indicators, 26 of which are climate and environmental indicators (Annex D). Just one of these indicators involves GHG emissions, and only a few of the other indicators are relevant for the development of GHG inventories. GSO's contribution to the national GHG inventory has been limited to supplying some activity data to MONRE, and GSO is generally not involved in reviewing data used for LEDS analyses.

GSO collects data from 63 provinces, and is charged with coordinating data collection among Vietnam's line ministries for the development of the NSIS. Individual ministries have their own systems for data collection, while the ultimate responsibility for indicator reporting lies with GSO. Other than data from

[43] Decision on approval of the National Climate Change Strategy, Decision No. 2139/QD-TTg, December 5, 2011.

the ministries, GSO also collects provincial-level indicators directly from the provinces. Reporting on environmental indicators has been particularly difficult, often because of a lack of capacity to provide the data at the provincial level.

GSO collects data in several ways: periodic censuses and surveys administered by the PSOs and DSOs and direct reporting by the ministries. Key economy-wide surveys conducted by GSO include an annual enterprise survey (available online), a household survey—the Vietnam Household Living Standard Survey (VHLSS), an establishment survey, and survey of costs for the input-output table (every five years). The enterprise survey produces indicators on labor, production, inputs (energy), and waste, among others. However, the quality of the survey suffers from a lack of responsiveness. For example, partly due to a lack of protections for confidential business information, the response rate of private enterprises is low. In addition, GSO conducts a census of population and census of agriculture every five years. To date, GSO surveys have relied largely on paper-based data collection, with about 33 provinces reporting electronically.[44]

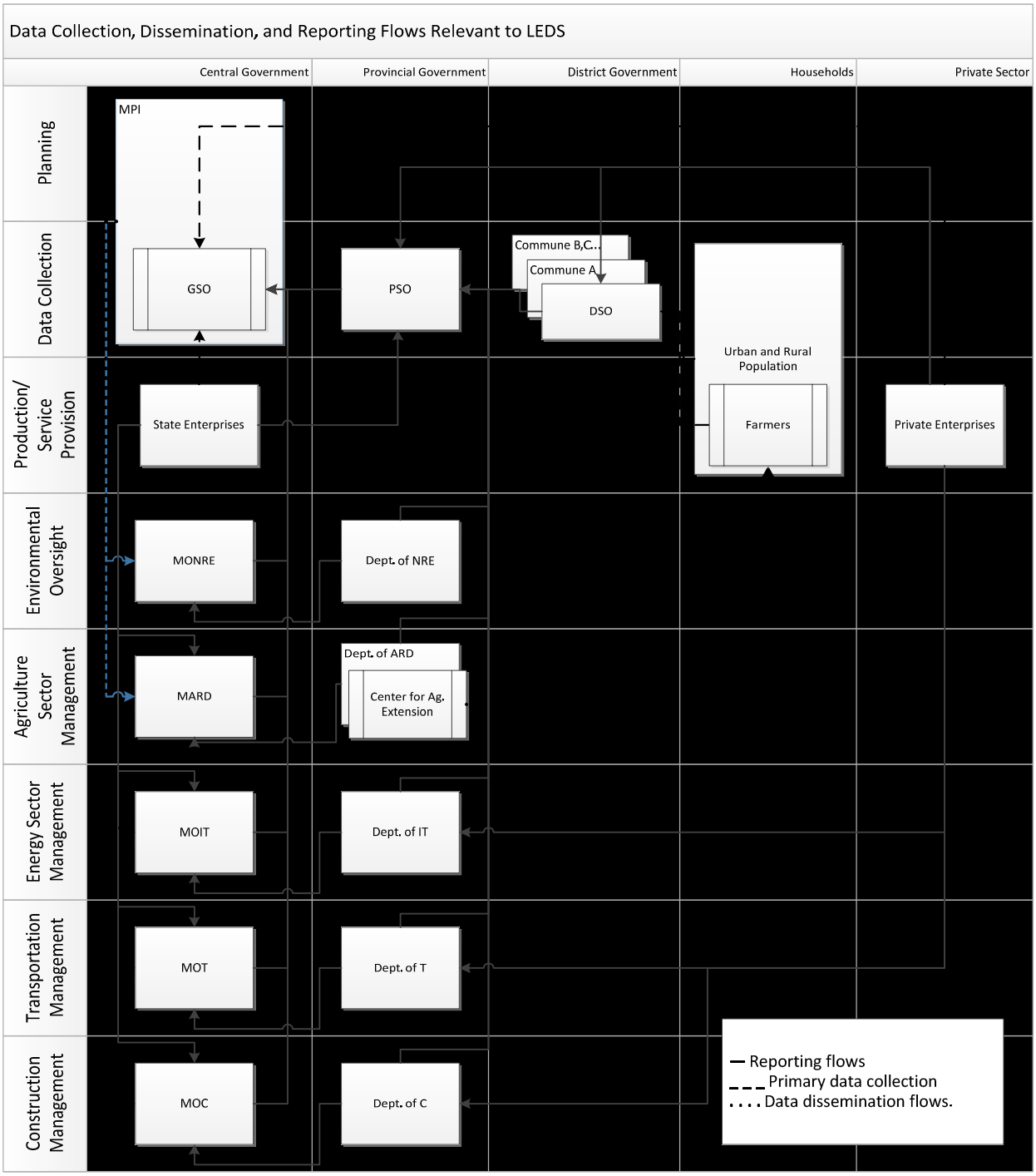
In recent years, GSO has taken steps toward becoming a modern, service-oriented statistical institution. Currently, GSO is working to improve environmental and agricultural indicators and systems, which have generally received less attention in the past than economic and social data. It also recently started working with the UN Statistics Division to develop an online system for storing existing data that would be available to the public. GSO has experimented with Information and Communications Technology (ICT) based survey systems, but due to resource constraints, has not yet incorporated these into its regular data collection efforts.

It is fairly straightforward for GSO to expand its census or surveys with new questions to support LEDS analysis. Typically, this would be done by conducting a pilot survey to test out the response rate of the new questionnaire. Such pilots are often implemented through funding and/or technical support from a donor. If the pilot is deemed successful and fits within GSO's existing reporters and survey respondents, MPI can authorize GSO to incorporate the new questions into its existing surveys or census.[45] Figure 9 provides more information on the general data collection process and functions within the GVN.

[44] In-person communication with Vu Thi Thu Thuy, GSO Social and Environmental Statistics Department, March 28, 2012.

[45] In-person communication with Vu Thi Thu Thuy, GSO Social and Environmental Statistics Department, June 14, 2012.

FIGURE 9: GENERAL DATA COLLECTION, DISSEMINATION, AND REPORTING RELATED TO LEDS IN VIETNAM



Definitions: Dept. of ARD – Department of Agriculture and Rural Development, Dept. of IT – Department of Industry and Trade, Dept. of NRE – Department of Natural Resources, Dept. of T – Department of Transport, Dept. of C – Department of Construction, DSO – District Statistics Office, GSO – General Statistics Office, MARD - Ministry of Agriculture and Rural Development, MOC – Ministry of Construction, MOIT – Ministry of Industry and Trade, MONRE – Ministry of Natural Resources and Environment, MOT – Ministry of Transport, MPI - Ministry of Planning and Investment, PSO – Provincial Statistics Office.

Source: Interviews with government stakeholders, Spring 2012.

4.6. PRIORITIES FOR IMPROVING DATA AND RECOMMENDATIONS

Economic and policy planning in Vietnam is mostly qualitative, but is moving further in the direction of relying on the use of economic modeling through collaborative GVN and donor activities. As planning advances, the need for better and more detailed activity data for LEDS analysis will be needed to generate the quantitative results on which policy decisions can be based.

Data availability and lack of resources has been a challenge for macroeconomic modeling in the past. For example, the DSI in MPI did employ a CGE model in the past, but it had to be abandoned due to the lack of data. To make up for these GVN resource constraints, donor-supported analytic efforts are often accompanied by one-time data collection efforts. In this context, CIEM pointed to a need for long-term, sustainable data system improvements that ensure systematic data collection beyond these one-time surveys. CIEM is in the process of choosing a CGE model for LEDS; CIEM currently uses a dynamic recursive model, and it may instead consider an expansion of VIPAG. CIEM will also be working with the World Bank to run the EFFECT model, but not over the long term. These efforts will require additional data, and as they continue in the future, robust, sustainable data management systems will become critical. The various Vietnam stakeholders will also benefit from efforts to make existing data publicly available.

GSO, MONRE, and other GVN stakeholders have expressed the need for clarifying roles and responsibilities and improving institutional arrangements for LEDS data collection and management, particularly when it comes to data that are multi-sectoral, such as environmental data. In particular, there is a recognized need for more coordination between MONRE and MPI/GSO, and between individual line ministries and MONRE on data collection and use for the preparation of national GHG inventories. GSO might play a greater role in ensuring the collection and publication of necessary data going forward, especially because international inventory practices place a high value on the use of high-quality, publicly available data sources. Figure 10 presents a summary of the recommendations from the GVN to strengthen LEDS data collection and management.

With respect to the development of GHG emission inventories, the Second National Communication[46] identifies the following as areas for improvement:

- Review of GSO indicators and statistics to determine data gaps and subsequent revision to support improved inventory preparation and LEDS analysis
- Increased availability and timeliness of reliable and comparable datasets
- Functionality of data collection and management systems to support inventory process needs
- The number and capacity of GHG inventory experts
- Determination of Vietnam-specific emission factors to reduce GHG inventory uncertainty levels.

Additional sector-specific emissions and economic assessment needs are discussed in more detail in the sections that follow.

[46] Vietnam Ministry of Natural Resources and Environment, *Viet Nam's Second National Communication.*

FIGURE 10: RECOMMENDATIONS TO STRENGTHEN GVN INSTITUTIONAL FRAMEWORK FOR LEDS DATA COLLECTION AND MANAGEMENT

1. **Clarity on oversight of LEDS data collection and reporting by other ministries**. GSO is not currently aware of the myriad data that are collected by various ministries. It is also not informed of data collection methodologies in use.
2. **Strong legal framework and mandate for data collection and sharing**. An enhanced legal framework will help clarify data collection roles and responsibilities and facilitate coordination and sharing among ministries.
3. **Standardization of GHG estimation methods and assumptions**. Given the nature of LEDS analysis in Vietnam, ministries are not always using similar GHG estimation methods and emission factors, with the result that baseline and emission scenarios can over- and under-estimate GHG emissions compared with the methods used by MONRE for the national GHG inventory and the National Communications. MONRE therefore recommends increased collaboration and information sharing among ministries as they begin to analyze low-emission strategies that could be formalized as NAMAs or other reportable commitments to the UNFCCC where the use of internationally recognized emission accounting practices is required.
4. **Coordination among ministries to identify and address data needs.** MONRE and other ministries involved in LEDS analysis have identified several data gaps, many of which will fall within the responsibility of other ministries that are not yet involved in the analytical process. There is therefore a need for greater coordination and communication of these gaps among the relevant stakeholders and for the development of a strategy for addressing them. This could be done by establishing a working group among GVN ministries that focuses on identifying data gaps for various sectors and LEDS analyses and determining which ministries and processes would be most effective at addressing them.
5. **Access to common, publicly available LEDS data repositories.** The existence of publicly available datasets or repositories for LEDS studies, emission factors, and estimation methods will help facilitate development, coordination, standardization, and comparability of analytical approaches and GHG estimation methods.

5. AGRICULTURE SECTOR LEDS ASSESSMENT IN VIETNAM

The agriculture sector accounts for a large percentage of the country's GDP, but it is also a key contributor to Vietnam's GHG emissions: in 2000 emissions from the agriculture sector amounted to more than 40% of Vietnam's total GHG emissions. Thus, it is a very important sector to address with LEDS policies and actions in Vietnam. In what follows, Section 5.1 outlines emissions and their growth trends for the agriculture sector. Section 5.2 presents the institutional framework and stakeholders for this sector. Section 5.3 presents the key low-emission growth initiatives in this sector. Section 5.4 presents the ongoing analytical efforts to support LEDS, and Section 5.5 presents the data collection and management systems for this sector. Finally, Section 0 presents the gaps and recommendations for further activity in this sector to support LEDS.

5.1. EMISSION AND GROWTH TRENDS

GDP growth in the agriculture sector averaged nearly 4% from 2000 to 2008. While agricultural land area is still expanding due to land conversion (mainly deforestation), this phenomenon is slowing, causing economic growth in this sector to depend increasingly on the intensification of production based on technological change. Sector growth is anticipated to slow going forward, with projected economic growth rates of 3% in 2011-2020, and 2.5% in 2021-2030.[47] Despite the sector's low contribution to overall economic growth relative to other, faster growing sectors, it remains a pillar of the Vietnamese economy. Agriculture represented 22% of national GDP in 2010 (down from nearly 25% in 2000), employed over half of Vietnam's workforce in 2005, and produced 30% of the country's exports.[48] Vietnam is among the world's largest exporters of rice. In addition, the sector is viewed as having an important role to play in sustainable development and poverty reduction.[49]

Not surprisingly, the agriculture sector is also a significant contributor to Vietnam's GHG emissions. Omitting emissions from agriculture-driven land conversion, which are counted separately in the national inventory as land use emissions, the agricultural sector accounted for the largest share of GHG emissions: 65 million tCO_2e in 2000, or 43% of total GHG emissions as reported in the Second National Communication to the UNFCCC.[50] In 2010, the energy sector is expected to overtake the agriculture sector as the largest emitter, but agriculture will continue to be a significant contributor largely because of emissions from rice cultivation. Overall, agriculture's contribution to national GHG emissions is

[47] Vietnam Ministry of Natural Resources and Environment, *Viet Nam's Second National Communication.*

[48] World Bank, *Agricultural Competitiveness Project,* Project Appraisal Document, August 2008.

[49] Vietnam Ministry of Natural Resources and Environment, *Viet Nam's Second National Communication.*

[50] Vietnam Ministry of Natural Resources and Environment, *Viet Nam's Second National Communication.*

expected to decline in the years ahead, as sector emissions are expected to climb more slowly compared to those of other sectors. Agriculture-related emissions are estimated to have increased little between 2000 and 2010, and are anticipated to grow moderately in the future, from 66 million tCO_2e in 2010 to 70 million tons in 2020 and 73 million tons in 2030.[51]

The critical drivers of agriculture-related GHG emissions in Vietnam are methane and nitrous oxide emissions linked to:

- Rice cultivation and the widespread use of flood irrigation
- Animal husbandry and open-pit manure management
- High and inefficient use of nitrogen fertilizers
- Improper disposal of agricultural residues.[52]

Rice—Vietnam's dominant crop—is the leading source of agricultural sector emissions (50%), followed by agricultural soils (e.g. from fertilizer use) (29%) and livestock (17%) (Table 5). Grown by some 80% of Vietnamese farmers, rice is cultivated on 45% of the country's agricultural land, which for the most part, is subject to methane-intensive flooded irrigation (occurring on 65% of the rice cultivating area).[53]

TABLE 5: AGRICULTURE SECTOR EMISSIONS, 2008

Agricultural Source	CH_4	N_2O	CO_2e	%
Enteric Fermentation	336.7		7,071.1	10%
Manure Management	123.3	7.4	4,885.8	7%
Rice Cultivation	1,620.6		34,033.5	50%
Agricultural Soils		64.3 (57.1*)	19,932.2 (17,701*)	29%
Field Burning of Agricultural Residues	67.9	1.6	1,915.2	3%
Total Agriculture	**2,149**	**73**	**67,838**	**100%**

*Alternate estimate.
Source: Estimate from Statistics Sweden and GSO workshop on emissions of greenhouse gases from agriculture (5th March 5, 2011 – April 12, 2011. Summary report by J. Bergström. Obtained by USAID Hanoi.

5.2. INSTITUTIONAL FRAMEWORK AND STAKEHOLDERS

MARD is the primary ministry responsible for a variety of government management functions in the agriculture sector (e.g., fishery, forestry, and rural development). In the context of LEDS, MARD is responsible for developing draft decrees, master plans, policies, five-year strategies, and regulations. In addition, it also guides research and development on crop and livestock management and management of agricultural waste, and is responsible for outreach and extension of management practices. Within MARD, the Science Technology and Environment Department is most relevant to development of LEDS policy, as it is the coordinating department for the Action Plan Framework for Adaptation and Mitigation of Climate Change in Agriculture and Rural Development sector.[54] Another entity with relevance for

[51] Vietnam Ministry of Natural Resources and Environment, *Viet Nam's Second National Communication.*

[52] Vietnam Ministry of Natural Resources and Environment, *Viet Nam's Second National Communication.*

[53] RCEE Energy and Full Advantage, for the World Bank Carbon Finance Assist Program – Vietnam, *Potential Climate Change Mitigation Opportunities in the Agriculture and Forestry Sector in Vietnam,* Background Paper, November 2009.

[54] Decision No. 2730/QD-BNN-KHCN dated 5th September 2008.

LEDS analysis is the Institute for Agriculture and Rural Development (IARD), which is the MARD-affiliated research institute responsible for sector-related modeling and analysis. The National Institute for Agricultural Planning and Projecting (NIAPP) is responsible for setting sector-related targets (e.g., production), but is not involved in economic analysis or modeling.

Among the donors, AusAID has provided direct assistance to MARD to support rural development and agriculture. In agriculture, AusAID's focus has shifted to funding activities related to climate change adaptation and mitigation. As outlined in more detail below, UNDP is currently providing support to MPI on the Green Growth Strategy, including for the analysis of low-emission strategies in the agriculture sector. Finally, the World Bank is planning on expanding EFFECT to include the agriculture sector in Vietnam by integrating FAO's Ex-ACT model.

5.3. KEY LOW-EMISSION GROWTH INITIATIVES

Until recently the GVN's focus has been on climate change adaptation, which is quite apparent in key policy documents and workshops.[55] The Five-Year Socioeconomic Development Plan for 2011–2015, for instance, focuses on disaster risk management as it relates to climate change, along with increasing farmers' income, food safety, and sanitary improvement. However, recent commitments underline the GVN's commitment to mitigation in the agriculture sector: in December 2011, the GVN signed Decision No. 3119/QD-BNN-KHCH, which is an ambitious strategy of reducing emissions from agriculture by 20%, while reducing poverty by 20% and increasing agricultural GDP by 20% ("20-20-20 Plan"). In response to this announcement, MARD is exploring mitigation options in agriculture in earnest. Recently, MONRE also announced a companion plan to reduce emissions from the agriculture and forestry sectors by 20% in 2020.[56] This plan is expected to cost VND 208 billion (USD 9.9 million) and uses 2005 as the base year for comparisons.[57] The draft plan is expected to be completed by the end of May 2012.

In exploring potential mitigation options for agriculture, the GVN is likely to leverage the potential mitigation co-benefits that exist for a number of agricultural development objectives:

- The development and adoption of sustainable farming techniques (e.g., actions to prevent the burning of crop residues)
- Improved manure and irrigation-drainage management in rice cultivation
- The exploitation of methane capture opportunities.

Some of the existing GVN strategies and initiatives leverage these co-benefits:

- **The National Strategy for Improving Irrigation Systems through 2020** has the potential to reduce methane emission from irrigation by improving water management to increase crop yields.
- **The Strategic Plan on Husbandry Development through 2020,** prepared by MARD in 2008, promotes the development and industrialization of animal husbandry. It could ultimately enhance livestock's carbon footprint.

[55] Jonas Bergstrom, *Workshop on Emission of Greenhouse Gases from Agriculture,* report to General Statistics Office, Hanoi, Vietnam by Vietstat 2011 and Statistics Sweden, 2011.

[56] CleanBiz Asia, "Vietnam Targets 20% Cut in Emissions to Exploit Carbon Trade," May 6, 2012, http://www.cleanbiz.asia/story/vietnam-targets-20-cut-emissions-exploit-carbon-trade.

[57] CleanBiz Asia, "Vietnam Targets 20% Cut in Emissions."

- MARD's **Biogas Program for Animal Husbandry** has introduced a large number of small-scale biogas systems, and the GVN is looking to expand these emission-mitigating options to include large-scale systems, which are more cost-competitive.

5.4. TECHNICAL ASSESSMENTS TO SUPPORT LEDS

IARD conducts sector-related modeling (e.g., Dynamic Integrated Climate Change Model) and applies the IPCC 2006 national GHG inventory methodology to develop GHG emission factors. They conduct macroeconomic analysis using the VIPAG CGE model and use VHLSS data to conduct partial equilibrium analysis to estimate demand and supply elasticity, total factor productivity, and production functions etc.

Several ongoing analytical macro- and microeconomic efforts in the agriculture sector are being funded by the donor community. Both IFPRI and LEI (from Wageningen University in the Netherlands) are engaged in agriculture and land use modeling; specifically, in helping the government assess the impacts of agricultural policies on land use change and GHG emissions. IFPRI is using IMPACT in conjunction with a spatially explicit land use model, and LEI is using MAGNET (Modular Applied GeNeral Equilibrium Tool)—a CGE model based on GTAP—and CLUE (Conversion of Land Use and its Effects), a spatial land allocation model. Data quality is a concern for both efforts, as researchers have found MARD and MONRE data to be inconsistent. Annex C summarizes some of the most commonly used models for analyzing the agriculture as well as forestry and land use sectors.

A few studies have been undertaken in Vietnam to identify and assess mitigation options in this sector. As noted above, for example, MONRE, working with UNDP, identified a number of GHG abatement options in the agriculture sector for the Second National Communication.[58] These options were developed following the methodology laid out in *Greenhouse Gas Mitigation Assessment: A Guidebook*.[59] The BAU scenario takes into account the country's national agricultural development targets. The options put forth include:

- Rice paddy field water drainage in the Red River Delta
- Rice paddy field water drainage in the South Central Coast
- Adoption of urea-molasses blocks as cattle feeds.

In 2010, the World Bank Carbon Finance Assist Program commissioned a study on mitigation opportunities in the agriculture and forestry sectors. Estimates in this report are based on nationally available statistics and studies on the emission reduction potential of specific technologies. However, the methodology is not described in detail. The mitigation options put forth are:

- Methane reduction from wetland rice cultivation through alternative wet/dry irrigation
- Effective use of nitrogen fertilizer through site-specific nutrient management
- Agricultural residues (rice husk and bagasse) for electricity generation
- Methane recovery with bio-digesters at livestock farms, flared or used for energy.

Also in 2010, the Institute of Environmental Science and Technology of the University of Hanoi, in coordination with MONRE, published a report specifically investigating mitigation options for agricultural

[58] Vietnam Ministry of Natural Resources and Environment, *Viet Nam's Second National Communication.*

[59] Jayant Sathaye and Stephen Meyers, *Greenhouse Gas Mitigation Assessment: A Guidebook* (AH Dordrecht, The Netherlands: Kluwer Academic Publishers, 1995).

waste management.[60] This analysis, which was supported by SIDA and JICA, used an accounting system to assess the potential and proposed waste management options for Vietnam.

Currently, AusAid is working with Global Development Solutions and MPI to map pathways for emission reductions in rice production and value chains. A team is gathering data for analysis in three Vietnamese provinces. Moreover, AusAID is funding work by the Environmental Defense Fund and the Mekong Delta Development Research Institute of Can Tho University (Vietnam Low Carbon Rice Pilot Project – VLCRP) on the *in situ* measurement of GHG emission from rice paddies across different management systems (e.g., a variant of the System of Rice Intensification called "One Must, Six Reductions") in An Giang and Kien Gang Provinces. A key challenge will be to scale up the sampling effort going forward.

UNDP is providing ongoing technical assistance to MPI, and through this effort, it is developing an initial set of marginal abatement cost (MAC) curves for the agriculture sector with MARD's Institute for Agricultural Environment (IAE). MARD's Institute of Agricultural Environment (IAE) and its international partners have used the DeNitrification-DeComposition (DNDC) model to estimate emissions from crop production as part of this work. However, overall the analysis has met with data gaps and has relied on expert judgment and IPCC default emission factors.

In January 2012, FAO launched the Economic Policy for Climate-Smart Agriculture (EPIC) program, which is looking at emission reduction co-benefits of agriculture and forestry sector activities that increase resilience and food security. The project is conducting econometric analysis relying on existing data, including VHLSS. Its work could be extended to estimate and project the distribution of cropping systems using VHLSS combined with climate, land use, and soil data.

5.5. DATA COLLECTION AND MANAGEMENT

Agricultural data collection is handled in part by GSO's Agriculture, Forestry and Aquaculture Statistics Department, and in part by MARD-affiliated research institutes, such as IARD and IEA. GSO conducts a census every five years covering the agriculture, forestry, and fishery sectors sector that collects information on production and fertilizer use, *inter alia*. MARD also collects agricultural commodity price, production, and input data through annual surveys at the district and municipal levels. In addition, MARD collects data from PSOs, which in turn gather data from heads of villages on crop and livestock production (e.g., crop varieties, crop calendars, or livestock headcount). These production and input data are shared with GSO, and the results are reported in a statistical yearbook. Some information relevant to developing LEDS for the agriculture sector may also reside with MARD's Centre for Agriculture Extension offices. Each of Vietnam's seven agro-ecological zones has its own extension office. These offices keep information on types of farming systems and livestock management systems prevalent in the provinces. They also keep information on crop budgets under various production systems that are useful inputs in analyzing the cost of mitigation options, which include shifting to other production systems.

In addition, the Department of Land Administration within MONRE conducts a land use survey every five years. The survey includes data at the provincial level with information on single or double cropping and area under specific crops (e.g., rice, coffee, or vegetables).

[60] Huynh Trung Hai and Nguyen Thi Anh Tuyet, *Benefits of the 3R approach for agricultural waste management (AWM) in Vietnam,* Institute of Environmental Science and Technology, Hanoi University of Science and Technology, October 2010.

According to MARD's Institute of Agricultural Environment, the inventory of agricultural GHG emissions rests on fairly poor data, particularly for aquaculture, which is not systematically surveyed in the country.[61] Information is relatively better for rice-farming systems. However, given the importance of rice for the economy, more research is needed to develop region- and cultivation system-specific emission factors. Figure 11 shows the data collection, dissemination, and reporting processes for the agriculture sector in Vietnam.

5.6. PRIORITIES FOR IMPROVING DATA AND RECOMMENDATIONS

There is a consensus that agricultural data can be improved for the development of GHG inventories. Key gaps in developing an emission inventory for the agriculture sector include activity data—namely related to rice cultivation, agricultural residues, and livestock management—and country-specific emission factors. Currently, the inventories presented in Vietnam's National Communications to the UNFCCC have relied on published statistics, IPCC defaults, and expert judgment. GVN ministries responsible for agriculture sector data collection have noted that data improvements are needed in both emission factors and activity data. Both the MARD-affiliated IARD and SIDA, which developed a 2008 inventory of agricultural GHGs working with GSO, concur that these data are lacking. The GVN has indicated that it requires support in the following areas:

5.6.1. EMISSION FACTORS FOR AGRICULTURE IN VIETNAM

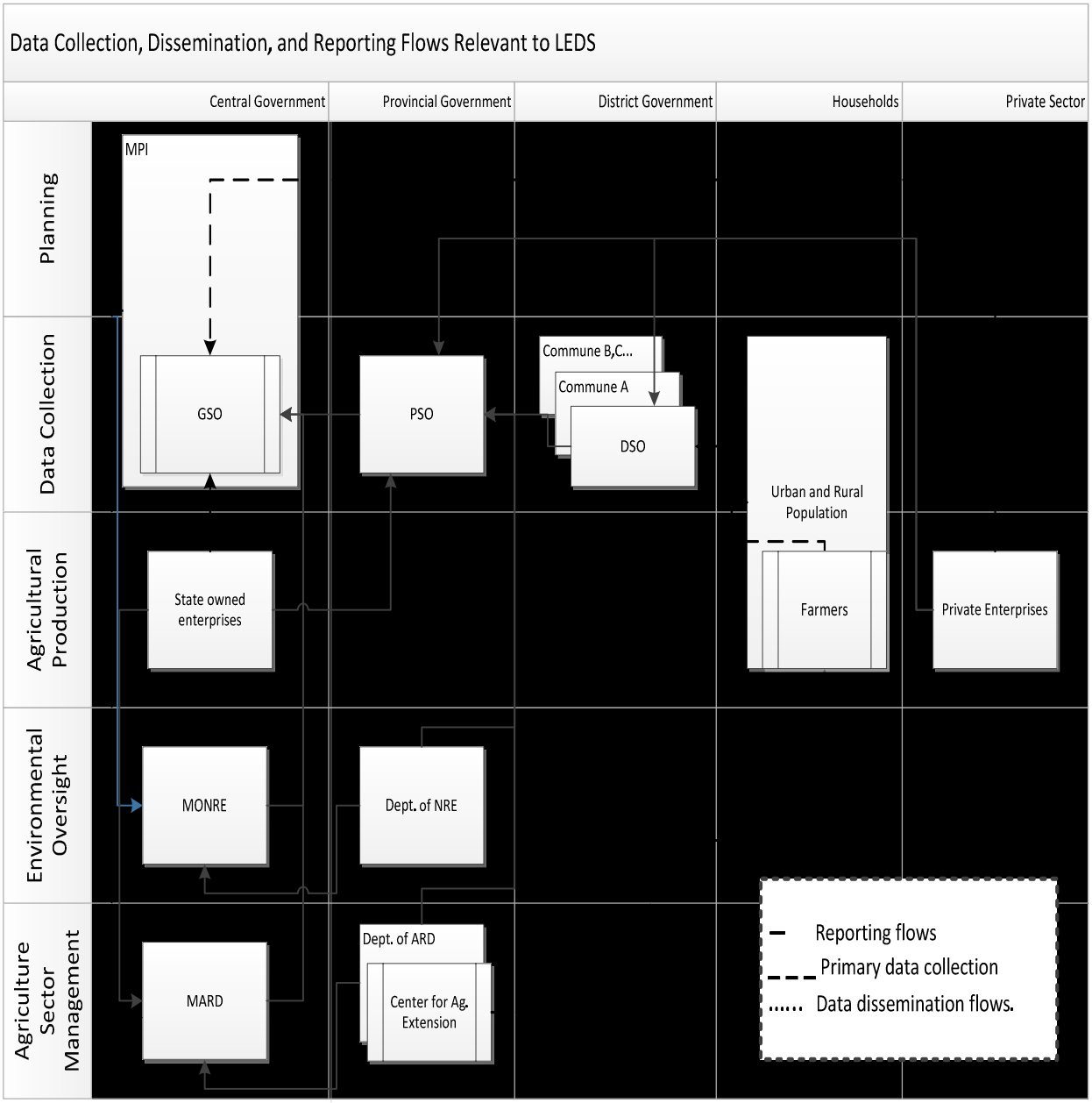
MARD has expressed a need for Vietnam-specific emission factors for rice cultivation, although Can Tho University has reportedly modeled rice-related GHG emissions for Vietnam. MARD's IAE has also carried out some pilots to measure agricultural methane emissions. As noted above, the Environmental Defense Fund and the Mekong Delta Development Research Institute of Can Tho University (VLCRP) are working on developing emission factors for rice systems in two provinces of the Mekong Delta. However, further assistance is needed to expand to more sites in these two provinces, as well as expand the geographic breadth of this sampling.

5.6.2. ACTIVITY DATA FOR AGRICULTURE IN VIETNAM

MARD, GSO, and MPI have noted that the activity data for LEDS analysis in the agricultural sector are not readily available. Data gaps include area and yield by rice management systems, fertilizer use and content, livestock management systems, the use of agricultural residues, and biogas generation. In cases where relevant activity data exist, they are difficult to obtain from the PSOs and DSOs. Moreover, while PSOs collect information on some key agricultural activities, sampling methods are not always known, and proper, rigorous sampling is not always used. In other cases, data are actually unavailable, perhaps as the result of unsystematic data collection systems. There is a need to: (1) review the existing data collection systems and identify approaches to improve data collection and management so that salient activity data that are collected are readily available, and (2) identify existing surveys that can be leveraged to include additional questions in order to generate activity data that are not currently collected. Figure 12 lists detailed recommendations for enhancing Vietnam's data collection and management systems necessary for low-emission development in the agriculture sector.

[61] AILEG team interviews with GVN stakeholders, Spring 2012.

FIGURE 11: DATA COLLECTION, DISSEMINATION, AND REPORTING FOR AGRICULTURE IN VIETNAM



Definitions: Dept. of ARD – Department of Agriculture and Rural Development, Dept. of NRE – Department of Natural Resources, DSO – District Statistics Office, GSO – General Statistics Office, MARD - Ministry of Agriculture and Rural Development, MONRE – Ministry of Natural Resources and Environment, MPI - Ministry of Planning and Investment, PSO – Provincial Statistics Office

Source: Interviews with GVN stakeholders, Spring 2012.

The gaps in the emission inventory data for the agriculture sector need to be addressed in order to conduct rigorous modeling and low-emission analysis. Figure 13 lists recommendations for specific low-emission economic analyses for which the GVN has expressed a need.

FIGURE 12: RECOMMENDATIONS FOR AGRICULTURE SECTOR EMISSION DATA

1. **Conduct a granular review of what, when and how agriculture sector data are currently being collected in the agricultural sector** (building on JICA's work) and draw conclusions on completeness and reliability, as well as on cost-effective approaches to improve data collection and quality. The review will examine, *inter alia*, the agricultural census (conducted every five years), data collected annually by MARD extension services at the province level, land use data, and the Vietnam Household Living Standards Survey.
2. **Design a system to collect and manage activity data**, particularly with regard to rice and livestock production, that will strive to maximize data quality, flow (from local to ministerial databases, national databases – and GSO), accessibility, and cost-effectiveness.
3. **Derive emission factors for various rice management systems** through enhancement of existing efforts to measure emissions at the field level, such as the work of VLCRP in the Mekong Delta. This would include expanding field measurements to other regions outside of the Mekong River Delta, such as the Red River Delta in the north. Alternatively, instead of making estimates in the field, model emissions across rice systems based on the preliminary data from the Mekong Delta study. Additionally, conduct in-depth literature reviews of other studies in Southeast Asia to develop plausible emission factors for Vietnam.

FIGURE 13: RECOMMENDATIONS FOR AGRICULTURE SECTOR ANALYSIS

- **Develop a MAC curve for the agriculture sector reflecting technical mitigation potential,** building on the efforts to improve data collection and prior technical work to assess mitigation options in the agriculture sector (e.g., World Bank, UNDP/MPI, AusAID). This will involve gathering information from a combination of primary and secondary sources on the mitigation potential and marginal cost of identified technologies.
- **Analyze the potential for mitigation options** in the rice cultivation and livestock management using the MAC curves generated above, but also considering the extent to which technical mitigation potential in these sectors is practical or achievable based on non-cost barriers to technology adoption (e.g., legal, regulatory, cultural, transactional).
- **Conduct financial analysis for methane capture,** which includes analysis of the feasibility, cost, and barriers to introducing methane capture and electricity generation from livestock waste and potential sources of finance for Vietnam.
- **Review the legal framework to provide recommendations for expanding MARD's mandate** to ensure that the data necessary for LEDS planning and analysis are collected each year. This involves a review of the existing legal mandate, drafting of legal language, and recommendations on how to incorporate this draft legal language into bills by the National Assembly or through other directives.

6. ENERGY SECTOR LEDS ASSESSMENT

Emissions estimation and economic modeling of the energy sector are critical components of Vietnam's LEDS programs for two reasons. First, Vietnam projects energy sector emissions to track its rising economic growth rate—unless decoupling occurs. Second, the energy sector offers perhaps the best national opportunities for introducing viable mitigation actions such as clean energy and energy efficiency projects. In 2000, the energy sector represented the second largest contributor to Vietnam's total national GHG emissions (Figure 7). By 2030, Vietnam expects its energy sector to produce the majority, 91.3%, of its total annual emissions—thereby overtaking contributions from the agriculture sector. [62]

Given the continued growth in energy demand, LEDS analysis for this sector has become a priority, particularly because of the planned investments in new generating capacity and the significant opportunities to improve energy efficiency in existing infrastructure. In what follows, Section 6.1 presents an overview of Vietnam's growing energy demand and associated GHG emissions. Section 6.2 provides a brief summary of the institutional framework and stakeholders involved in planning energy sector activities**.** Section **Error! Reference source not found.** presents the key low-emission growth initiatives related to energy, while Section 6.4 describes some of the analytic efforts that have been implemented in this sector to date. Section 6.5 summarizes existing data collection and management systems. Finally, Section 6.6 presents data gaps and recommendations for future activities to support LEDS analysis.

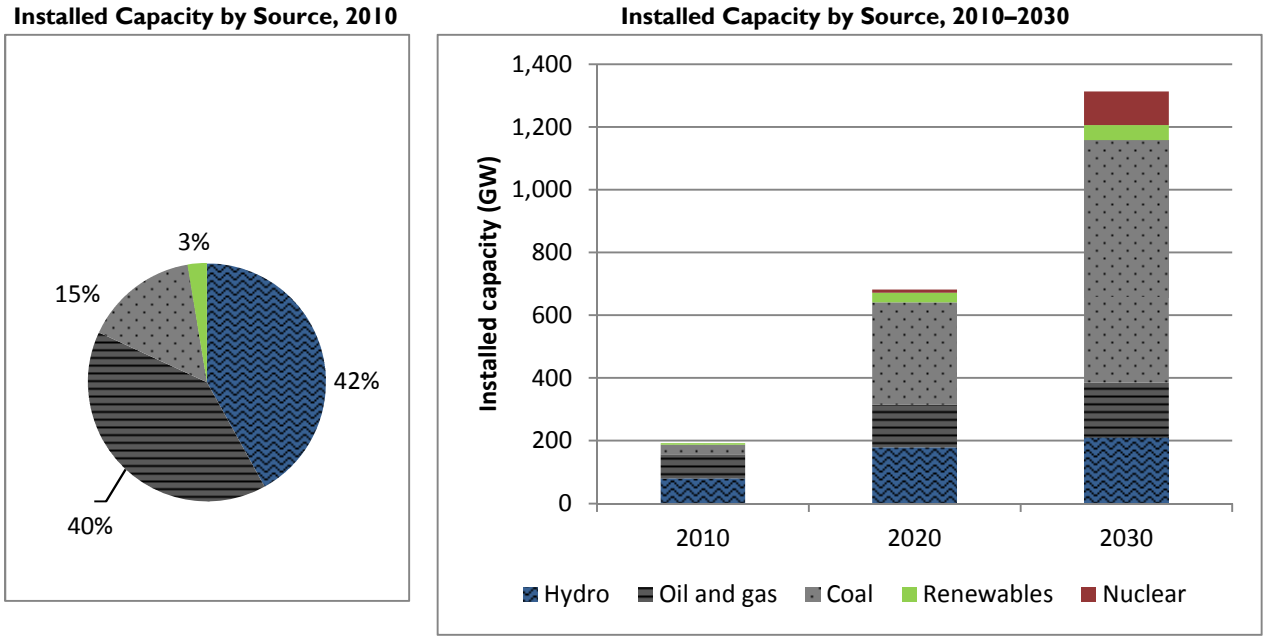
6.1. ENERGY DEMAND AND GHG EMISSION TRENDS

Vietnam's rapid economic growth over the past decade has led to increased energy demand. While Vietnam's economy grew by 7.3% per year between 1998 and 2007, end-use energy consumption grew by an estimated 12.1% per year over the same period. Between 1999 and 2009, electricity demand surged at a rate of 15% per year. Vietnam's generation mix has evolved substantially, with coal declining from 33% in 1995 to 17% in 2007, and hydropower decreasing from 72% to 34%, while natural gas expanded as a share of generation (Figure 14). In the transportation sector, rising incomes have translated into increased ownership and usage of motorbikes and passenger cars. Energy consumption for transport increased tenfold between 1980 and 2005.[63]

[62] Ministry of Natural Resources and Environment, *Viet Nam's Second National Communication*.

[63] World Bank, *Climate-Resilient Development in Vietnam: Strategic Directions for the World Bank*, January 2011.

FIGURE 14: INSTALLED CAPACITY BY SOURCE (2010 AND 2010–2030)



Source: Authors, based on Hai et al., *Economics of Low Carbon, Climate-Resilient Development.*

Prior to the 2008 recession, energy demand was projected to grow by 10% a year over the next several years,[64] outstripping GDP growth and putting pressure on domestic energy supply. As Vietnam's energy surplus is projected to turn into a deficit by 2020, the extraction and production of the country's coal and natural gas reserves is seen as critical for the country's energy security. Vietnam's Seventh Power Sector Master Plan for 2011–2030 envisions an ambitious build-out of national generating capacity to meet increasing electricity demand (14% per year through 2015), including the addition of 30 gigawatts of coal-fired generating capacity by 2020—an increase of a factor of 10 compared to 2010.[65] Clean energy is expected to represent a shrinking share of Vietnam's primary energy supply.

In line with these trends, energy accounts for a significant and growing share of Vietnam's GHG emissions. Between 1994 and 2000, the energy sector's contribution to national GHG emissions rose from 25% to 35%. In 2010, energy-related emissions were estimated to have doubled over 2000 levels from 52 to 113 million tCO_2e, and are expected to more than double again in the current decade, reaching more than 250 million tCO_2e in 2020.[66]

6.2. INSTITUTIONAL FRAMEWORK AND KEY STAKEHOLDERS

The Ministry of Industry and Trade (MOIT) is the lead ministry responsible for developing and implementing energy policies, plans, and regulations in Vietnam, with input from a range of other ministries and institutes with overlapping or interrelated responsibilities. MOIT is responsible for establishing, implementing, and monitoring the National Energy Development Strategy and the Power

[64] World Bank, *Vietnam Renewable Energy Development Project, Project Information Document,* December 23, 2008. Note: this projection was prior to the global economic recession.

[65] Hai et al., *Economics of Low Carbon, Climate-Resilient Development.*

[66] Ministry of Natural Resources and Environment, *Viet Nam's Second National Communication.*

Sector Master Plan. The Ministry is authorized to administer the Vietnam National Energy Efficiency Program (VNEEP) and, under Ministerial Decision No. 919/QD-BCN, established the Energy Efficiency and Conservation Office. This office develops organizations and systems for improving energy efficiency and conservation on the government level, from the central government to local governments.

Within MOIT, the General Directorate of Energy coordinates activities related to LEDS analysis and policy implementation. Electricity of Vietnam (EVN), a vertically-integrated State-owned utility that manages generation, transmission and distribution systems, provides data to MOIT for planning purposes. The Institute of Energy is responsible for nearly all the modeling done at MOIT, and it is mandated to gather all data needed for the Power Sector Master Plans. These data come from EVN, the provincial Departments of Industry and Trade, as well as other sources such as investors.

Several other ministries are involved in various stages of the establishment, implementation, and monitoring of LEDS policy for energy. MPI plays a significant role because of its responsibility for overall national planning within the government, including the development of the country's Green Growth Strategy. CIEM is the lead institute supporting MPI, and is therefore also directly involved with analyzing energy-related LEDS strategies—usually from an economy-wide perspective. GSO supports this process by collecting and publishing data for the planning process, and by reporting on more than 100 economic and environmental indicators that may be relevant for LEDS analysis. In addition, the MOC, MOT, MARD, and MOST are involved due to the importance of energy in their sectors.

Because of the importance of the energy sector in low-emission planning, a large number of donors are supporting LEDS related activities, many of which are summarized in Table 6.

6.3. KEY LOW-EMISSION GROWTH INITIATIVES

Vietnam's energy policies have a strong economic growth orientation. As such, they primarily emphasize creating the supply needed to meet rapidly rising energy demand across different sectors. However, the government has recently introduced policies aimed at improving energy efficiency and renewable energy sources with the joint goals of improving energy security and decarbonizing the energy sector.

Vietnam's key energy strategies, plans, and policies with implications for the country's emission growth are summarized below.

- **Vietnam's National Energy Development Strategy (2007)** aims to ensure an adequate supply of energy for economic development. While it primarily foresees investment in the fossil economy, it also lays out targets for the development of nuclear power and renewable generation. The target for renewable energy is to represent 3% of total primary commercial energy in 2010, over 5% in 2020, and over 11% in 2050.
- **Various energy sector master plans** lay out objectives for the electricity system; coal, oil, and gas exploitation; and nuclear power for the period 2011–2030. For instance, the Seventh Master Plan on Power Energy (2011), which lays out a vision for the electricity sector through 2030, foresees significant increases in natural gas, hydroelectric, nuclear and renewable capacity. While these sources are relatively clean compared to coal, these capacity additions may be overshadowed by a projected build-out of coal-fired thermal-electric capacity, which is slated to largely dominate Vietnam's fleet by 2020, representing 46 percent of installed capacity (and implying that coal would likely represent an even larger share of the generation mix). Moreover, significant fossil fuel subsidies remain in place, encouraging continued use of these fuels.

TABLE 6: EXAMPLE OF DONOR SUPPORT FOR LEDS ANALYSIS IN THE ENERGY SECTOR

Donor Organization	Energy Sector Activity
The Asian Development Bank	• Supports the implementation of the NTP-RCC 2011–2015, through model and software development, LEDS analysis, and training, including for the energy sector. • With France and Spain, provides technical assistance to the Energy Efficiency and Conservation Office under MOIT to promote energy efficiency in the industrial sector through the Supporting Implementation of the National Energy Efficiency Program project.
The World Bank	• Supports design and implementation of the VNEEP, managed by MOIT. • Extended Vietnam a $70 million climate change development policy credit to increase the GVN's capacity to respond to climate change by supporting the development of a low-carbon development study, which will support the GVN in formulating nationally appropriate mitigation actions (NAMAs), including for the energy sector. • Works with various ministries and affiliated research institutes—including the Institute of Energy (IE) and CIEM—to analyze Vietnam's low-emission development policies, and has developed preliminary MAC curves for Vietnam using the MACTool being developed under the ESMAP division.
International Finance Corporation (IFC)	• Promotes greater energy efficiency, renewable energy, and cleaner production methods through the Vietnam Energy Efficiency and Cleaner Production Financing Project, which aims to increase finance available for sustainable energy investments.
Denmark	• Works on the development of renewables including waste-to-energy and energy efficiency in the Mekong region. • Supports energy efficiency improvements in the industrial sector through training, development of a national certification system for audits, energy efficiency audits at large enterprises, development of energy management systems, an investment fund to support energy savings, and studies to establish energy sector benchmarks.
The European Commission	• Supports energy efficiency in SMEs through the Mainstreaming Energy Efficiency through Business Innovation Support Project.
Clean Technology Fund	• Will give Vietnam $250 million in funding for activities spanning the power and transportation sectors, including World Bank smart grid and energy efficiency in heavy industry projects and an IFC energy efficiency project.
UNDP	• Implements projects to promote the efficient use of energy in SMEs and residential buildings and assess the impacts of energy taxes and subsidies on emission and the economy.
USAID	• Will initiate a Vietnam Clean Energy Program to support clean energy development through the increased use of renewable energy technologies and energy efficiency practices, and by building Vietnamese capacity in energy data management and analysis for policy making • With funding from USAID, the U.S. Department of Energy's Pacific Northwest National Laboratory is reviewing the revised building code for the country and providing training based on the results. The National Renewable Energy Laboratory is reviewing renewable energy resource data and will provide training on its renewable energy geo-spatial toolkit.

Source: Authors, based on interviews conducted by the AILEG team in April 2012.

- **VNEEP** has a target of a 3–5% reduction of national energy consumption relative to BAU projections from 2006 to 2010 and 5–8% from 2011 to 2015. It is a comprehensive program to improve energy efficiency measures in all sectors. Under this plan, funds are allocated for energy efficiency and conservation projects, technical assistance for demand-side management, and development of standards and labeling for appliances.
- The **Law on Energy Efficiency and Conservation** was passed in 2010, and requires large energy users to conduct energy audits, submit annual energy consumption plans, and identify specific solutions to save energy. They are also required to file an energy report to the GVN and assign energy management officers to be responsible for implementing their energy plans.
- A **Renewable Energy Master Plan** was prepared by MOIT, with support from ADB, and is waiting for approval by the Prime Minister. This plan sets targets for renewable energy generation by 2020 and 2050.
- The **Green Growth Strategy for the Period 2011-2020 with a Vision to 2050** (see Section 4.3) to be released by the end of 2012 will also direct and organize activities in the energy sector, including those related to low-emission planning. Energy sector options considered under the draft strategy include fuel switching, energy efficiency, electricity savings in industry, carbon capture and storage, coal mine methane recovery, increased renewable energy generation, and pricing on GHG emission and other pollutants.

6.4. TECHNICAL ASSESSMENTS TO SUPPORT LEDS

6.4.1. SECTOR ANALYSIS

Vietnamese energy policy research typically uses a scenario analysis approach to explore alternative energy futures. The study on the National Energy Master Plan, carried out by the IE with JICA in 2007, for instance, uses scenario analysis to examine the impacts of economic growth, population growth, oil prices, and nuclear and renewable energy on the development of Vietnam's energy system over the period 2005–2025. Three energy policy studies carried out by the IE in 2002 also use a scenario approach to investigate the impacts of fuel prices and carbon taxes on electricity tariffs over the period 2000–2025.[67] Scenarios are assessed using a combination of engineering-based bottom-up and top-down models.

Engineering sector-based models (e.g., energy optimization and energy simulation) are in wide use in Vietnam (see Section 3.2). They are commonly used to project energy demand and supply along with the energy and generation mix based on alternative assumptions. Engineering-based models that have been used or are being considered in Vietnam include the Model for Energy Supply Strategy Alternatives and their General Environmental Impact (MESSAGE), the Energy Forecasting Framework and Emission Consensus Tool (EFFECT), MARKet Allocation Model (MARKAL), LEAP (Long-range Energy Alternatives Planning System), Energy Flow Optimization Model (EFOM), *Modèle d'Evolution de la Demande d'Energie* (MEDEE), Wien Automatic System Planning (WASP) and Energy Outlook Models—many of these models are optimization models that solve for lowest-cost solutions to meeting future energy needs subject to assumed policy constraints. Annex C describes the energy sector models being used in Vietnam in more detail.

[67] Tien Minh Do, "Analysis of Future Energy Pathways for Vietnam," Dissertation, University of Technology, Sydney, 2011.

6.4.2. LEDS POLICY ANALYSIS

LEDS analysis is generally more developed in the energy sector than it is for other sectors. Several of the aforementioned models used for energy sector modeling and planning in Vietnam have been adapted to assess the energy system costs of hypothetical GHG constraints or other low-emission policies.

The **EFFECT** model is being introduced to MPI and MOIT by the World Bank's Energy Sector Management Assistant Program (ESMAP) to support the analysis of development scenarios and GHG emissions.[68] So far, the World Bank has focused on the following sectors: electricity generation, industry, on-road transportation, household electricity, and non-residential electricity use.

MARKAL has been used by the IE and others to model Vietnam's energy system at the national and sub-national levels. It also has been used to simulate energy supply and prices subject to CO_2 emission constraints. However, for cost reasons, government organizations such as the IE tend to favor some of the other models with lower resource requirements.

The **LEAP** model is used by the IE for the analysis of energy supply policies and GHG mitigation options, and with support from UNDP, it was employed by MPI for the development of mitigation scenarios under the Green Growth Strategy. The LEAP model was also used by CIEM to derive the energy sector GHG projections and mitigation options presented in Vietnam's Second National Communication. The Second National Communication identifies six mitigation options in residential energy efficiency, two others in industrial energy efficiency, two in transportation, one in the commercial sector, and four options involving the use of renewables in the energy industry.[69] Most of these were derived by the IE, working with UNDP.

In 1999, Vietnam's Hydro-meteorological Service used **EFOM** and the **Comprehensive Mitigation Assessment Process (COMAP)** models to carry out a study analyzing the economics of GHG mitigation actions in the energy, forestry, and agriculture sectors from 2003 to 2020, in cooperation with MOIT, MARD, and several other ministries. The study examined 13 scenarios involving energy efficiency, renewables, fuel-switching in electricity generation, reforestation, and changes in agricultural practices. COMAP was used to assess GHG mitigation options in the forestry and agricultural sectors. In 2007, the Institute of Energy used the **WASP**[70] model to analyze three economic growth scenarios for 2006–2025 for the Master Plan for Power Development VI, which covers a roadmap for the expansion of the electricity supply network. The study did not consider energy efficiency or fuel substitution options. In 1999, the Institute of Energy determined that nuclear power is the most cost-effective option for mitigation growth in CO_2 emission using the WASP model. The model, however, does not examine the economy-wide impacts of power supply options. Also in 2007, the IE and JICA used the **Energy Outlook Models** to carry out a study of the National Energy Master Plan, which lays out an energy supply plan for 2006–2025, as well as energy security, energy efficiency, and energy market policies. They also used these models to assess Vietnam's Roadmap for Fundamental Energy Policies and Action Plans for the power, coal, and gas industries.

[68] ESMAP, "Low Carbon Development," 2012, http://www.esmap.org/esmap/node/1335.

[69] Ministry of Natural Resources and Environment, *Viet Nam's Second National Communication.*

[70] International Atomic Energy Agency (IAEA), "Wien Automatic System Planning (WASP) Package: A Computer Code for Power Generating System Expansion Planning, Version WASP-IV, User's Manual," 2001, http://www-pub.iaea.org/MTCD/publications/PDF/CMS-16.pdf.

6.5. DATA COLLECTION AND MANAGEMENT

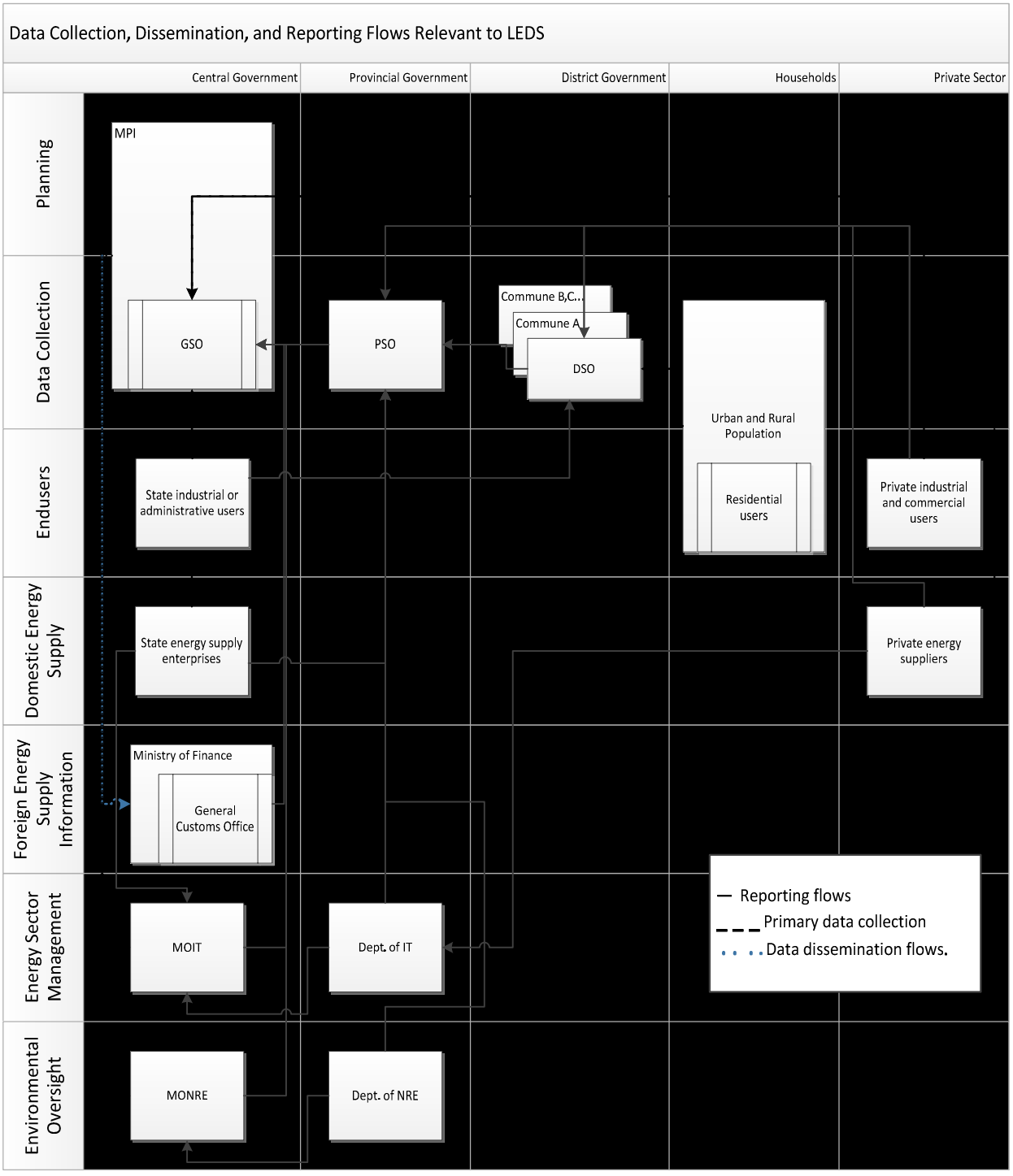
Data collection for energy sector analysis is primarily led by MOIT with support from its affiliated research institute, the IE. This includes developing Vietnam's National Energy Balances and collecting other data for the development and analysis of energy and power sector plans. MOIT has the primary responsibility for collecting data on building energy use in support of the Law on Energy Efficiency and Conservation, with cooperation from MPI and GSO. In the past, MOIT prepared annual energy statistics but discontinued this due to a lack of funds. EVN and CIEM also collect and analyze data related to the energy sector. Some of the indicators tracked by GSO also relate to energy. MOC tracks energy use in buildings and building materials. Table 7 lists the range of government agencies that are collecting and analyzing data related to the energy sector, while Figure 15 illustrates the data collection functions and process of MOIT.

TABLE 7: GOVERNMENT ENTITIES RESPONSIBLE FOR ENERGY SECTOR DATA

Energy Sub-Sectors	Entities Responsible for Data Collection
Power sector	EVN, Institute for Industry Policy and Strategy (IPSI), Energy Institute, General Directorate of Energy - MOIT; GSO - MPI
Transportation	Vietnam Register; Transport Development and Strategy Institute - MOT; GSO - MPI
Buildings	MOC; IE – MOIT
Non-residential data	CIEM, GSO - MPI; Energy Institute – MOIT
Household data	CIEM, GSO - MPI; NIAPP - MARD; Energy Institute - MOIT
Industrial data	Energy Institute, IPSI, Department of Planning, MOIT; CIEM, GSO - MPI; Provincial Departments of Information Technology

Source: Author interviews by AILEG team with government stakeholders, April 2012.

FIGURE 15: DATA COLLECTION, DISSEMINATION, AND REPORTING FOR ENERGY IN VIETNAM



Dept. of IT – Department of Industry and Trade, Dept. of NRE – Department of Natural Resources, Dept. of T – Department of Transport, Dept. of C – Department of Construction, DSO – District Statistics Office, GSO – General Statistics Office, MOIT – Ministry of Industry and Trade, MONRE – Ministry of Natural Resources and Environment, MPI - Ministry of Planning and Investment, PSO – Provincial Statistics Office

Source: Author interviews by AILEG team with government stakeholders, April 2012.

Currently, there is no centralized system for managing and sharing data collected by these agencies and institutes, including new data generated through various donor efforts to improve capabilities for low-emission analysis. This includes information on technology costs, historical electricity generation mix and emission factors, and energy use by facility and sector. If institutes generate GHG mitigation or technology scenarios, the underlying assumptions and datasets are typically not made public. As a result, researchers in one ministry must rely on contacts in another ministry to identify and obtain available data.

6.6. PRIORITIES FOR IMPROVING DATA AND RECOMMENDATIONS

Data on activities in the energy sector are more widely available than data in other sectors, and the expansion of existing datasets is being supported by a number of donors. In spite of these developments, several gaps remain in the context of running low-emission models. There is a consensus, among GVN stakeholders, that better data collection and management is needed for evaluating abatement options in the energy-consuming subsectors, developing NAMAs, supporting the new energy efficiency law, and implementing the National Climate Change Strategy and the Green Growth Strategy. Specific recommendations voiced by various government stakeholders are described below.

6.6.1. GHG EMISSION INVENTORY DATA

Key gaps in developing GHG emission inventories for the energy sector include country-specific emission factors for the coal mining and power generation sectors and up-to-date National Energy Balances for the 2008 and 2010 inventory activity data.

EMISSION FACTORS FOR THE ENERGY SECTOR

MONRE would like support to update and peer-review its study of the carbon content of Vietnamese anthracite coal, and advice as to whether it needs to undertake additional analytical steps to determine an emission factor for this coal type. Currently, Vietnam uses the IPCC default emission factor for anthracite coal, but a recent MONRE study indicates that the carbon content of Vietnamese coal is lower than the IPCC default. MONRE is interested in resolving this discrepancy, as the Vietnamese emission factor could reduce the country's annual GHG inventory and potentially avoid over-crediting of Clean Development Mechanism (CDM) projects that rely on anthracite coal in the baseline.

Another data gap in the coal sector relates to coal mining. The government and the Vietnam National Coal–Mineral Industries Holding Corporation Limited (VINACOMIN) do not yet have a clear picture of fugitive methane emission from coal mining and have requested support for developing an improved monitoring scheme. VINACOMIN's samples are not comprehensive enough to establish a reliable estimate of emission from all coal mines, and they have questions on the methodology.

MONRE has also expressed the need for an annual process for developing national electricity generation emission factors. MONRE uses these emission factors for the annual update of Vietnam's electricity sector baselines submitted to the CDM Executive Board for use in crediting CDM projects. Such a process for establishing grid emission factors would also be important for the development and monitoring of NAMAs in the electricity and end-use sectors.

ACTIVITY DATA FOR THE ENERGY SECTOR

The main challenge for MONRE in developing the national GHG inventory for the energy sector is the absence of up-to-date National Energy Balances for the most recent GHG inventory years (2008 and 2010). ADB is providing support to MOIT for updating the Energy Balances; in the meantime, MONRE must rely on other data sources for the activity data. This process is complicated because the relevant MOIT planning documents, such as the Master Plan for Electricity, do not use the same data categories as those in the Energy Balances.

In summary, Figure 16 lists the detailed recommendations for enhancing Vietnam's LEDS data collection and management systems for the energy sector.

FIGURE 16: RECOMMENDATIONS FOR ENERGY SECTOR EMISSION DATA

1. **Develop national electricity generation emission factors**. Support clarification of data requirements and data collection processes for developing annual national grid emission factors, and establish a legal mandate for MOIT, or another agency, to publish the requisite activity data.
2. **Improve emission factors for coal** by: (1) conducting a peer review of MONRE's assessed carbon content of Vietnamese anthracite coal to evaluate the soundness of methodology used and provide recommendations for any potential improvements; and (2) working with VINACOMIN to establish and implement a monitoring framework for measuring fugitive methane emissions from coal mines.
3. **Recommend options for updating energy sector data and standardizing the use of these data in national plans.** This would include looking at GSO and various MOIT energy plans to identify discrepancies in energy reporting and categorization and provide recommendations for addressing these.

6.6.2. ANALYSIS OF MITIGATION OPTIONS

Dedicated, regular, and systematic data collection efforts are needed for the analysis of LEDS policies and programs for the energy sector, as current studies remain *ad hoc* given limited GVN resources. The World Bank is expected to conduct data collection for the energy sector to implement the EFFECT model, and various targeted data collection efforts are being supported by other donors (e.g., World Bank/IFC, Danish International Development Agency, and ADB). Most of the data collection, however, is one-off and may not be made available to the public.

Better energy use data for buildings are particularly needed. The Vietnamese government has a fairly good understanding of the expected costs and emission reduction potential of mitigation options for electricity generation, but it has significantly fewer data for evaluating options to reduce energy demand (e.g., energy efficiency data). For example, the IE requested support for the development of benchmark data to assess demand-side management options, such as efficient lighting and cooling in buildings, or industrial energy efficiency measures. Subsectors where data are particularly lacking include industry, in general; administrative and commercial buildings; hospitals; hotels; and restaurants. Similarly, MOC has requested support for the development of benchmark activity data for large buildings (larger than 2,500 m^2) covered under the new energy efficiency law. The World Bank and IFC are implementing a

project to conduct a one-time survey of energy use in 20 buildings in the three largest cities in the country, and the Ministry is interested in support for improving data collection over time or expanding the survey to include additional buildings.

There is also an interest in improving the modeling capability for analyzing energy sector strategies. The IE expressed a need for development of a full energy system model that links its existing models (i.e., MESSAGE, and LEAP – See Annex C) into one integrated system for analyzing general energy sector plans and specific abatement strategies for the entire sector. This could include payment of staff salaries to develop the model or provision of experts to develop technology and cost scenarios for individual energy options, such as nuclear, refining, coal mining, and clean coal.

Figure 17 presents recommendation for measures to strengthen activity data and analytic capabilities for LEDS analysis.

FIGURE 17: RECOMMENDATIONS FOR ENERGY SECTOR ANALYSIS

1. **Develop a full energy system model.** Provide technical expertise to develop specific modules for a proposed full energy sector model for Vietnam, focusing on development of costs, benefits, co-benefits, and penetration scenarios for relevant energy options such as nuclear, hydroelectric, clean coal, or refining.
2. **Develop benchmark activity data for large and medium-sized buildings** This would involve reviewing building types within the industrial, residential, and commercial sectors where there is a particular need for new survey data to analyze abatement strategies, and designing and implementing a pilot survey to increase access to relevant datasets. For example, for the commercial sector, this could include medium-sized and large hospitals, hotels, and administrative buildings that are targeted under the new energy efficiency law.
3. **Design a public database and/or website housing results of existing energy sector studies**. This includes development of a public database or website to make results of existing energy survey efforts available to all ministries. Based on review of the existing data collection efforts, recommendations for making data collection a systematized, repeated process and proposing a legal framework for doing so would also be useful.

7. SOLID WASTE SECTOR LEDS ASSESSMENT

Vietnam's solid waste sector accounts for 5% of Vietnam's total GHG emissions. Although a small contributor in comparison to other sectors, its emissions are growing quickly as incomes rise and more people migrate to urban areas. In addition, solid waste management mitigation activities are well understood and often provide excellent opportunities for climate financing from internal and/or external funding sources. The sector is therefore receiving increased attention from multiple national and international stakeholders for its emission reduction potential, especially because some activities, such as improved landfill management, can result in significant emission reductions at fairly low cost.

Section 7.1 provides background on emission growth from the waste sector. The subsequent sections concentrate primarily on municipal solid waste, where relatively easy policy directives and regulations can reduce emissions over time. Sections 7.2, 7.3, and 7.4 present Vietnam's key low-emission growth initiatives, relevant stakeholders, and analytical efforts in the solid waste sector, respectively. As will be illustrated, low-emission initiatives are still limited given the past focus on other, higher emitting sectors. Section 7.5 presents existing data collection and management capabilities. Section 7.6 presents recommendations from MONRE and MOC on how data sources and general capacity for LEDS analysis can be improved.

7.1. EMISSIONS AND ECONOMIC TRENDS

In 2000, the waste sector accounted for 5% of Vietnam's total GHG emissions, or 7.9 million tCO_2e. Solid waste generated nearly 71% of these emissions, and industrial wastewater generated close to 17%; human waste and wastewater made up the remainder. While waste-related emissions are much smaller than those from the agriculture, energy, or land use and forestry sectors, between1994 and 2000 waste-related emissions more than tripled, recording the highest growth in emissions among all sectors (see Table 8). This trend highlights the waste sector as being a significant area for future LEDS planning.

TABLE 8: EMISSIONS FROM WASTE IN VIETNAM, 2000

Sub-Sector	CH_4 (thousand tonnes)	N_2O (thousand tonnes)	CO_2e (thousand tonnes)	Percentage (%)
Solid waste	267	0	5,597	70.6
Wastewater	1	0	28	0.4
Industrial wastewater	64	0	1,336	16.8
Human waste	0	3	964	12.2
Total	**331**	**3**	**7,925**	**100**

Source: Ministry of Natural Resources and Environment, *Viet Nam's Second National Communication.* Base year is 2000.

7.2. KEY LOW-EMISSION GROWTH INITIATIVES

The waste sector is a potential source of cost-effective mitigation and abatement options with potential health and environmental benefits from pollution reduction and improved sanitation, and economic benefits from on-site energy generation. Recognizing this potential, Vietnam's 2011 **National Climate Change Strategy** includes a few waste-related objectives.[71] These objectives are:

- Create a solid waste management plan to build management capacity, reduce solid waste, and promote reuse and recycling of waste to reduce GHG emissions
- Strengthen research and the application of advanced waste treatment technologies
- Apply modern waste treatment technologies in municipalities and rural areas
- Build management, treatment, and recycling capacity for industrial and household wastewater
- Collect and treat, by 2020, 90% of urban household waste, 85% of which is to be recycled, reused, and recovered for energy generation.

In addition, the GGS being finalized by MPI is expected to address the waste sector. Strategies under consideration by MPI include minimizing landfill waste, developing and promulgating a law on recycling, developing a modern recycling industry, increasing the use of household waste as an energy resource, and improving waste treatment systems across the country.

In the meantime, the government is working to strengthen the legal framework for solid waste management. The GVN recently issued a decree on waste management focusing on solid waste separation, for instance. MONRE is considering developing a plan for improving the management/restoration of existing landfills in the next year. The Vietnam Environment Agency's Waste Management and Promotion Agency (WEPA) within MONRE has been mandated to establish regulations targeting landfill-related methane emissions.

7.3. INSTITUTIONAL FRAMEWORK AND STAKEHOLDERS

In Vietnam, the responsibility for waste management is organized according to the sector generating the waste, and as such reporting of data is tied to the line ministries responsible for those sectors. The MOC is responsible for municipal solid waste management and for managing most of Vietnam's landfills. MONRE manages the remaining municipal landfills that have been designated as unsanitary and will be phased out. MOC has the mandate to formulate plans and legislation related to landfills. The Ministry of Industry and Trade is responsible for industrial waste, and it directs, inspects, and supervises compliance with industrial waste management regulations, and coordinates with waste disposal units regarding the disposal of industrial waste. The Ministry of Health is responsible for hospital waste, while MARD is in charge of waste in the agriculture sector in rural areas. MPI provides funding to government agencies and localities to implement waste management plans and offers economic incentives to facilitate waste management activities. The Urban Environment Company (URENCO) is the main company in charge of waste collection, transport, and treatment in provinces and cities. URENCO is often solely responsible for the management and operation of landfills. Table 9 describes the functions and reporting roles of the organizations involved in managing waste in Vietnam.

[71] Vietnam's National Climate Change Strategy, Decision 2139/QD-TTg, December 5, 2011.

TABLE 9. ORGANIZATIONS INVOLVED IN WASTE MANAGEMENT AND REPORTING

Organization	Role/Activity
Ministry of Construction (MOC)	• Responsible for municipal solid waste management in the provinces and in economic zones and formulation of planning for waste management. • Mandated to collect data and to report on solid waste indicators tracked by GSO. • Initiates surveys and monitoring of landfills, including by preparing a questionnaire and sending it to the Departments of Construction (DOCS). The ministry will also provide training as needed for implementing surveys.
Departments of Construction (DOCs) in each of the 63 provinces/cities	• DOCs are departments under the PPCs. The DOCs report directly to the MOC. They contract the CPCs that manage landfills, but have no direct administrative power to instruct the CPCs. In cases where the landfill is directly under the PPC and not the CPC, then the DOC will directly contact the PPC. • When conducting surveys, the DOCs will send the questionnaire to the CPC (or the PPC).
Provincial People's Committee (PPC) in each province	• The PPC is the provincial government. In some cases, the landfill operator is directly under the PPC. • When conducting surveys, the PPC will instruct the landfill operator to complete the questionnaire.
City People's Committee (CPC) in each town	• The CPC is the town administration. In some cases, the landfills are directly under the CPC. • When conducting surveys, the CPC will instruct the landfill operators to complete the questionnaire.
Landfill operators (URENCO, private entity) in each province	• Responsible for operating the landfills and collecting and transporting solid waste to the landfills. They report directly to the CPC or the PPC, but within these organizations the reporting line can differ. In Ho Chi Minh City, for example, URENCO operates under the Department of Natural Resources and Environment (DONRE). In Hanoi, it operates under the DOC. Moreover, all provincial landfill operators belong to the Association of the Urban Environment, which is under the authority of MOC.
Ministry of Natural Resources and Environment (MONRE)	• Formulates policies and strategies, issues guidelines, and develops regulations and standards on waste management in coordination with other ministries. Decides priorities for citing new landfills, issues a list of hazardous wastes, and is licensed to treat hazardous wastes. • Is responsible for managing landfills that have been designated as unsanitary and must be phased out. • Prepares the annual State of the Environment Report, which includes data from MOC on waste management. • Coordinates reporting on waste indicators to GSO. • Initiates surveys and monitoring of landfills, including by preparing a questionnaire and sending it to DONRE. The ministry will also provide training as needed for implementing surveys.

Organization	Role/Activity
Department of Natural Resources and Environment (DONRE) in each province	• Is responsible for formulating, implementing, and monitoring waste policies at the province level. • Supports MONRE with data collection for reporting on environmental performance and works with the PPC and CPCs as needed to obtain information.
Ministry of Planning (MPI)	• Determines the annual budget for waste management.
General Statistics Office (GSO)	• Housed within MPI, GSO is responsible for reporting on national statistical indicators, which include two indicators related to waste.
Ministry of Science and Technology (MOST)	• Researches and reviews new technologies for landfill management.
Ministry of Health (MOH)	• Is responsible for managing hospital waste.
Ministry of Defense	• Is responsible for management military waste.
Ministry of Agriculture and Rural Development (MARD)	• Is responsible for managing agricultural waste.
Ministry of Industry and Trade (MOIT)	• Responsible for managing industrial waste.

Source: AILEG team conversations with GVN representatives; Ministry of Construction and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, *A Monitoring System for the Wastewater and Solid Waste Sectors in Vietnam: Documentation of GIZ Support to the Ministry of Construction (2007-2011)*, GIZ Project Document No: C1-001, Edition 01, Hanoi, March 2012; and L.H. Viet, N.V.C Ngan, N.X. Hoang, D.N. Quynh, W. Songkasiri, C. Stefan and T. Commins, "Legal and Institutional Framework for Solid Waste Management in Vietnam," *Asian Journal on Energy and Environment,* 2009 (10(04), 261-272.

MONRE, as the central agency responsible for environmental affairs, plays an important role in waste management. It formulates policies and strategies, issues guidelines, and develops regulations and standards on waste management in coordination with other ministries.[72] MONRE would also be responsible for formulating mitigation actions in the waste sector, but currently the ministry is not involved in such activities.

At the local level, the PPCs—the executive branch of the People's Council—has several waste management responsibilities in the provinces including the direction of Transport and Public Works Service and URENCO in organizing waste collection, transport, and treatment. PPCs also approve waste treatment projects in their localities and implement state management regulations. The Departments of Construction, which are provincial-level bodies working within the PPCs but also reporting directly to the MOC, supervise implementation of urban master plans and organize the design and construction of landfill projects. Similarly, DONRE, which works under MONRE, manages and implements waste management policies and regulations.

Among the donors, GIZ recently provided support to MOC to recommend a monitoring and reporting system for wastewater in Vietnam. The pilot study was conducted through 2008 to 2010 and focused on wastewater, with a small component related to identifying reporting indicators for solid waste. With World Bank support, MOC is planning to implement a full review of its wastewater utilities. The key output is a survey followed by a technical report on the performance of the wastewater sector with a focus on wastewater collection, treatment, and disposal facilities built over the past decade. This project is intended as a first step in developing indicators for wastewater management as well for evaluating the

[72] Viet et al., "Solid Waste Management in Vietnam," 261-272.

management systems themselves. The process for developing a survey and data management system for solid waste would be fairly similar, and could potentially be developed and implemented by MOC at a later stage. Responding to the GVN's new focus on waste, the World Bank is also exploring options to support LEDS analysis for the waste sector and is expanding its upcoming EFFECT modeling effort to include this sector.

7.4. TECHNICAL ASSESSMENTS TO SUPPORT LEDS

To date, little work has been done to assess waste-related emissions or mitigation potential. Activity data are lacking to generate robust emission estimates and technical potential, and cost of mitigation options will need to be generated in order to analyze abatement scenarios for this sector. MONRE conducted some work to identify mitigation options in the waste sector with assistance from the World Bank's Carbon Finance Assist program.[73] However, Vietnam's Second National Communication does not present GHG mitigation options for the waste sector, except for a few related to agricultural waste that were captured under the agriculture sector. This is largely attributable to the sector's small contribution to overall GHG emissions.

Going forward, it is expected that low-emission policy analysis for this sector will be undertaken since Vietnam's National Climate Change Strategy and the Green Growth Strategy include the waste sector. Stakeholders in both MONRE and MOC have requested support for strengthening their capability to assess low-emission options in this sector.

7.5. DATA COLLECTION AND MANAGEMENT

Several ministries have jurisdiction over data collection and management of waste in Vietnam. The Vietnam Environment Agency's WEPA within MONRE has primary responsibility for waste management and the protection of water basins. Currently, the agency collects some monthly and annual data on household, health, and industrial waste in some areas, but the data are incomplete and have some accuracy issues. In general, ministries of the originating sector are responsible for reporting on waste generated by their sector. In the absence of any regulation, MONRE is responsible for collecting data from these ministries. As indicated in Annex D, GSO is also tracking several indicators related to waste and is relying on MOC, MONRE, and the provinces to provide the requisite data. The MOC is in charge of all urban waste and most landfills. However, local governments (i.e., PPCs and CPCs) have immediate control over the landfills, so the MOC works through the provincial-level DOCs to communicate with the landfill operators.

The MOC has been charged with collecting the requisite data for reporting on GSO's indicators related to solid waste. However, it has not yet developed a system for supporting full reporting on these, and is under pressure from GSO and MPI to do so. When conducting its current surveys of landfills, the MOC will contact the Departments of Construction in the provinces, which will contact the PPC or CPC. The PPC or CPC will then instruct the landfill operators to fill any relevant questionnaires, or will query the landfill operators in order to complete the surveys themselves. Using this approach, the MOC conducts annual surveys of landfill waste that are reported in the State of the Environment Report. MOC has data on solid waste volumes going back to 2003, but they are incomplete. As many as 50 of the 63 provinces/cities either report incomplete data or no data at all. Moreover, data are not reported on

[73] MONRE, "Vietnam Greenhouse Gas Mitigation Waste Sector," Paper 58030, World Bank Carbon Assist, undated.

solid waste composition and landfill depth, which are some of the key inputs needed to estimate GHG emissions. MOC can disaggregate the solid waste stream by broad sectors—household, industry—but not more finely than that. By virtue of being responsible for the implementation of CDM projects, MOC does have some information on the potential for GHG offset projects that can be useful for developing mitigation options. Furthermore, MOC has spatially referenced Geographic Information System (GIS) data on the location of landfills for 50 provinces.

URENCO is expected to have administrative records that include information on solid waste volumes collected and deposited at landfills. At a majority of landfills, URENCO weighs the trucks before they unload their waste. These data are a potential source of information on waste volumes and waste composition, but it is not clear to what extent URENCO tracks this information internally and whether MOC has the ability to access these data. MOC did note that URENCO is required to report waste landfilled to provincial offices. However, insofar as getting the data from provinces is difficult, accessing the data continues to be a constraint.

A few initiatives are underway that could help improve data availability, quality, and completeness going forward. MONRE is working to establish a centralized database for solid waste management by 2014. The database will cover all the landfills in the country and utilize the GIS capabilities of MONRE's Center for Environmental Monitoring. It is envisaged that the database would track waste volumes as well as composition. However, this project is still in its initial phases, and MONRE has not yet designed a process for obtaining this data.

MONRE is also working on a law to streamline and clarify who is responsible for data collection, and to outline responsibilities with respect to the planned database. A draft is expected in the summer of 2012 with potential technical support from the U.S. Environmental Protection Agency. If the proposal fails to get approved, MONRE will design the proposed data management system based on current reporting structures.

7.6. PRIORITIES FOR IMPROVING DATA AND RECOMMENDATIONS

Notwithstanding the aforementioned initiatives, there is general consensus among stakeholders that data collection and management for the solid waste sector needs improvement and that the technical capabilities for analyzing low-emission strategies can be strengthened. The recommendations for potential data collection and management strengthening expressed by the GVN and other stakeholders are presented below.

7.6.1. GHG EMISSION INVENTORY DATA

Timely access to complete and accurate data on solid waste volume and composition as well as information on landfill depth and management remains a challenge. Emission factors for waste are not country-specific, but robust activity data on waste volume and composition and landfill depth are necessary in order to generate a reliable estimate of GHG emissions. The responsibility for data collection for the waste sector is split among several ministries along with the responsibility for managing the waste once it is landfilled. As mentioned above, provinces report data on industrial waste to MOIT and household waste to MOC. Currently, most provinces report on total amounts of waste generated and landfilled; however, they do not always report on the specific amounts sent to each landfill, nor do they report the composition of the waste. The MOC survey on wastewater conducted

with GIZ support in 2010 revealed that provinces' capacity to report data is fairly low. It is expected that data collection for solid waste would be met with similar institutional challenges.

MONRE and MOC have both indicated that they would like support in improving data collection and management for the waste sector, so that the data are available for developing GHG emission inventories, analyzing abatement options, and establishing NAMAs and LEDS policies for the waste sector. This would include a regular and systematic data collection process, digitization of data, and the development of databases that are easily accessible by all ministries. It would also include an improved legal mandate for collecting data and analyzing abatement options. These and other recommendations are outlined in Figure 18.

FIGURE 18: RECOMMENDATIONS FOR WASTE SECTOR EMISSION DATA

1. **More robust waste sector activity data, including waste volume and composition by landfill.**
2. **Development of a publicly available management system for tracking and reporting of activity data.**
3. **Clear legal guidance on the roles and responsibilities of MONRE, MOC and GSO** in terms of solid waste sector data collection and management and the ability to analyze and implement low-emission strategies.

7.6.2. ANALYSIS OF MITIGATION OPTIONS AND TECHNICAL SUPPORT

Among MONRE and MOC stakeholders, there is significant interest in strengthening the GVN's technical capabilities for analyzing, implementing, and mandating low-emission strategies in the solid waste sector. MOC requested support for the development of a low-emission strategy for the solid waste sector and with incorporating the necessary GHG reporting indicators into its legal and monitoring frameworks. MOC would also like more information on NAMAs, including information on how these could be established in the waste sector.

Over the next year, MONRE and MOC are planning to update the 2007 Decree related to management of household waste and waste water (Decree 59; Strategy 2149), and would like support in updating the decree to address the current situation by analyzing low-emission strategies and getting an understanding of best waste management practices in the United States and other countries. This includes technical advice on better treatment methods for methane emissions; waste reduction, recycling, and composting initiatives; and incineration methods. They would also like advice and analysis of options for attracting investors to landfill treatment projects. Staff from WEPA in MONRE visited USEPA in June 2012 to learn more about best practices in the United States. WEPA has not yet started examining abatement options in this sector and would welcome support in this area.

Some of MOC's landfills are affected by drainage from flooding and sea level rise, and MOC is interested in best practices for making its landfills more resilient, including suggestions for how resilient landfill management and construction practices can be incorporated into the revised decree for waste management.

Finally, MPI is working on the development of a Green Growth Strategy that will also address the waste sector. The Ministry was interested in technical support for the development and implementation of strategies to ensure that the overall waste reduction, recycling, and landfill management goals are met.

Figure 19 shows recommended measures to strengthen analytic capabilities for low-emission planning in the waste sector.

FIGURE 19: RECOMMENDATIONS FOR WASTE SECTOR ANALYSIS

1. **Support development of low-emission waste policy,** including updates to the decree on waste management for MONRE and MOC.
2. **Develop MAC curves for abatement activities** in the solid waste sector in order to facilitate low-emission analysis and scenario planning.
3. **Incorporate GHG indicators into MOC's and GSO's legal mandates and monitoring frameworks.**
4. **Explore waste management best practices, including emission reduction options and flood resilience practices that could be applied in Vietnam**. These could be included in forthcoming updates to the 2007 Degree on the management of household waste and waste water (Decree 59; Strategy 2149).
5. **Develop a strategy to attract investors to landfill treatment projects.**
6. **Provide technical support in building an information system** that would track landfill management data and support the analyses and implementation of mitigation projects.

8. CONCLUSIONS

The GVN has expressed a detailed set of data collection and management needs to enhance its LEDS analytics and policy development. These recommendations, which are summarized in Table 10, emerged from extensive interviews with key GVN ministries and other stakeholders conducted by AILEG in the spring of 2012. A clear message is that there is a need for more country-specific activity data and emission factors and capacity building of data collection and management systems. In addition, enhanced coordination and data sharing across the GVN stakeholders and expanded legal mandates for data collection were also identified as priority areas for Vietnam.

During the next phase of AILEG support in Vietnam, AILEG in collaboration with the GVN looks to focus on improving data collection and management in the agriculture and waste sectors, exploring the expansion of legal mandates to make sure the requisite LEDS data are collected and shared and training on LEDS. Specifically, AILEG plans to provide capacity-building assistance to the GVN in:

- **Data Collection and Economic Analysis for the Agriculture Sector:** Conducting a pilot survey involving the use of ICT to collect finer-scale activity data on rice cultivation and livestock production, creating a web database, modeling rice emissions across management systems, conducting economic analysis of mitigation options in the agriculture sector and developing MAC curves, and analyzing the financial viability of methane capture and energy generation in the country.
- **Feasibility Study for Municipal Solid Waste Data Collection and Management:** Assessing the feasibility of a data collection system for waste volume and composition at each solid waste landfill and the potential for using ICT and the creation of a database that would be accessible by various ministries and the general public.
- **Legal and Technical Support for the Incorporation of GHG Indicators and LEDS Data Collection in GVN Mandates:** Defining the critical GHG indicators and LEDS data that need to be collected in Vietnam, working with legal experts in Vietnamese law to review the legal mandates of the various ministries and exploring legal avenues (e.g., National Assembly laws and decrees) to increase the mandates, establishing a GHG Indicators Working Group, and conducting a workshop on NAMAs.

AILEG expects to launch this technical assistance in September 2012 through July 2013 with USAID funding and GVN collaboration. This activity will work closely with GVN ministries, local institutes, USAID, and the donor community to support LEDS assessment, preparation, and implementation in Vietnam.

TABLE 10: RECOMMENDATIONS FOR LEDS DATA COLLECTION, MANAGEMENT, AND ANALYSIS IN VIETNAM

LEDS Component	Sector/Recommendations			
	Economy-Wide	**Agriculture**	**Energy**	**Waste**
Data Collection and Management	• Clearer ministerial mandates and GSO oversight of LEDS data collection and reporting • A strengthened legal framework and mandate for data collection and sharing • Standardization of GHG estimation methods and assumptions • Coordination among ministries to identify and address data needs • Increased access to publicly available LEDS data repositories	• Conduct a granular review of what, when, and how data are currently being collected in the agricultural sector • Design a system to collect and manage activity data • Derive Vietnam-specific emission factors and gather more precise data on agricultural activity and how rice and livestock management systems vary across the country	• An annual process for developing national electricity generation emission factors • Improve emission factors for coal • Recommend options for updating energy sector data and standardizing the use of these data in national plans	• More robust waste sector activity data, including waste volume and composition data from each landfill • Clarified roles and responsibilities of MONRE and MOC
Analysis	• Avoid duplicating the efforts of multiple donors already supporting economy-wide economic assessments • Provide support for improved sector data rather than CGE modeling, according to GVN priorities	• Build on MPI's ongoing work to refine a MAC curve for the agriculture sector • Analyze the potential for mitigation options in the rice cultivation and livestock management sectors using the MAC curves generated above • Conduct financial analysis for methane capture • Review the legal framework to provide recommendations to expand the mandate of MARD for collecting LEDS data	• Develop a full energy system model • Develop benchmark activity data for large and medium-sized buildings • Design a public database and/or website housing results of existing energy sector studies	• Develop a low-emission waste policy and support for the decree on waste policy for MOC • Incorporate GHG indicators into MOC's legal mandates and monitoring • Develop a MAC curve for the waste sector reflecting technical mitigation potential and analyze the potential for mitigation options

ANNEX A: AILEG CONSULTATIONS

TABLE A.1: AILEG INTRODUCTORY WORKSHOP PARTICIPANT LIST – HANOI, MARCH 29, 2012

	Date	Name, Title	Organization
1	Tiziana Smith	Climate Change Research Assistant	World Bank
2	Patrick Smith	Climate Change Advisor	USAID
3	Richard Nyberg	Communication Advisor	USAID
4	Taylor Tinney	Environmental & Science Officer	U.S. Embassy
5	Koos Neefjes	Policy Advisor	UNDP
6	R. R. Smith	GIS Analyst	Grays Harbor County, Washington State, USA
7	Takako Ono		JICA
8	Pham Thu Hien		JICA
9	Tong Vo Le Ha	Officer	Planning Department, MONRE
10	Dao Minh Trang	Researcher	Institute of Meteorology and Hydrology and Climate Change, MONRE
11	Tran Dai Nghia	Vice Director	Information Center, Institute of Strategy and Policy on Natural Resources and Environment, MONRE
12	Pham Thi Thuy	Officer	Center for Environmental Monitoring, MONRE
13	Nguyen Thuy Duong	Project Officer, Green Industry project	UNIDO
14	Phan Sy Hieu		Statistics and Informatics Center for Agriculture and Rural Development, MARD
15	Nguyen Manh Hai	Vice Director	Central Institute for Economic Management, MPI
16	Bui Ngoc Tu	Officer	Department of Trade and Services, GSO
17	Nguyen Thi Dieu Trinh	Officer	Department of Science Technology, Education and Environment, MPI
18	Vu Thi Hang	Officer	Institute of Environment and Agriculture, MARD
19	Chu Tuan Anh		MONRE
20	Quach Tat Quang	Director	Center for Ozone Layer Protection, Department of Meteorology and Hydrology and Climate Change, MONRE
21	Tran Thu Huyen	Officer	Center for Ozone Layer Protection, Department of Meteorology and Hydrology and Climate Change, MONRE
22	Nguyen Thanh Ha	Program Officer	JICA
23	Do Thi Ngat	Officer	Institute of Statistical Science, GSO
24	Truong Dac Tri	Deputy Director	Department of Meteorology and Hydrology and Climate Change, MONRE
25	Le Tuan Anh	Officer	MARD
26	Bui Thi Phuong Loan	Vice Director	Modeling, Institute of Agricultural Environment, MARD
27	Doan Ngoc Chanh	Officer	GSO
28	Nguyen Thu Trang	Officer	GSO

	Date	Name, Title	Organization
29	Nguyen Thi Viet Nga	Officer	Social and Environmental Statistics Department, GSO
30	Than Viet Dung	Officer	Social and Environmental Statistics Department, GSO
31	Nguyen Thanh Tu	Officer	Social and Environmental Statistics Department, GSO
32	Nguyen Thi Bich Phuong	Officer	Social and Environmental Statistics Department, GSO
33	Nguyen Ngoc Hai	Vice Director	Development Strategy Institute, MPI
34	Nguyen Phong	Director	Social and Environmental Statistics Department, GSO
35	Vu Thi Thu Thuy	Statistic Officer	Social and Environmental Statistics Department, GSO
36	To Thuy Hanh	Officer	Social and Environmental Statistics Department, GSO
37	Nguyen Duc Hanh	Officer	Social and Environmental Statistics Department, GSO
38	Nguyen Thi Hon	Officer	Social and Environmental Statistics Department, GSO
39	Ngo Nhu Ve	Officer	GSO
40	Pham Minh Tien	PA	JICA
41	Nguyen Truong Huynh	Officer	Vietnam Environment Administration, MONRE
42	Michael Westphal	Senior Associate	Abt Associates Inc.
43	Jette Findsen	Senior Associate	Abt Associates Inc.
44	Tulika Narayan	Senior Associate	Abt Associates Inc.

TABLE A.2: LIST OF MEETINGS CONDUCTED DURING THE AILEG MISSION – HANOI, MARCH 21–APRIL 6, 2012

	Date	Name, Title	Organization
1	March 21, 2012	Land Use Models, LEDS, and Future Scenarios (Workshop)	Alex de Pinto (IFPRI), Michiel van Dijk (LEI – Wageningen). A number of donors, including Henk Hilderink (Netherlands Environment Assessment Agency), Nguyen Van Kien (DFID), Vu Minh Duc (Norwegian Embassy), Hoang Thanh (EU)
2	March 27, 2012	Green GDP Workshop	Central Institute of Economic Management
3	March 28, 2012	Ms. Vu Thi Thu Thuy	Social and Environmental Statistics Department General Statistics Office, MPI
4	March 28, 2012	Tran Hong Viet, Climate Change Program Manager	Embassy of Denmark
5	March 30, 2012	Buu Tat Thang	Development Strategy Institute, MPI
		Phan NGOC Mai Phuong, MDM, Vice President	Development Strategy Institute, MPI
		Tran Anh Tuan, Researcher – Vice Director	Department of Information and International Relations, Development Strategy Institute, MPI
		Nguyen Ngoc Hai, Deputy Director	Department of Territorial Research and Development, Development Strategy Institute, MPI
6	March 30, 2012	Bui Thi Phuong Loan, Vice Chair of Department	Institute for Agricultural Environment, MARD
7	March 30, 2012	Mr. Andrea Cattaneo, Senior Economist, Agricultural Development Economics Division, and Climate Smart Agriculture Project Leader	Food and Agriculture Organization, UN
		Ms. Leslie Lipper, Senior Environmental Economist, Agricultural Development Economics Division, and EPIC Program Leader	Food and Agriculture Organization, UN
		Ms. Wendy Mann, Senior Policy Advisor, Climate Smart Agriculture	Food and Agriculture Organization, UN
		Ms. Aslihan Arslan, Natural Resource Economist, Climate Smart Agriculture Project	Food and Agriculture Organization, UN
8	March 30, 2012	Nguyen Manh Hai, Vice Director	Central Institute for Economic Management, MPI
9	March 30, 2012	Dr. Hoang Tien Dung, Directorate General	Institute of Energy, MOIT
		Dr. Tuan A. Nguyen, Director, International Relations	Institute of Energy, MOIT
		Tran Manh Hung, Head of Energy Economic, Demand Forecast, and Demand Side Management	Institute of Energy, MOIT
10	April 2, 2012	Lauren Sorkin, Country Specialist	Vietnam Office, Asian Development Bank
11	April 3, 2012	Laura Altinger, Senior Economist	Vietnam Office, World Bank

	Date	Name, Title	Organization
12	April 3, 2012	Nguyen Thuong Hien, Vice Director	Waste Management and Environment Promotion Agency, Vietnam Environment Administration, MONRE
		Nguyen Thanh Lam	Division of Non-Hazardous Waste, Waste Management and Environment Improvement Department, Vietnam Environment Administration, MONRE
13	April 3, 2012	Nguyen Van Thuy, Acting Director	Center for Environmental Monitoring, Vietnam Environment Administration, MONRE
		Nguyen Thuy Quynh, Database and Information System Division	Center for Environmental Monitoring, Vietnam Environment Administration, MONRE
		Pham Thi Vuong Linh	Air Group, Center for Environmental Monitoring, Vietnam Environment Administration, MONRE
14	April 4, 2012	Pham Xuan Luong, Statistician	Social and Environmental Statistics Department, General Statistics Office
		Phi Thi Thiang Nga	Department of Construction and Investment, General Statistics Office
		Lo Thi Nhung	Department of Industry, General Statistics Office
		Nguyen Dieu Huyen	Department of Systems of National Accounts, General Statistics Office
15	April 4, 2012	Takako Ono, JICA Chief Advisor, Project for Capacity Building of National Greenhouse Gas Inventory in Vietnam	JICA
		Nguyen Khac Hieu, Vice Chairman, Deputy Director General	National Steering Committee for Climate Change, Institute of Meteorology, Hydrology, and Climate Change, MONRE
		Nguyen Van Huy	Department of Integrated Research, Institute of Strategy and Policy on Natural Resources and Environment, MONRE
		Dao Minh Trang, Researcher	Climate Change Research Center, Institute of Meteorology, Hydrology and Environment, MONRE
		Tran Thi Bich NGOC, Climate Change Division Official	Institute of Meteorology, Hydrology and Climate Change, MONRE
		Dang Quang Thinh, Head of Division for Climate Change Adaptation	Institute of Meteorology, Hydrology and Environment, MONRE
		Quach Tat Quang, Acting Director	Center for Ozone Layer Protection, Department of Meteorology and Hydrology and Climate Change, MONRE
		Nguyen Lahn, Head	Department of Climate Change, Marine, and Islands, Institute of Strategy and Policy on Natural Resources and Environment, MONRE
16	April 4, 2012	Kathryn Elliott, First Secretary	AusAID
		Nguyen Quoc Viet, Senior Program Manager	AusAID
17	April 4, 2012	Nguyen Trung Hoa, General Director	Department of Science, Technology, and Environment, MOC
		Nguyen Cong Thinh, Expert	Department of Science, Technology, and Environment, MOC
18	April 4, 2012	Koos Neefjes	UNDP Vietnam
19	April 5, 2012	Mai Van Trinh, Deputy Director General, Head of Environmental Modeling and Information Department	Institute for Agricultural Environment, MARD

	Date	Name, Title	Organization
		Le Hoang Ahn, Senior Officer	Department of Science, Technology, and Environment, MARD
20	April 5, 2012	Quach Tat Quang, Acting Director	Center for Ozone Layer Protection, Department of Meteorology and Hydrology and Climate Change, MONRE
21	April 5, 2012	Le Tuan Phong, Deputy Director General	General Directorate of Energy, Ministry of Industry and Trade
22	April 5, 2012	Nguyen Thi Dieu Trinh, Official	Department of Science, Education, Natural Resources and Environment, MPI
		Mr Nguyen Tuan Anh, DNPD	Department of Science, Education, Natural Resources and Environment, MPI
		Mr. Tim Suljada	UNDP
		Mr. Johan Kieft Technical Specialist, Climate Change and Sustainable Development	UNDP
23	April 6, 2012	Tapio Leppänen, Chief Technical Advisor	Niras Finland Oy, embedded in Vietnam Administration of Forestry
24	April 6, 2012	Steve Jaffe, Rural Development Sector Coordinator	Vietnam Office, World Bank
25	April 6, 2012	Ms. Vu Thi Thu Thuy	Social and Environmental Statistics Department, General Statistics Office, MPI
		Ms. Minh	Department of Agriculture, Forestry and Aquaculture, General Statistics Office, MPI
26	April 6, 2012	Mr. Dang Quang Thinh, Head of Division for Climate Change Adaptation	Climate Change Research Center, Institute of Meteorology, Hydrology and Environment, MONRE
27	April 6, 2012	Le Ngoc Thang, Deputy Head of Department, Department of Environmental Technology	Centre for Environmental Consultancy and Technology, Vietnam Environment Administration, MONRE
28	April 6, 2012	Nguyen Thanh Tung, Official	International Cooperation Department, Ministry of Construction
		Nguyen Van Hoa Binh, Vice Director	Administration of Technical Infrastructure, Ministry of Construction
		Pham Khanh Toan, PhD, Director General	International Cooperation Department, Ministry of Construction
29	April 6, 2012	Dr. Tuan A. Nguyen, Director, International Relations	Energy Institute, MOIT

TABLE A.3: AILEG STAKEHOLDER WORKSHOP PARTICIPANT LIST – HANOI, JUNE 13, 2012

	Name	Title	Organization
1	Jay Kryk		USAID
2	Tran Chinh Khuong		USAID
3	Nguyen Thi Lien Huong		National Center for Agricultural Extension, MARD
4	Phạm Quang Hà	Deputy Director	Institute of Agricultural Environment, MARD
5	Do Anh Kiem	Director	Social and Environmental Statistics Department, GSO
6	Vu Thi Thu Thuy	Vice Director	Social and Environmental Statistics Department, GSO
7	Nguyen Ngoc Hai	Vice Director	Development Strategy Institute, MPI
8	Hiroshi Tsujihara	JICA Expert	MONRE
9	Johan Kieft		UNDP
10	Ms. Jane Hughes	Director	Environmental Defense Fund
11	Doan Ngoc Pha	Deputy Director	An Giang Department of Agriculture and Rural Development
12	Nghiem Dinh Thuan	Director	Department of Agricultural Extension, Bac Ninh Province
13	Ngo Van Tue	Head of General Coordination Office	Department of Agricultural Extension, Bac Ninh Province
14	Tran Xuan Dan	Head of Technical Office	Department of Agricultural Extension, Bac Ninh Province
15	To Hai Long		Development Strategy Institute, MPI
16	Le Duc Chung	Expert	Project under the Department of Science Technology, Education and Environment, MPI
17	Le Thanh Xuan	Director	General Office of Land Administration, MONRE
18	LeTuan Anh		Statistics Office, MARD
19	Vu Duc Chinh	Officer	MONRE
20	Bui Trong Tu		Trade and Service Statistics Department, GSO
21	Hoang Thai Ninh		MARD
22	To Thuy Hanh		Social and Environmental Statistics Department, GSO
23	Quach Tat Quang	Director	Center for Ozone Layer Protection, Department of Meteorology, Hydrology and Climate Change, MONRE
24	Ha Hai Ly	Officer	Statistical Center, MARD
25	Nguyen Truong Huynh	Officer	MONRE
26	Nguyễn Thu Trang	Officer	GSO
27	Do Thi Ngat	Officer	Institute of Statistical Science, GSO
28	Pham Thi Thuy	Officer	Center for Environmental Monitoring, MONRE
29	Dang Quang Thinh	Deputy Director	Division for Climate Change Adaption, Climate Change Research Center, Institute of Meteorology, Hydrology and Environment, MONRE
30	Nguyen Thi Hon	Officer	Social and Environmental Statistics Department, GSO
31	Nguyen Thuy Quynh	Officer	Vietnam Environment Administration, MONRE
32	Nguyen Manh Hai	Vice Director	Central Institute for Economic Management (CIEM), MPI
33	Nguyen Thi Hong Lieu	Deputy Director	Waste Management Administration, Vietnam Environment Administration, MONRE
34	Bùi Thị Phương Loan	Vice Director	Modeling, Institute of Agricultural Environment, MARD
35	Tran Thi Minh	Statistician	Department of Agriculture, Forestry and Aquaculture, GSO
36	Kim Van Chinh	Researcher	Institute of Policy and Strategy for Agriculture and Rural Development, MARD
37	Nguyen Thanh Ngoc	Officer	Social and Environmental Statistics Department, GSO
38	Ngo Nhu Ve	Officer	Social and Environmental Statistics Department, GSO
39	Nguyễn Thị Việt Nga	Officer	Social and Environmental Statistics Department, GSO
40	Ngo Duc Hanh	Officer	Social and Environmental Statistics Department, GSO
41	Nguyễn Thanh Tú	Officer	Social and Environmental Statistics Department, GSO
42	Nguyen Dieu Huyen	Officer	National Statistics System Department, GSO

	Name	Title	Organization
43	Dao Minh Trang	Researcher	Institute of Meteorology and Hydrology and Climate Change, MONRE
44	Bui Hong Phuong (Ms.)	MPI-UNDP Strengthening Sustainable Development and Climate Planning Project	UNDP
45	Nguyen Thanh Ha	Program Officer	JICA
46	Pham Thi Thanh Thuy	Director	Department of Environment and Development, AIT – Vietnam
47	Pham Xuan Luong	Officer	Social and Environmental Statistics Department, GSO
48	Nguyen Thi Bich Phuong	Officer	Social and Environmental Statistics Department, GSO
49	Võ Thanh Sơn	Officer	Social and Environmental Statistics Department, GSO
50	Hồ Thị Kim Nhung	Officer	Social and Environmental Statistics Department, GSO
51	Cao Thanh Sơn	Officer	Social and Environmental Statistics Department, GSO
52	Tô Thúy Hạnh	Officer	Social and Environmental Statistics Department, GSO
53	Nguyễn Đức Hạnh	Officer	Social and Environmental Statistics Department, GSO
54	Nguyen Thi Hon	Officer	Social and Environmental Statistics Department, GSO
55	Michael Westphal	Associate	Abt Associates
56	Jette Findsen	Associate	Abt Associates
57	Tran Hong Nguyen	Consultant	
59	Nguyen Lanh	Consultant	
60	Pham Que Anh	Coordinator	Center for Research on Family Health and Community
61	Tran Vu Diem Hang	Operations Officer	
62	Nguyen Lan Anh	Operations Officer	
63	Dang Hong Diem	Senior Assistant	
64	Bui Ngoc Trang	Operations Officer	

TABLE A.4: LIST OF MEETINGS CONDUCTED DURING THE AILEG MISSION – HANOI, JUNE 10 – 16, 2012

	Date	Name, Title	Organization
1	June 11, 2012	Vu Thi Thu Thuy (Ms.)	Social and Environmental Statistics Department, General Statistics Office, MPI
2	June 12, 2012	Laura Altinger, Senior Economist	Vietnam Office, World Bank
3	June 14, 2012	Nguyen Ngoc Duong, Expert	Administration of Technical Infrastructure, Division of Environment, MOC
4	June 14, 2012	Vu Thi Thu Thuy (Ms.)	Social and Environmental Statistics Department General Statistics Office, MPI
5	June 15, 2012	Nghiem Dinh Thuan, Director	Statistics Office, Bac Ninh Province
6	June 15, 2012	Nghiem Dinh Thuan, Director	Department of Agricultural Extension, Bac Ninh province
		Ngo Van Tue, Head of General Coordination Office	Department of Agricultural Extension, Bac Ninh province
		Tran Xuan Dan, Head of Technical Office	Department of Agricultural Extension, Bac Ninh province

ANNEX B: ECONOMY-WIDE MODELS FOR CLIMATE POLICY ANALYSIS USED IN VIETNAM

TABLE B.1: ECONOMY-WIDE MODELS FOR CLIMATE POLICY ANALYSIS

Name	Type	Source	Users	Analytical Purpose	Input Data
VIPAG	Dynamic CGE; Implemented in GEMPACK	Centre of Policy Studies, Monash University	DSI	Examine macroeconomic effects of sector-specific policies	National SAM; elasticities; sector-specific mitigation costs
IFPRI Standard CGE model	CGE; Implemented in GAMS	IFPRI	CIEM	Examine macroeconomic effects of sector-specific policies	• National SAM; elasticities; sector-specific mitigation costs • VHLSS household data for modeling poverty impacts • GTAP data for modeling regional trade and competitiveness impacts
CNAM (CIEM-Nordic Institute of Asian Studies (NIAS) Analytical Model)	Dynamic CGE; Implementation method unknown	CIEM	CIEM	Examine macroeconomic effects of sector-specific policies	National SAM; elasticities; sector-specific mitigation costs
GTAP Model	Multi-Region CGE; Implemented in GEMPACK and in GAMS	Purdue University	Researchers from universities in Vietnam	Examine regional trade and competitiveness effects of national policies	GTAP database; national sector-specific mitigation costs

Name	Type	Source	Users	Analytical Purpose	Input Data
ICES (Intertemporal Computable Equilibrium System)	Dynamic CGE; Implemented in GEMPACK	Climate Change Modeling and Policy Research Programme of the *Fondazione Eni Enrico Mattei*	CIEM	Examine world macroeconomic effects of climate change, with flexible regional and sector aggregations	GTAP database and GTAP-E core structure; agricultural land productivity derives from the IMAGE model by IFRPI; future population growth rates are taken from World Bank statistics; changes in regional labor supply and productivity are estimated by running the G-Cubed model

Abbreviations and acronyms used:

CGE – Computable General Equilibrium
CIEM – Central Institute of Economic Management
DFID – UK Department for International Development
DSI – Development Strategy Institute
GEMPACK – General Equilibrium Modeling PACKage
GAMS – General Algebraic Modeling System
GTAP – Global Trade and Analysis Project
IFPRI – International Food Policy Research Institute
SAM – Social Accounting Matrix
VHLSS – Vietnam Living Standard Survey

ANNEX C: SECTOR-SPECIFIC MODELS USED IN VIETNAM

ENERGY SECTOR MODELS

TABLE C.1: ENERGY SECTOR MODELS AND TOOLS USED IN VIETNAM

Name	Type	Source	Users	Analytical Purpose	Input Data
MARKAL (MARKet Allocation Model)	Linear optimization model for integrated energy-environmental analysis. Models both supply and demand.	Developed by the International Energy Agency (ESTAP). Available for a fee (depending on type of institution).	Institute of Energy (IE), universities	Exploring energy supply options, the energy price impacts of environmental policy, competitiveness of energy technologies, the energy system costs of GHG mitigation policies. Useful at range of scales: city to multi-country.	Energy costs, plant costs, plant performances, building performance, etc.
LEAP (Long-range Energy Alternatives Planning system)	Physical accounting, simulation model using for integrated energy environmental analysis.	Developed by Stockholm Environment Institute. Free for qualified developing country users, licensed to others.	IE	Economic and emission (GHG and other pollutant) impacts of energy scenarios and policies.	Demographic, economic, Energy Balances, energy policies, sector activity data, energy intensity, energy transformation, emission factor, fuels data. Can be more or less data-intensive depending on data availability. Default data provided in Technology and Environmental Database and in "starter" country datasets.
MEDEE (*Modèle d'Evolution de la Demande d'Energie*)	Energy sector end-use model (Demand side).	Proprietary model developed by Enerdata.	Hanoi University of Technology	Future energy demand over the long term, impacts of energy prices on demand.	Demand drivers in the form of sector-specific activity data and policies (industry, households, service, transport, other). Data-intensive, though adjustable.

Name	Type	Source	Users	Analytical Purpose	Input Data
EFOM (Energy Flow Optimization Model)	Linear optimization model for long-term integrated energy-environmental analysis (supply and demand sides). Runs in GAMS.	European Commission	Vietnam's Hydro-meteorological Service	Least-cost energy system optimization to meet demand subject to constraints. Energy system impacts and costs of mitigation policies and technology change.	Technology data (cost, emission data), energy flows within country, policies. Seems data-intensive. Contains an energy-environmental database.
WASP (Wien Automatic System Planning)	Dynamic optimization model for electricity generation expansion.	International Energy Agency	IE	Optimal power supply and power system expansion, given emissions, fuel usage and energy generation constraints. CO_2 mitigation costs.	Peak electricity loads and load duration curves of the energy system; electricity generation and fuel usage of existing and candidate plants and costs, constraints to be considered.
Energy Outlook Models	Optimization models (wand demand sides).	Various	IE JICA	Energy demand and supply.	Data on energy supply and demand.
EFFECT (Energy Forecasting Framework and Emission Consensus Tool)	Multi-sector optimization model covering energy supply and demand (electricity, industry, non-residential buildings, residential electricity, road transport).	World Bank	MPI	Policy impacts on energy use, GHG and other emission. Energy system costs of GHG mitigation.	Current and projected energy demand by key energy-consuming sectors: Transport, Residential, Non-Residential, Industry, using microeconomic data. (Pre-existing models or data might be needed) Projected GDP growth, urbanization and population growth. Requires customization for each country.

Name	Type	Source	Users	Analytical Purpose	Input Data
MESSAGE (Model for Energy Supply Strategy Alternatives and their General Environmental Impact)	A systems engineering optimization model used for medium- to long-term energy system planning, energy policy analysis, and scenario development.	International Institute for Applied Systems Analysis	IE	MESSAGE combines technologies and fuels to construct so-called "energy chains" that map energy flows from supply (resource extraction) to demand (energy services). The model allows for energy system optimization through minimizing the total systems costs under various constraints. It provides the installed capacities of technologies, energy outputs and inputs, energy requirements at various stages of the energy system, costs, emissions, etc. The IE uses this model for general energy sector analysis and for the assessment of GHG mitigation options in the energy sector.	Costs and production capacities of various energy supply technologies, energy flows, and sectoral energy demands in an economy

Abbreviations and acronyms used:

CGE – Computable General Equilibrium
GHG – Greenhouse Gas
IE – Institute of Energy
GEMPACK – General Equilibrium Modeling PACKage
GAMS – General Algebraic Modeling System
MPI – Ministry of Planning and Investment
IFPRI – International Food Policy Research Institute
ESTAP – Energy Technology Systems Analysis Program

AGRICULTURE, FORESTRY, AND LAND USE SECTOR MODELS

TABLE C.2: AGRICULTURE, FORESTRY, AND LAND USE SECTOR MODELS

Model	Type	Source	Users	Analytical Purpose	Input Data
COMAP (Comprehensive Mitigation Assessment Process)	Optimization model	Lawrence Berkeley National Laboratory	Not used in Vietnam.	Estimates net carbon implications, costs and benefits of mitigation and carbon sequestration options for land use and forestry sector, and identifies the least-cost approach to providing forest services while minimizing carbon emission.	• Land use categories and area by land use categories • Biomass density • Carbon storage by vegetation type • Cost of inputs for mitigation options • Direct flow of benefits from mitigation options • Projected and sustainable rate of extraction of products under baseline and mitigation options • Population growth rate, GDP growth rate, crop area and income, per capita, base-year demand, growth of agricultural output.
IMPACT 2009 (International Model for Policy Analysis of Agricultural Commodity and Trade)	Global simulation model coupled with bio-physical crop model (Decision Support System for Agro-Technology Transfer)	IFPRI (not freely available)	IFPRI in cooperation with the GVN.	Impact of climate change on agriculture (crop yields and subsequently food prices), being extended to estimate the emission impact of land use change in Vietnam.	Global demand for agricultural products (food, feed, fuel, and other uses), population growth, prices and elasticities, fertilizer use by five crops.

Model	Type	Source	Users	Analytical Purpose	Input Data
DAYCENT (Daily Century Model)/DNDC (Denitrification Decomposition)	Biophysical process-based models	DAYCENT (Colorado State University); DNDC (University of New Hampshire)	DNDC is being used by MARD, (Institute of Agricultural Environment)	Estimates non-CO_2 GHG emission and marginal abatement costs. It estimates the heterogeneous emission and yield effects over space and time of adopting mitigation practices.	Soil conditions, detailed crop physiology and phenology, crop types, crop management practices.
CLUE (Conversion of Land Use and its Effects)	Spatial allocation land use simulation model	University of Amsterdam (Netherlands), Institute of Environmental Studies	LEI, Wageningen University, in cooperation with the GVN	Used to model how land use will change (e.g., forest cover, cropping patterns) due to changes in demand.	Spatially explicit data on land use/land cover, soil, climate, cropping patterns, various socioeconomic measures, etc. The model uses statistical regression analysis to model land use change, so the important explanatory variables driving land use change must be included.

Abbreviations and acronyms used:

CLUE – Conversion of Land Use and its Effects
COMAP – Comprehensive Mitigation Assessment Process
DAYCENT – Daily Century Model
DNDC – Denitrification-Decomposition
GDP – Gross Domestic Product
GHG – Greenhouse Gas
GVN – Government of Vietnam
IFPRI – International Food Policy Research Institute
IMPACT – International Model for Policy Analysis of Agricultural Commodity and Trade
MARD – Ministry of Agriculture and Rural Development

ANNEX D: NATIONAL STATISTICAL INDICATORS OF VIETNAM

TABLE D.1: LIST OF NATIONAL STATISTICAL INDICATORS IN VIETNAM TRACKED BY THE GSO

No	ID	Group, Name of Indicator	Main Disaggregation	Frequency	Agency in Charge of Collection and Aggregation
		01. Land, Climate, Administration			
4	0104	Number of sunny hours, air humidity, air temperature	Month, monitoring stations	Annually	MONRE
5	0105	Increase of average temperature	Climate zone	5 years	MONRE
6	0106	Rainfall, water level and water flow of some main rivers	Monitoring stations	Annually	MONRE
7	0107	Change of average rainfall	Climate zone	2 years	MONRE
8	0108	Average sea water level	Sea monitoring stations	5 years	MONRE
		21. Environment Protection			
330	2104	Number of natural disasters and damage level	Type of disaster, province/city	Monthly, Annually	MARD
331	2105	Content of harmful substances in the air	Monitoring stations, type of harmful substance	Annually	MONRE
332	2106	Proportion of dates with content of harmful substances in the air exceeding national standards	Monitoring stations, type of harmful substance	Annually	MONRE
333	2107	Content of harmful substances in water	Surface water/ground water, monitoring stations, type of harmful substance	Annually	MONRE
334	2108	Content of harmful substances in sea water in some estuaries, coastal areas, and open seas	Monitoring stations, type of harmful substance	Annually	MONRE
335	2109	Content of harmful substances in the sediment in some estuaries	Monitoring stations, type of harmful substance	Annually	MONRE
336	2110	Number of cases, amount of overflow oil and leaked out chemical in the sea, affected areas	Sea area, type	Annually	MONRE
337	2111	Rate of maintained forest areas for special use	Region, province/city	Annually	MARD
338	2112	Rate of protected land areas, maintained with diversified biology	Region, province/city	Annually	MONRE

No	ID	Group, Name of Indicator	Main Disaggregation	Frequency	Agency in Charge of Collection and Aggregation
339	2113	Area of degraded land	Type of degradation, type of land, province/city	2 years	MONRE
340	2114	Cultivated area without proper irrigation	Province/city	2 years	MARD
341	2115	Decrease of ground water, surface water	Province/city	2 years	MONRE
342	2116	Number of springs dried up seasonally or permanently	Province/city	2 years	MARD
343	2117	Proportion of enterprises granted with certificate for environmental management	Types of ownership, kinds of economic activity, province/city	Annually	Leading: MONRE Coordinating: GSO
344	2118	Rate of urban areas, industrial zones, export processing zones disposing solid waste, waste water in accordance with corresponding defined national standards	Type of urban, province/city	Annually	Leading: MOC Coordinating: MONRE
345	2119	Rate of harmful waste disposed in accordance with corresponding defined national standards	Type of waste, province/city	Annually	Leading: MONRE Coordinating: MOIT, Ministry of Health
346	2120	Rate of waste water of establishments disposed in accordance with defined national standards	Type of waste water, province/city	Annually	Leading: MOC Coordinating: MONRE
347	2121	Rate of collected solid waste treated in accordance with corresponding defined national standards	Type of solid waste, province/city	Annually	Leading: MOC Coordinating: MONRE
348	2122	Expenditure on environment protection activities	Source, spending item, province/city	Annually	Leading: MONRE Coordinating: Ministry of Finance, GSO
349	2123	Environment sustainability index		2 years	GSO
350	2124	GHG emissions per capita	Type of gas	2 years	MONRE

Source: Based on Prime Minister's Decision No 43/2010/QD-TTG dated June 2, 2010.