Project to Support the Planning and Implementation of NAMAs in a MRV Manner

Operational Manual for MRV on City-level Climate Change Mitigation Actions

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Acronyms and Abbreviations

ADB	Asian Development Bank
CCAP	Climate Change Action Plan
CCB	Climate Change Bureau
CDM	Clean Development Mechanism
CNG	Compressed nature gas
DARD	Department of Agriculture and Rural Development
DOC	Department of Construction
DOF	Department of Finance
DOIT	Department of Industry and Trade
DONRE	Department of Natural Resources and Environment
DOT	Department of Transport
DPI	Department of Planning and Investment
GHG	Greenhouse gas
GWP	Global Warming Potential
HCMC	Ho Chi Minh City
IFC	International Finance Corporation
IPCC	Intergovernmental Panel on Climate Change
JBIC	Japan Bank for International Cooperation
JCM	Joint Crediting Mechanism
JICA	Japan International Cooperation Agency
LED	Light emitting diode
LPG	Liquefied petroleum gas
MONRE	Ministry of Natural Resources and Environment
MRV	Measurement, Reporting and Verification
NAMA	Nationally Appropriate Mitigation Action
NDC	Nationally Determined Contribution
PV	Photovoltaic
SPI-NAMA	Project to Support the Planning and Implementation of NAMAs in a MRV Manner
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change

Glossary

Greenhouse gases (GHGs): Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere, and clouds. This property causes the greenhouse effect. Currently, seven greenhouse gases, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydro fluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3), are covered by the United Nations Framework Convention on Climate Change (UNFCCC).

GHG emissions: GHG that is generated/emitted/released to the atmosphere from various human activities.

Nationally Determined Contribution (NDC): A plan that describes how to address climate change mitigation efforts and measures for adaptation in the country under the Paris Agreement. This will be updated every five years.

Mitigation actions: Actions and efforts to reduce or prevent human-induced emissions of GHGs.

Measurement, Reporting and Verification (MRV): An indispensable component of mitigation actions that allows check and report in a systematic way. It consists of three steps, namely measurement, reporting and verification.

Measurement ("M"): First part of MRV that involves direct measurement using instruments and/or collection of information and data that are necessary to calculate GHG emission reductions of the mitigation action.

Reporting ("R"): Second part of MRV that involves compilation and reporting of data and information that is collected or measured at the Measurement (M) stage.

Verification ("V"): Third part of MRV that involves checking and confirming the contents that are reported at the Reporting (R) stage from the viewpoint of completeness, accuracy and consistency.

Chapter 1. Introduction

(1) Purpose of this manual

This manual aims to guide local governments (provinces and municipalities) in Vietnam to initiate Measurement, Reporting and Verification (MRV) of climate change mitigation actions. It describes the methods and procedures to implement MRV. It also provides formats that can be used for effective MRV and case studies on MRV for several mitigation actions.

This manual was developed based on the experiences from the MRV trials in Ho Chi Minh City (HCMC) conducted under the Project to Support the Planning and Implementation of NAMAs in a MRV Manner (SPI-NAMA)[1] in which six mitigation actions from energy, transport and waste sectors were MRV-ed. Although substantial efforts were made to enable this manual to cover a wide range of mitigation actions, it is limited in scope. It may not be entirely suitable or practical for some local governments since it was developed solely on the experiences of HCMC. However, readers outside HCMC can still refer to this manual and obtain useful guidance when initiating MRV in their city or province.

(2) Basis of this manual

This manual was prepared based on:

- Law on Environmental Protection No: 55/2014/QH13;
- Resolution 24/NQ-TW: Active response to climate change, improvement of natural resource management and environmental protection;
- Decision No. 2139/QD-TTg of December 5, 2011: Approving the national strategy for climate change;
- Decision No. 1393/QD-TTg of September 25, 2012: Approving the national strategy on green growth;
- Decision No. 1474/QD-TTg of October 5, 2012: Issuance of the national action plan on climate change period 2012 – 2020;
- Decision No. 2053/QD-TTg of October 28, 2016: Promulgating the plan to implement the Paris Agreement on Climate Change; and
- Decision No. 1775/QD-TTg of November 21, 2012: Approval of the project of greenhouse gas emission management

(3) Recommended readers

The main targets of this manual are the officials of HCMC who are involved in planning, implementation and evaluation of climate change mitigation actions. This manual is also intended for officials of other local governments intending to initiate MRV.

[1] Decision No.1911/QD-BTNMT dated 29/7/2015 of Ministry of Natural Resources and Environment on Approval of SPI-NAMA Project.

(4) Concept of MRV and its benefits to the city

In order to ensure that the mitigation goal of the city is successfully achieved, both the progress and effectiveness of mitigation action needs to be monitored on a regular basis, and reported to, and checked by relevant authorities in the city. Figure 1-1 shows the major steps of MRV of climate change mitigation actions.

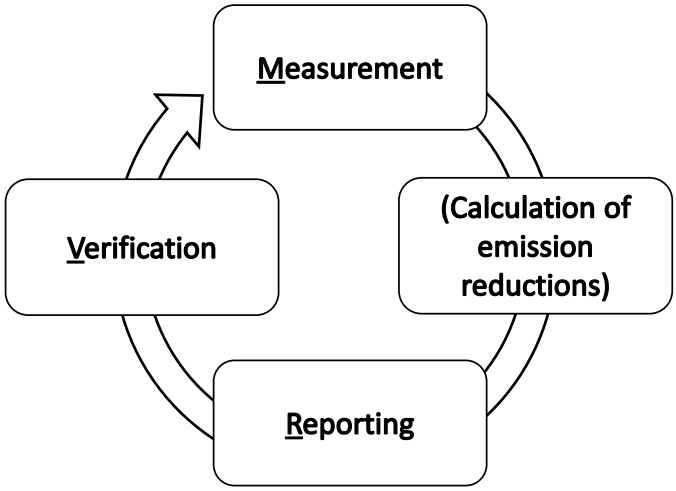


Figure 1-1 MRV Steps

Implementing MRV on mitigation actions can bring multiple benefits to the city. Typical benefits are summarized in the Table 1-1.

Table 1-1 Benefits of MRV

Type of benefit	Example
Enhanced clarity of project effectiveness	By performing a well-planned MRV activity, the city can visualize the effectiveness and impacts of the project, in terms of its GHG emissions and emission reductions.
Enhanced opportunity to access finance	By conducting MRV activities under specified rules, the mitigation project may have access to various types of climate finance sources, including international finance.
Improved policy/ project formulation	By applying the experience of MRV activities, policy development or project planning/ evaluation can be improved in the future.

The stringency level of MRV may differ depending on whether a mitigation action applies to a carbon trading scheme or not. Stringent GHG emission reduction calculation and monitoring methods are required for MRV under carbon crediting system such as the Clean Development Mechanism (CDM)[2] or Joint Crediting Mechanism (JCM)[3]. On the other hand, if a mitigation action is not intended to generate carbon credits, less stringent GHG emission reduction calculation and

[2] An international mechanism under Kyoto Protocol that allows emission-reduction projects in developing countries to earn carbon credits. For details on CDM, see UNFCCC CDM website at https://cdm.unfccc.int/.

[3] A bilateral mechanism between developing countries and Japan that facilitates diffusion of low carbon technologies, products, systems, services, and infrastructure in developing countries. For details on JCM, see JCM website at https://www.jcm.go.jp/.

monitoring methods can be applied, because the objective of such MRV is not to ensure the credibility of generated carbon credits but rather to evaluate the effect of project implementation.

(5) Structure of this manual

This manual consists of the main text and annexes. The main text contains three chapters. Chapter 1 provides an introduction including the purpose of this manual and outline of MRV. Chapter 2 presents the method to define the scope of mitigation actions to MRV and responsibilities of relevant organizations within the local government in respect to MRV. Chapter 3 gives a step by step guide to implement MRV. Annexes contain examples of MRV plan, GHG emission reduction calculation methods and monitoring methods of typical mitigation actions in Vietnam.

Chapter 2. Basic MRV framework

2-1. Defining scope of mitigation actions to MRV in the city

The first step is to identify and decide which mitigation actions in the city will be subject to MRV, in other words, to define the scope of mitigation actions to MRV. The scope can be defined by taking either of the following two approaches:

Approach 1

If the city *already has* its own city-wide plan related to climate change, (e.g. climate change master plan, mitigation action plan), the city can employ that plan. Because such a plan usually contains major actions related to GHG emission reduction or prevention in the city.

Approach 2

If the city *does not have* such a plan yet, the city can set the sectors that are identified as major GHG emission sources in the city as the scope of mitigation actions to MRV.

Regardless of the approach to be chosen, it is highly advisable for the city to define a realistic scope taking into account the city's available resources and current capability.

The following elements should be taken into account when defining the scope of mitigation actions to MRV.

- Cities are encouraged to take mitigation actions at all levels, including policies, programs, and projects into the scope. However, MRV of the policies is usually difficult because the monitoring method tend to be complicated.
- Cities are encouraged to include programs and projects that are implemented by businesses/ private investment.
- Cities should include mitigation actions that are financed and implemented by central ministries. However, since such mitigation actions are likely to be MRV-ed by the respective central ministries, double reporting for the same mitigation action and double-counting of the same GHG emission reductions need to be avoided.

Box 2-1 Case study: Defining scope of mitigation actions to MRV in HCMC

Because HCMC has developed the Climate Change Action Plan (CCAP)[4], which stipulates priority sectors for climate change mitigation, HCMC can choose Approach 1 to define its scope of mitigation actions to MRV. Based on the priority sectors of the CCAP, HCMC can set its scope of mitigation actions to MRV as all mitigation actions stipulated in the CCAP.

The defined scope of HCMC is characterized as follows:

- The scope contains various levels of mitigation actions from policy-level to project-level actions.
- The scope covers mitigation actions by the private sector.

2-2. Setting up MRV framework for the city

The MRV framework is a structure and institutional arrangement under which MRV activities are conducted within the city. It also defines the organizations involved in MRV along with their roles and responsibilities. A robust MRV framework needs to be established to ensure MRV is conducted in an effective, transparent and sustainable manner.

An indicative MRV framework and major **MRV actors** (institutions) are illustrated in Figure 2-1. Each city is advised to establish its own MRV framework within its current capacity and available resources, while harnessing the existing governance structure as much as possible.

There are principally four major actors in the MRV processes: *MRV Authorization Unit*, *MRV Management Unit*, *Sectoral Oversight Unit*, and *Mitigation Implementing Entity*. Depending on the current institutional structure and available resources, a city can either assign existing organizations, departments and divisions to these MRV units, or create new entities that specifically deal with MRV-related activities.

[4] Climate Change Action Plan of Ho Chi Minh City for the Period of 2017-2020, with a Vision to 2030 approved at the Decision No.1159/QD-UBND dated 17/3/2017 of Ho Chi Minh City People's Committee;

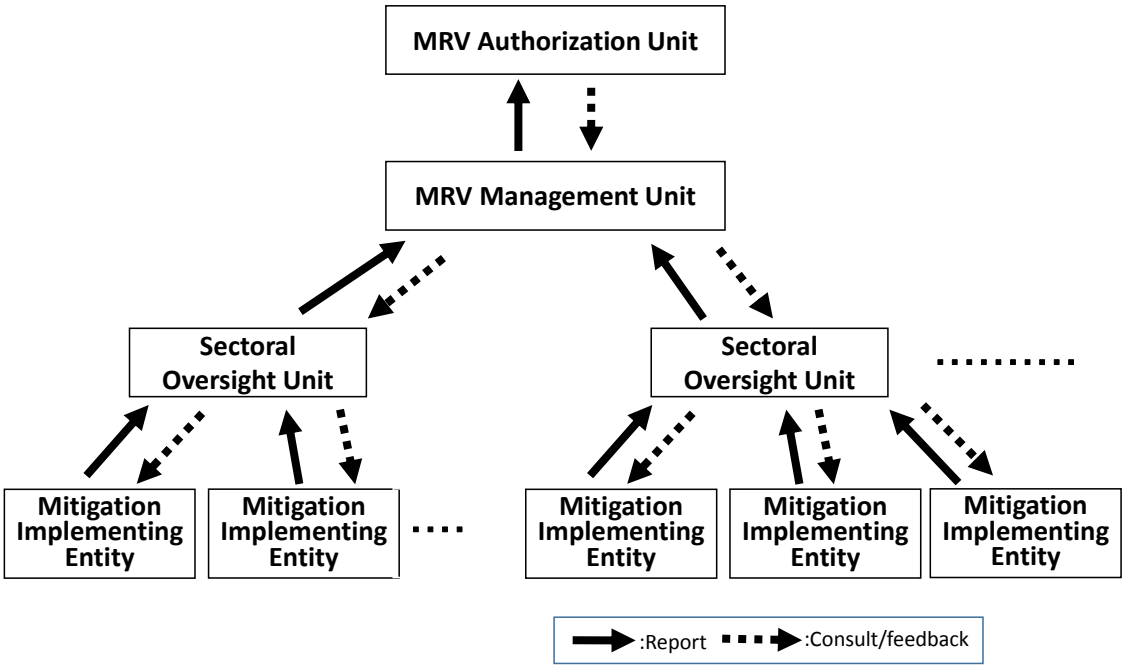


Figure 2-1 General MRV framework of a city

Outline of responsibilities for each MRV actor is described below (see Chapter 3 for more detailed explanation). Some elements that need to be taken into consideration in identifying each of these MRV actors are also explained.

1) Responsibility of MRV Authorization Unit

As the supreme administrative body of MRV in the city, the main role of this unit is to check and approve plans and results of MRV for all mitigation actions. More specifically, the MRV Authorization Unit will perform the tasks shown in the Table 2-1.

Table 2-1 Responsibility of MRV Authorization Unit

MRV actor	Responsibility	Reference in the Manual
MRV Authorization Unit	• **Check and approve** the **Mitigation Actions List** and the **MRV Plans** submitted by the MRV Management Unit	• p. 26
	• **Check and approve** the **MRV Report** submitted by the MRV Management Unit	• p. 35
	• **Dispatch** the **MRV Report** to concerned departments and organizations in the city and to MONRE	• p. 35

This unit needs to be a public entity or unit that has authority to request relevant departments and organizations in the city to ensure thorough implementation and administration of overall MRV activities.

2) Responsibility of MRV Management Unit

This unit manages and provides oversight to MRV activities in the city. One of the main tasks of the unit is to thoroughly check the contents of the MRV Plans and the MRV Report for all relevant

sectors in the city. The MRV Management Unit submits these documents to the MRV Authorization Unit for final approval.

In order to enhance and ensure operational effectiveness of MRV, some cities may want to equip the MRV Management Unit with a function to serve as a city-wide help desk of MRV-related issues. The unit can receive and answer administrative and technical inquiries from the stakeholders in the city. The specific responsibilities are described in the Table 2-2.

Table 2-2 Responsibility of MRV Management Unit

MRV actor	Responsibility	Reference in the Manual
MRV Management Unit	• **Examine** the Sectoral Mitigation Actions Lists and MRV Plans submitted by the Sectoral Oversight Units and compile them into the Mitigation Actions List and the MRV Plans	• p. 25
	• **Submit** the Mitigation Actions List and the MRV Plans to the MRV Authorization Unit	• p. 25
	• **Examine** the Sectoral Monitoring Reports submitted by the Sectoral Oversight Units	• p. 33
	• **Compile** the Sectoral Monitoring Reports into a MRV Report, and submit it to the MRV Authorization Unit	• p. 33
	• **Prepare and update** the database on mitigation actions to MRV and on the result of monitoring	• p. 26, 35

This unit should be a public entity or a unit whose current duty covers planning and promotion of climate change mitigation or environmental activities of the city. The persons assigned to this unit and the above-mentioned tasks should possess a fundamental and broad knowledge on climate change mitigation.

3) Responsibility of Sectoral Oversight Units

As a regulatory unit of the concerned sector in the city, each Sectoral Oversight Unit checks MRV-related activities of the concerned sector. The main role of the Sectoral Oversight Units is to review the plans and results of MRV for all mitigation actions of the concerned sector.

The Sectoral Oversight Units are usually represented by line departments and relevant agencies in charge of the concerned sectors in the city. For example, for transport-related projects, the department of transport of the city can be assigned as the Sectoral Oversight Unit, while the department of environment plays the role as the Sectoral Oversight Unit for projects related to municipal solid waste management.

Table 2-3 Responsibility of Sectoral Oversight Units

MRV actor	Responsibility	Reference in the Manual
Sectoral Oversight Units	• **Examine** the Mitigation Actions Lists and MRV Plans submitted by the Mitigation Implementing Entities and compile them into a Sectoral Mitigation Actions List and MRV Plans	• p. 24
	• **Submit** the Sectoral Mitigation Actions List and MRV Plans to the MRV Management Unit	• p. 24
	• **Examine** the Mitigation Monitoring Reports submitted by the Mitigation Implementing Entities	• p. 31
	• **Compile** the Mitigation Monitoring Reports submitted by the Mitigation Implementing Entities into a Sectoral Monitoring Report	• p. 31
	• **Submit** the Sectoral Monitoring Report to the MRV Management Unit	• p. 31

4) Responsibility of Mitigation Implementing Entities

These entities are basically implementers of the mitigation actions in the city. The Mitigation Implementing Entity can be a public administrative unit such as a department or division of the city, a public company, or a private company. Specific roles of the entities are described in Table 2-4.

Table 2-4 Responsibility of Mitigation Implementing Entities

MRV actor	Responsibility	Reference in the Manual
Mitigation Implementing Entities	• **Identify** the mitigation actions to MRV in the city and develop the Mitigation Actions List (See Table 3-1 Image of Mitigation Actions List) together with respective MRV plans	• p. 13
	• **Submit** the Mitigation Actions List and MRV Plans to the Sectoral Oversight Unit	• p. 13
	• **Conduct** monitoring of the identified mitigation actions under the respective MRV Plans and prepare the Monitoring Sheet	• p. 27
	• **Prepare** a GHG calculation sheet and calculate GHG emission reductions for the identified mitigation actions	• p. 27
	• **Prepare** the Mitigation Monitoring Report and submit to the Sectoral Oversight Unit	• p. 30

Box 2-2: MRV framework of HCMC

A provisional MRV framework of HCMC shown below was developed by referring to the indicative MRV framework shown in page 6. It took into account the MRV trial activities.

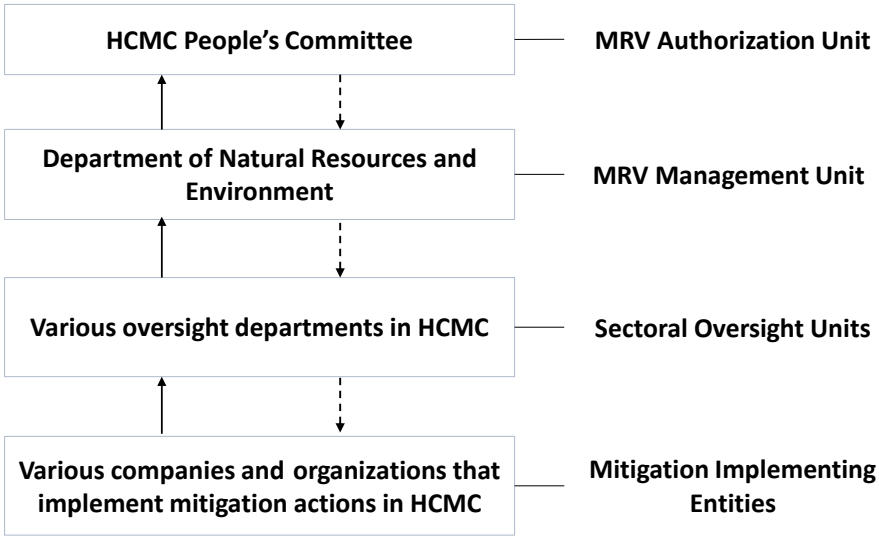


Figure 2-2 MRV framework of HCMC (provisional)

Approach taken to define the MRV actors in HCMC

The four MRV actors in HCMC were identified on the basis of the current institutional arrangement and capacities in HCMC, as well as the specific skills and experiences required to fulfill the responsibility of each MRV actor.

MRV Authorization Unit

HCMC People's Committee was identified as the **MRV Authorization Unit.** This authority is a supreme decision making unit of the city to approve activities in the city. It orders/ requests relevant departments and organizations in HCMC to ensure implementation and administration of MRV activities.

MRV Management Unit

The Department of Natural Resources and Environment (DONRE), which is the Standing Department of Climate Change Steering Board of the city, was designated as the **MRV Management Unit.** The unit has an administrative responsibility to plan and promote climate change mitigation activities in the city. The unit also has an experience and knowledge related to climate change mitigation that is necessary to facilitate MRV activities in the city.

The DONRE plays the role of the MRV Management Unit and communicates with relevant departments and organizations in the city. The Climate Change Steering Board of HCMC, in which Climate Change Bureau (CCB) of the DONRE is the secretariat, consists of representatives from the relevant departments in the city, which are assigned as the Sectoral Oversight Units or the Mitigation Implementing Entities.

Sectoral Oversight Units

The sectoral departments of HCMC are designated as the **Sectoral Oversight Units** of the concerned sectors since such departments are overseeing the respective sector's plans and activities in the city under CCAP of HCMC. The Sectoral Oversight Units of HCMC are shown below.

HCMC's Mitigation Sectors	Sectoral Oversight Units of HCMC
Urban planning	Department of Architecture and Planning
Energy	Department of Industry and Trade (DOIT)
Transport	Department of Transport (DOT)
Industry	Department of Industry and Trade (DOIT)
Water management	Department of Transport (DOT)
Waste management	Department of Natural Resources and Environment (DONRE)
Construction	Department of Construction (DOC)
Health	Department of Health
Agriculture	Department of Agriculture and Rural Development (DARD)
Tourism	Department of Tourism

Reference: CCAP of HCMC

Mitigation Implementing Entities

The **Mitigation Implementing Entities** will basically be the main entity that implements the mitigation action in the city, e.g. the main entity that operates the low-carbon equipment and facility.

For some mitigation actions, the departments/ organizations that are designated as the Sectoral Oversight Units may also act as the Mitigation Implementing Entity. For example, the DONRE oversees activities in the city related to municipal solid waste management, but the department also carries out mitigation actions such as waste reduction and recycle. In this case, this department is responsible for the tasks of both the Sectoral Oversight Unit and Mitigation Implementing Entity.

Note: In terms of securing the budget for MRV activities, the Department of Finance (DOF) and Department of Planning and Investment (DPI) play the role of advisory bodies for planning and financing to the People's Committee of HCMC.

Chapter 3. MRV process

The MRV process for mitigation actions taken by cities is implemented by the following 3 steps.

A. Determining mitigation actions to MRV

In the first place, in accordance with the scope of mitigation actions to MRV that has been set by the city in Chapter 2, the scope of mitigation actions to MRV are to be determined. Through examining the projects, programs and policies of the city, the mitigation actions are selected on the basis of its contribution to GHG emission reduction, and are compiled into the **Mitigation Actions List**. For each selected action, an **MRV plan** is prepared.

For details, refer to Section 3-1

B. Implementing MRV

Secondly, in accordance with the prepared MRV plans, the responsible entities implement MRV. MRV starts by collecting/ measuring the necessary data for quantification of GHG emission reductions. Using these data, GHG emission reductions are calculated and the result is shown in the **Mitigation Monitoring Report**. The Mitigation Monitoring Reports are then compiled into the **Sectoral Monitoring Report** for each sector.

For details, refer to Section 3-2

C. Approving MRV result

Thirdly, the Sectoral Monitoring Reports are compiled into the **MRV Report**. It is submitted to the MRV Authorization Unit for approval.

For details, refer to Section 3-3

The overall MRV steps are summarized in Figure 3-1, and the annual timeline of MRV activities is illustrated in Figure 3-2.

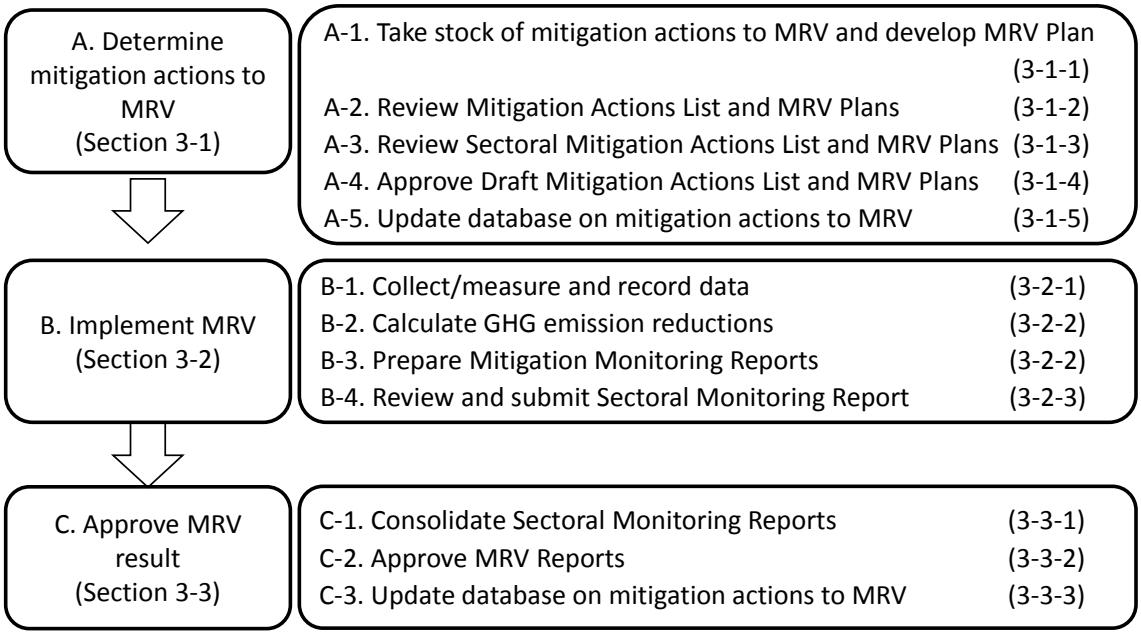


Figure 3-1 Steps of MRV of mitigation actions

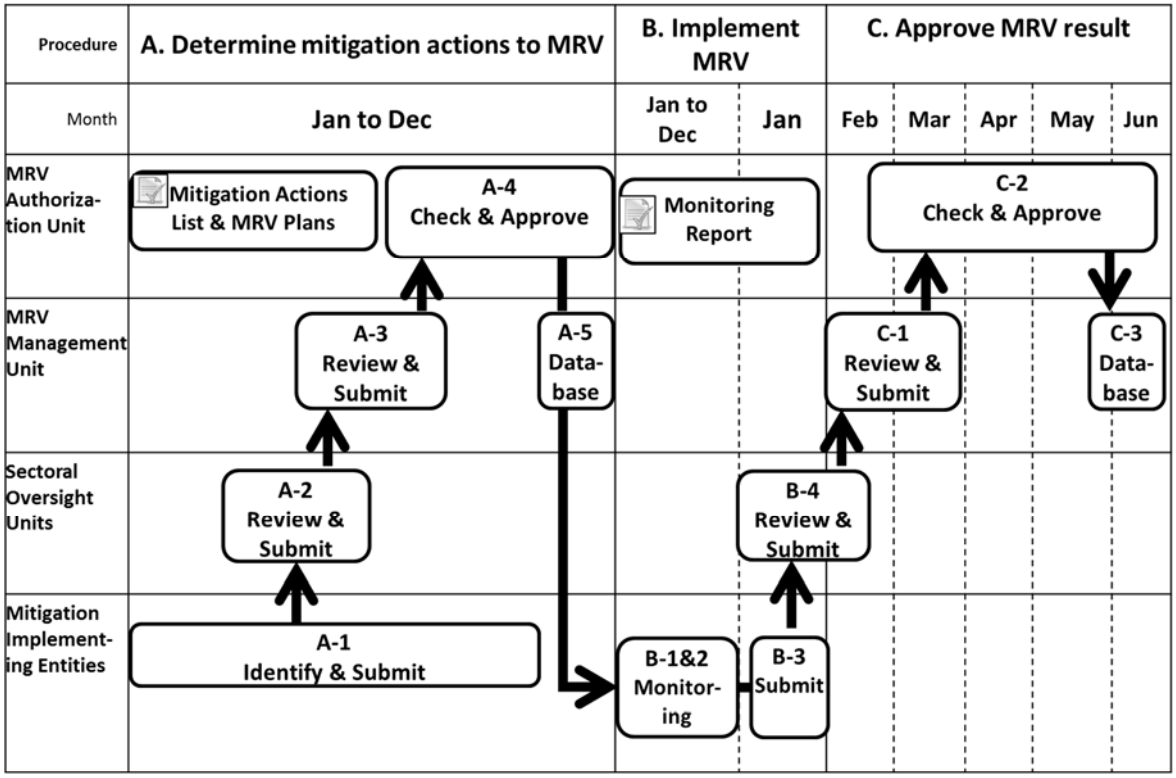


Figure 3-2 General timeline of MRV of mitigation actions

3-1. Determining mitigation actions to MRV

3-1-1. Take stock of mitigation actions to MRV and develop MRV Plan

Procedure

Responsible organization: **Mitigation Implementing Entities**

- The Mitigation Implementing Entity identifies the mitigation actions that will start operation in the next fiscal year in the scope of mitigation actions to MRV and develops the Mitigation Actions List (See below "1) Steps to develop Mitigation Actions List").
- The Mitigation Implementing Entity develops the MRV Plan for each identified mitigation action using the designated format (See below "2) Preparation of MRV Plan").
- The Mitigation Implementing Entity can submit the Mitigation Actions List and MRV Plans to the Sectoral Oversight Unit anytime throughout the year.

The Sectoral Oversight Unit and Mitigation Management Unit can support or work closely to develop the Mitigation Actions List and MRV Plan, in case the Mitigation Implementing Entity does not have enough capacity or is not designated to carry out those activities.

1) Steps to develop Mitigation Actions List

The following three steps need to be taken by each Mitigation Implementing Entity to develop the Mitigation Actions List.

Step 1 Prepare a long list of mitigation actions
Step 2 Assess the actions in accordance with the pre-defined criteria
Step 3 Select the actions to MRV and develop the Mitigation Actions List

Step 1 Prepare a long list of mitigation actions

Each Mitigation Implementing Entity takes stock of all actions that fall into the approved scope (see Chapter 2.2), and creates a long list of candidate mitigation actions.

Effective mitigation actions are often already included in the existing/ planned actions of the city. These measures are expected to have GHG emission reduction impacts. However, they are not often framed nor perceived as mitigation actions per se. This internal process of identifying, recognizing and capturing the measures to frame as mitigation actions increases the opportunity for promoting GHG emission reduction in the city as a whole.

For each action, the following information and data should be collected as a minimum requirement to prepare the long list and for the assessment in Step 2.

- Name of the action;
- Type of the action, e.g. project, program or policy;

- Equipment and technology currently used and equipment and technology that will be introduced under the mitigation action including the type of energy consumed, such as electricity, heavy oil, diesel fuel, LPG;
- Data to quantify GHG emission reductions, if emission reduction estimation is possible.

Step 2 Assess actions in accordance with the pre-defined criteria

Each Mitigation Implementing Entity assesses each mitigation action in the long list using a set of pre-defined criteria, and selects the mitigation actions to include in the Mitigation Actions List. The basic criteria can include the following attributes. However, other criteria can be proposed and added by the city to suit.

Criterion 1: Mitigation Potential - Whether the action reduces GHGs
Criterion 2: Practicability of MRV - Whether the action has practical ways to MRV

Criterion 1: Mitigation Potential - Whether the action reduces GHGs

The most fundamental point in selecting the mitigation actions is whether the implementation of the action reduces GHGs or not. If the action does not reduce GHGs, it falls short of mitigation action category, and should not be selected.

In order to know whether the action reduces GHGs, it is necessary to assess how GHG emission is reduced by the action concerned. The points for consideration are described in “Methodology to calculate GHG emission reduction,” in “2) Preparation of MRV Plan” in detail. The Mitigation Implementing Entity examines the logic of emission reduction of each action and if the necessary data is available, estimates the GHG emission reductions. If the result is positive, the action can reduce GHGs.

In order to grasp whether each action can be framed as a mitigation action, the action lists in Annex II “Typical Mitigation Actions and Emission Reduction Logic” can be used as a reference. If the candidate mitigation action falls under the category, the action is highly likely to have a GHG emission reduction effect, and therefore can be considered as a mitigation action. However, the list in Annex II only provides typical, indicative actions, and various other actions can also reduce GHG emissions.

Criterion 2: Practicability of MRV - Whether the action has practical ways to MRV

It is important to consider the level of complexity on MRV of each action in advance when identifying mitigation actions to MRV. One of the most important viewpoints on MRV for cities is practicality of MRV. Application of a complex MRV approach may lead to high cost. While the MRV process often requires various dataset for GHG emission reduction calculations, practicality can be achieved through:

1) Minimizing the number of parameters/data to be used,
2) Using a practical calculation method rather than a complex method
3) Utilizing the existing statistics/data as much as possible.

The level of complexity on MRV also depends on the nature of the mitigation action. For example, policy-based mitigation actions such as laws, policies, and regulations contribute to GHG emission reductions; however, MRV is not simple and straightforward as compared to project-based actions. There are very few examples of policy-based actions that were MRV-ed. Examples of policy-based mitigation actions include, inter alia,

- Feed-in Tariff;
- Regulation for energy consumption;
- Standard for energy saving;
- Subsidy for research, procurement, installation of low-carbon technologies and measures; and
- Awareness raising.

On the other hand, MRV for program- and project-based mitigation actions is more straightforward, and there are a lot of examples which can be referred to. Examples of program- and project-based mitigation actions include, inter alia,

- Solar PV installation;
- High efficiency air-conditioner installation;
- Hybrid bus introduction;
- Switch to low-emission vehicles; and
- Aerobic treatment of sludge.

The availability of data is also an important point to make the MRV practical. If MRV of the action requires many parameters and there are difficulties in data collection, and thus impose a strain on the city resources, such action should not be selected as a mitigation action to MRV. It can, however, be noted as a Non-MRV action in the Mitigation Actions List.

If the necessary data is not available in Vietnam, the data applied to a similar mitigation action in other countries may be applied.

Box 3-1 Example of policy-based mitigation actions and MRV

<Feed-in-tariff (FIT)>

An FIT is a policy instrument for promoting the introduction of renewable energy. An FIT ensures the sales of electricity generated by renewable energy sources at a fixed price on a long-term basis.

To MRV and to estimate the GHG emission reductions achieved through the introduction of an FIT, information on the amount of electricity generated by the renewable energy units utilizing the FIT and CO_2 emission factor of the grid is required. This may be fairly straightforward. However, care must be taken to avoid double-counting of the same GHG emission reductions. Some of the renewable energy units under the FIT may also utilize schemes such as the JCM on a project basis in which the GHG emission reductions is accounted. It is necessary to distinguish such units in MRV.

<Energy efficiency standard for electric appliances>

An energy efficiency standard is employed to encourage the use of energy efficient appliances. It may be accompanied by labelling schemes and subsidies for energy-efficient equipment. The intended effect is the replacement of old electric appliances by high efficiency appliances.

The calculation of GHG emission reductions requires the following information:

1. the energy performance and number of the energy-efficient appliances sold;
2. the energy performance and number of the replaced appliances;
3. the operating hours of both the energy- efficient and replaced appliances;
4. the emission factor of the grid

Obtaining the first and second information is difficult, particularly in developing countries, because aggregated retail data on such items are most likely not readily available. In order to obtain the third information, a detailed survey on the use of electric appliances is necessary. Many policy-based mitigation actions, such as the policy on energy efficiency standard for electric appliances, may face considerable challenges in MRV.

Step 3 Select the actions to MRV and develop the Mitigation Actions List

Using the information obtained in Step 1 and Step 2, each Mitigation Implementing Entity selects the mitigation actions that meet the above-mentioned two evaluation criteria as the mitigation actions to MRV. The Mitigation Implementing Entity can then list these selected actions to prepare a Mitigation Actions List.

It is important for cities to recognize not only the actions that suit MRV, but also other actions that have a potential to reduce GHG emissions. Therefore, the mitigation actions that may reduce GHGs but are difficult to implement MRV, can also be included in the Mitigation Actions List. Such actions can be marked as “Non-MRV” actions. By doing this, the list can be a comprehensive list of

mitigation actions of the city encompassing both MRV-able and non-MRV-able mitigation actions. The list can be utilized for policy formulation/ implementation particularly for the cities that have not yet formulated climate change mitigation plans. An image of the Mitigation Actions List is shown in Table 3-1.

The Mitigation Actions List will be updated by the Mitigation Implementing Entity every year.

Table 3-1 Image of Mitigation Actions List

No.	Name of mitigation action	Mitigation Implementing Entity	Location	MRV/ Non-MRV
1		Entity A		MRV
2		Entity A		MRV
3		Entity A		Non-MRV
4		Entity A		MRV

2) Preparation of MRV Plan

For each of the mitigation actions to MRV contained in the Mitigation Actions List, the Mitigation Implementing Entity prepares an MRV plan. The MRV Plan needs to be developed only once even if the operation of the mitigation action lasts for more than a year. The Mitigation Implementing Entity needs to modify and re-submit the MRV Plan if a significant change is required to the submitted MRV Plan. Significant changes may include changes in the project scope, involved organizations, and the technology to be applied, and so on. The Mitigation Implementing Entities should consult with the Sectoral Oversight Unit and MRV Management Unit to clarify whether the change requires re-submission of the MRV Plan.

The contents of the MRV plan are shown in Table 3-2. The format for the MRV Plan is shown in Annex III.

In case the Mitigation Implementing Entity does not have the role/mandate to describe all of the contents of the MRV plan, the Sectoral Oversight Unit, with technical support from the MRV Management Unit, may assist the Mitigation Implementing Entity to complete the MRV Plan.

Table 3-2 Contents of MRV Plan

I. General information on the mitigation action
a) Name of the mitigation action
b) Involved organizations and their roles
c) Objectives
d) Technology introduced under the mitigation action
e) Target GHG type
f) Location
g) Timeframe
h) Cost of mitigation action
i) Benefits of mitigation action and contribution to sustainable development
j) Source of funding and supporting financial scheme
k) Information on international market mechanisms
II. Emission reduction calculation, monitoring and reporting
a) Logic of GHG emission reduction
b) Methodology to calculate GHG emission reduction
c) Estimated GHG emission reduction
d) Organizational structure for monitoring and reporting
e) Monitoring period
f) Monitoring methods

- **General guides to complete MRV Plan**

The following section provides a general guidance and key principles to complete an MRV Plan, which consists mainly of two parts; I. General information on the mitigation action and II. Emission reduction calculation, monitoring and reporting.

I. General information on the mitigation action

a) Name of mitigation action

Give the name of the mitigation action. The name can be the same as the name used in the existing activity of the city.

b) Involved organizations and their roles

Give the name of all organizations and departments involved in the implementation of the mitigation action and describe their role. The organizations should include the Sectoral Oversight Unit, Mitigation Implementing Entity and operator/ data provider.

c) Objectives

Describe the objective of the project. If the main objective of the project is not climate change mitigation, state the main objective and also the intended or likely mitigation effects.

d) Technology introduced under the mitigation action

Describe the technology(ies) that is installed to reduce/ avoid GHG emissions. Contain the description of the scale of the technology (e.g. how much MW installed, how much MWh generated or saved, how many tons of waste/ wastewater treated, etc.)

e) Target GHG type

Select what type(s) of GHG is reduced/ avoided through the mitigation action from the following: CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, and NF3.

f) Location

Give the information on the location the mitigation action takes place.

g) Timeframe

Explain when the mitigation action starts (construction/ installation and operation) and is expected to end.

h) Cost of mitigation action

Give the cost of the mitigation action or mitigation component of the project, including: initial investment cost (where applicable, describe the total cost of the entire project and cost of mitigation component) and operation cost.

i) Benefits of mitigation action and contribution to sustainable development

Describe what kind of benefits besides GHG emission reductions will be brought to the beneficiaries by implementing the mitigation action, such as social benefits (e.g. creation of jobs, opportunity for education), economic benefits (e.g. contribution to economic growth, improved energy condition, technology transfer), and environmental benefits (e.g. reduced air pollution and water pollution).

j) Source of funding and supporting financial scheme

Describe the source(s) and size of funding of the mitigation action. Funding sources may include city budget, national budget, support from donors and international agencies, others (specify the source), and/or combination of the above. Also describe the existing financial support scheme such as tax exemption if applicable to the mitigation action.

k) Information on international market mechanisms

Describe whether the mitigation action has been registered with any international or bilateral carbon market mechanism, such as the Clean Development Mechanism (CDM), the Joint Crediting Mechanism (JCM), and other schemes.

II. Emission reduction calculation, monitoring and reporting

a) Logic of GHG emission reduction

Explain how GHG emissions are reduced by the mitigation action (see Annex II).

b) Methodology to calculate GHG emission reduction

Give the name of the methodology that is applied to the mitigation action to calculate GHG emission reductions and describe the methodology.

Quantification of GHG emission reduction is one of the most important elements in MRV. In order to quantify GHG emission reductions of the mitigation action, it is essential to identify a proper methodology. However, the identification and application of a methodology needs technical knowledge and experience in GHG emission reduction calculations. Therefore, it is recommended to identify a methodology through consultation with experts in this field or by outsourcing if the city lacks such technical skills. In general, a methodology is composed of contents shown in Table 3-3.

Table 3-3 Major contents of methodology for GHG emission reduction calculation

Contents	Outline
Applicability	A methodology contains description/ explanation on what types of mitigation actions can use the methodology.
Logic of emission reduction	Description on how GHG emission is reduced through the mitigation action.
Formulae of emission reduction calculation	Description on calculation formulae for the baseline and project emissions as well as emission reductions.
Monitoring method of necessary data for emission reduction calculation	Description on the method for measurement/collection of each parameter in the formulae for calculating the baseline/project emissions and emission reductions.

The procedure of identifying a methodology for a mitigation action should be in line with the Vietnamese Government's policy on MRV (which is currently under development). If the policy has not been issued, follow the following procedure.

Supported mitigation actions

For supported mitigation actions[5], use of a designated methodology is oftentimes required by the financial mechanism such as JCM, CDM or others that the mitigation action is registered with. If the methodology is not specified in the mechanism, follow the procedure for domestic mitigation actions.

[5] Supported actions are any action or a part of the action that has received financial support through bilateral cooperation (such as official development assistance), multilateral development organizations (such as UN, ADB, World Bank), or climate change mitigation schemes (such as JCM or CDM).

Domestic mitigation actions

For domestic mitigation actions, which are implemented by own resources and do not receive any financial or technological support from developed countries or international organizations, the implementing entity can choose any methodology or develop a new methodology. If the Vietnamese government has issued a guidance on the methodology, it should be followed.

There are two possible options to identify the methodology.

The first choice is to revisit and select an appropriate and suitable methodology for the mitigation action out of the existing pool of methodologies. The existing methodology can be adjusted to fit to the actual situation of the mitigation action in terms of the calculation formula and/or monitoring method. In selecting the methodology, it is recommended to have advice from experts in the field. For reference, a list of the existing methodologies is shown in Table 3-4.

The second choice is to develop a new methodology. If an appropriate methodology cannot be identified, a new methodology should be developed. In developing a new methodology, first, consider the logic of GHG emission reductions by the mitigation action, i.e. how the emission reduction can be realized by the action (see Annex II). In the next step, express the logic into formulae (baseline/ project emissions, emission reduction) and identify the necessary parameters for monitoring, and fixed parameters such as the emission factors. It should be emphasized that the development of a new methodology often requires expertise, and it is recommended to develop a methodology under advice from experts in the relevant field or by outsourcing.

Numerous methodologies already exist, but their level of complexity (such as the formulae and the number of parameters that have to be collected in order to perform the calculation) greatly varies from one another (Annex 1 “MRV Case Study” shows various methodologies with different complexity. For example, methodology for “Case Study 1: Solar PV system installation on the roof top of the public building” uses a simple methodology that involves only two parameters while “Case Study 11: Organic fertilizer production” uses a methodology that consists of seven equations and 16 parameters). Another element that needs to be taken into account in selecting a methodology is data availability. Selection of the commonly used methodology may not be the best choice if the data required is not readily available or cannot be accessed.

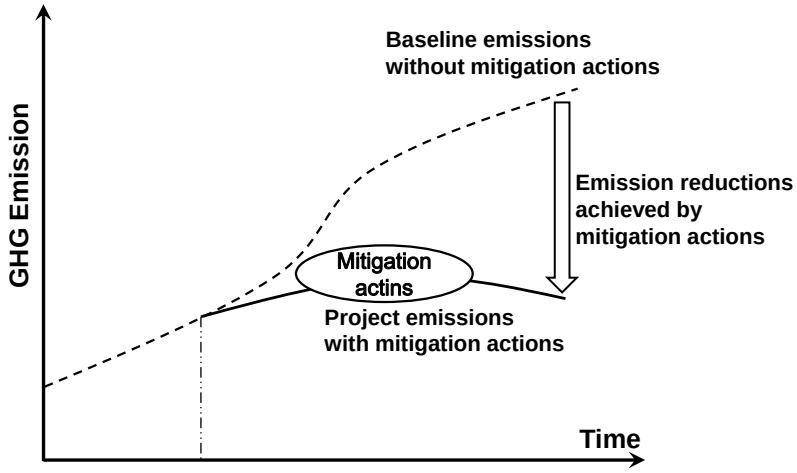
In any case, the selected/developed methodology should be practical in terms of data collection/measurement and calculation by the implementing entity, and transparent for domestic and international stakeholders. It is highly recommended to identify a practical methodology that requires minimum additional work for the implementing entity in terms of data collection, monitoring and GHG emission reduction calculation.

Table 3-4 Sources of existing methodologies

Title	Reference
Intergovernmental Panel on Climate Change (IPCC)	http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html
Clean Development Mechanism (CDM)	http://cdm.unfccc.int/methodologies/index.html
Greenhouse Gas Protocol: GHG Protocol for Project Accounting	http://www.ghgprotocol.org/standards/project-protocol
International Finance Corporation (IFC) Greenhouse Gas Reduction Accounting Guidance for Climate Related Projects	http://www.ifc.org/
Gold Standard	http://www.goldstandard.org/
Joint Crediting Mechanism (JCM)	http://www.jcm.go.jp
Japan International Cooperation Agency (JICA)	http://www.jica.go.jp/english/our_work/climate_change/mitigation.html
Japan Bank for International Cooperation (JBIC)	http://www.jbic.go.jp/en/efforts/j-mrv

Box 3-2 Principles and basic examples of emission reduction calculation

"Emission reduction" is calculated as a difference between "Baseline emission" and "Project emission" shown in the figure below and the general formula below. Baseline emission is a GHG emission under the most likely scenario that would have occurred without the mitigation action. Project emission is the GHG emission by the mitigation action. Emission reductions are often calculated for a year as annual emission reductions.



$$\boldsymbol{Emission\ reduction\ = Baseline\ emission - Project\ emission}$$

In most cases, as shown in a basic formula below, GHG emission is not directly measured, but is calculated as a product of "activity data" and "emission factor." In case of GHG type other than CO_2, in order to express as CO_2 equivalent mass, emission is calculated as a product of "activity data," "emission factor" and "Global Warming Potential (GWP)."

$$\boldsymbol{Emission\ = Activity\ data\ \times\ Emission\ factor}$$

Based on the basic formula above, emissions associated with, for example, consumption of grid electricity is calculated by applying the formula below. Electricity consumption can be known from invoices of the electricity company or direct measurement by an electricity meter.

The CO_2 emission factor of grid electricity can be found by referring to the nationally published data.

$$\boldsymbol{Emission}\ (\boldsymbol{tonCO_2/year}) = \boldsymbol{Electricity\ consumption}\ (\boldsymbol{kWh/year}) \times \boldsymbol{CO_2\ emission\ factor\ of\ grid\ electricity}\ (\boldsymbol{tonCO_2/kWh})$$

In case of GHG emissions associated with consumption of gasoline, emissions are calculated by applying the formula below. Gasoline consumption can be known from invoices of the fuel supply company or direct measurement of fuel. The CO_2 emission factor of gasoline can be found by referring to the nationally published data or IPCC default value.

$$\boldsymbol{Emission}\ (\boldsymbol{tonCO_2/year}) = \boldsymbol{Gasoline\ consumption}\ (\boldsymbol{liter/year}) \times \boldsymbol{CO_2\ emission\ factor\ of\ gasoline}\ (\boldsymbol{tonCO_2/liter})$$

c) Estimated GHG emission reduction

Give the estimated GHG emission reduction of the mitigation action by applying the identified methodology, if the necessary data is available.

d) ***Organizational structure for monitoring and reporting***

Give the name of the entities involved in MRV and describe their roles in the MRV plan. A schematic diagram can be prepared to show the relationship among these entities.

In order to thoroughly carry out MRV plans in a systematic manner, organizations involved in MRV, and their roles and responsibilities need to be clearly defined before MRV starts. In establishing such an MRV structure, it is highly recommended to utilize the existing monitoring and reporting arrangements that have been applied regardless of climate change activities in the city in order to avoid creating excessive additional work on data collection and documentation for MRV. For example, the existing organizational structure and processes to prepare and compile monthly or annual statistical data can be utilized, such as the bus transportation statistics submitted by the bus companies to the transport-related department. Many departments and public companies in cities would have already established and utilizing a regular monitoring and reporting system, which deals with data such as electricity generation, fuel consumption by public buses, volume of municipal solid waste treated, and etc. These existing organizational structure and processes can be utilized.

e) Monitoring period

Give the period during which the monitoring of the mitigation action is implemented.

f) Monitoring methods

In line with the identified methodology, describe methods for monitoring such as methods for direct measurement and/or data collection of each parameter, data collection interval of each parameter, and sources of the values in case default values are applied. In order to ensure practicality in the monitoring, it is important not to apply a complicated methodology which

requires a lot of monitoring parameters and data that are hard to obtain. Monitoring should be as practical as possible considering data availability, and technical and financial constraints.

3-1-2. Review Mitigation Actions List and MRV Plans

Procedure

Responsible organization: **Sectoral Oversight Unit**

- The Sectoral Oversight Unit thoroughly examines the Mitigation Actions Lists and MRV Plans submitted by the Mitigation Implementing Entities.
- The example viewpoints of examination are as follows.
  - Whether there is a lack in the submitted list/ detailed information
  - Whether the target, procedure and timing for MRV are clearly stated
  - Whether the target project can reduce GHG emissions
  - Whether the target project complies with the upstream, guiding plans/strategies
  - Whether the target project is MRV-able
- The Sectoral Oversight Unit requests the Mitigation Implementing Entities to modify and re-submit the Mitigation Actions List and/ or MRV Plans if they are not complete or sufficiently written in accordance with the above items.
- The Sectoral Oversight Unit compiles information on all the Mitigation actions Lists and MRV Plans of the sector into the Sectoral Mitigation Actions List and a set of MRV Plans and submits it to the MRV Management Unit.
- The Sectoral Oversight Unit reviews the Mitigation Actions List and MRV Plans once they are submitted by the Mitigation Implementing Entity, and submits them to the MRV Management Unit anytime throughout the year.

The Sectoral Oversight Unit reviews the Mitigation Actions Lists submitted by the Mitigation Implementing Entities and compiles them into the Sectoral Mitigation Actions List as shown in Table 3-5.

Table 3-5 Image of compiled Sectoral Mitigation Actions List

No.	Sector	Name of mitigation action	Sectoral Oversight Unit	Mitigation Implementing Entity	Location	MRV/ Non-MRV
1	Energy		Unit AA	Entity A		MRV
2						MRV
3						Non-MRV
4				Entity B		MRV
5						MRV
6						MRV
7						MRV
8						Non-MRV
9				Entity C		MRV
10				Entity D		Non-MRV
…						

3-1-3. Review Sectoral Mitigation Actions List and MRV Plans

Procedure

Responsible organization: **MRV Management Unit**

- The MRV Management Unit thoroughly examines the Sectoral Mitigation Actions Lists and MRV Plans submitted by the Sectoral Oversight Units.
- The example viewpoints of examination are as follows.
  - Whether there is a lack in the submitted list/ detailed information
  - Whether the target, procedure and timing for MRV are clearly stated
  - Whether the target project can reduce GHG emissions
  - Whether the target project is MRV-able
- The MRV Management Unit requests the Sectoral Oversight Units to modify and re-submit the Sectoral Mitigation Actions Lists and/ or MRV Plans if they are not complete or sufficiently written in accordance with the above items.
- By the end of April, the MRV Management Unit compiles all the Sectoral Mitigation Actions Lists and MRV Plans that will be MRV-ed in the next fiscal year into a Mitigation Actions List and a set of MRV Plans, and submits them to the MRV Authorization Unit with a recommendation for approval. This process is implemented once a year.

All Sectoral Oversight Units submit the Sectoral Mitigation Actions List to the MRV Management Unit. The MRV Management Unit examines them and compiles these lists into a Mitigation Actions List as shown in Table 3-6.

The MRV Management Unit can provide advice and recommendations to the Sectoral Oversight Units and Mitigation Implementing Entities, such as on the viewpoints of selection of mitigation actions and revisions on the descriptions of the Mitigation Actions List and MRV Plan.

Table 3-6 Image of Mitigation Actions List

No.	Sector	Name of mitigation action	Sectoral Oversight Unit	Mitigation Implementing Entity	Location	Year of addition to the list	MRV/ Non-MRV
1	Energy		Unit AA	Entity A		2016	MRV
2						2016	MRV
3						2017	Non-MRV
4				Entity B		2016	MRV
5						2016	MRV
6						2017	MRV
7						2017	Non-MRV
8				Entity C		2016	MRV
9				Entity D		2017	Non-MRV
10	Transport		Unit BB	Entity E			MRV
11							Non-MRV
12				Entity F			MRV
13				Entity G			MRV
14	Waste		Unit CC	Entity H			MRV
…							

3-1-4. Approve Mitigation Actions List and MRV Plans

Procedure

Responsible organization: **MRV Authorization Unit**

- By the end of May, after receiving the Mitigation Actions List and MRV Plans with a recommendation for approval, the MRV Authorization Unit approves them.
- By the end of June, the MRV Authorization Unit dispatches the approved Mitigation Actions List and MRV Plans through the MRV Management Unit to the Sectoral Oversight Units.

3-1-5. Update database on mitigation actions to MRV

Procedure

Responsible organization: **MRV Management Unit**

- The MRV Management Unit updates the database on mitigation actions to add the actions in the newly approved Mitigation Actions List and MRV Plans.

As a part of MRV procedure, each city needs to prepare a simple database and update it every year before and after MRV activities. The database can be a simple spreadsheet that contains basic information on the mitigation actions and GHG emission reductions. A database using spreadsheets is convenient for management and maintenance.

The contents and structures of the database can be designed by each city based on the current data management approach of the city and available resources. It is not necessary to develop a database system for managing the Mitigation Actions List and MRV plans, but it is necessary to manage the Mitigation Actions List and MRV Plans in one archived dataset. Table 3-7 shows an example of the database.

Table 3-7 Image of database

No.	Sector	Name of mitigation action	Sectoral Oversight Unit	Mitigation Implementing Entity	Location	Year of addition to the list	MRV/ Non-MRV	Emission reduction in year 1	Emission reduction in year 2
…	…	…	…	…	…	…	…	…	…
Total	-	-	-	-	-	-	-	XXXX	XXXX

3-2. Implement MRV

3-2-1. Collect/measure and record data (Monitoring)

Procedure

Responsible organization: **Mitigation Implementing Entities**

- The Mitigation Implementing Entity conducts monitoring in accordance with the respective MRV Plan, and prepares the Monitoring Sheet every determined period such as monthly/ quarterly/bi-annually.
- Monitoring activity needs to be carried out using the designated method, procedure and period described in the respective approved MRV plan.
- The Mitigation Implementing Entity monitors (through either direct measurement (monitoring) of parameters or data collection from operators such as bus companies) and collects all data (such as CO_2 emission factors) that is necessary to calculate GHG emission reductions.
- The Mitigation Implementing Entity inputs all the collected and measured data, and information into the Monitoring Sheet.
- The Monitoring Sheet and GHG emission reduction calculation sheet need to be prepared for each mitigation action. The monitored data and its measurement method/ procedure are needed to be determined before implementing the monitoring activity.

In case the mitigation action is implemented by the Sectoral Oversight Unit, the Sectoral Oversight Unit should carry out the above activities related to monitoring. For example, activities relating to municipal solid waste management are directly carried out (instead of supervising or overseeing the activity) by the department of environment in many cities. In this case, the department of environment will function as the Mitigation Implementing Entity and at the same time will function as the Sectoral Oversight Unit because the department is a regulating unit for waste management in the city.

1) Prepare Monitoring Sheet

The Mitigation Implementing Entity needs to prepare the Monitoring Sheet for each of the selected mitigation action referring to the MRV Plan. Necessary information such as monitoring items, monitoring method, monitoring interval are determined in the MRV Plan.

Table 3-8 Basic contents of Monitoring sheet

I. Information on the mitigation action
a) Name of the mitigation action
b) Sector
c) Mitigation Implementing Entity
d) Sectoral Oversight Unit
e) Name of the site
II. Results of monitoring
a) Monitoring year
b) Monitoring month
c) Creation date
d) Name of the person in charge
e) Monitoring results
f) Monitoring period

An image of the Monitoring Sheet is shown in Figure 3-3. For the case of solar PV project, parameters that need to be measured periodically after the project starts are the "amount of generated electricity by the solar PV system." Basically, the generated electricity should be measured by an electricity meter. The monitored results are compiled in the format.

Monitoring (Measurement) Sheet for Solar PV project

Project title	
Name of the site	
Name/ No. of the Monitoring Meter	
Starting date of Monitoring	
Name of the person in charge	

Monitoring period		Measured date	Electricity generation amount indicated by electric meter (kWh)	Accumulated electricity generation amount (kWh)
From	to			
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0

Figure 3-3 Image of Monitoring Sheet

2) Prepare GHG emission reduction calculation sheet

The Mitigation Implementing Entity needs to prepare a GHG emission reduction calculation sheet for each selected mitigation action referring to the MRV Plan and Monitoring Sheet. To make GHG calculations practical and for easier cross-checking, it is better to prepare a simple GHG emission reduction calculation spreadsheet. If it is difficult to prepare a GHG emission reduction calculation sheet, consultation with consultants is recommended.

A GHG emission reduction calculation sheet can consist of two worksheets; one for data input and output, the other for the calculation formula. Examples of the GHG emission reduction calculation sheets are shown in Annex V.

3) Conduct monitoring

The Mitigation Implementing Entity conducts monitoring activity on a designated interval such as monthly, quarterly or bi-annually in line with the approved MRV plan and enters the monitored data into the Monitoring Sheet. The original monitored data need to be stored securely.

3-2-2. Prepare and submit Mitigation Monitoring Reports

Procedure

Responsible organization: **Mitigation Implementing Entities**

- The Mitigation Implementing Entity prepares the Mitigation Monitoring Report using the data of the Monitoring Sheet and the results of GHG emission reduction calculations.
- General information on the mitigation action are also described in the Mitigation Monitoring Report. The contents of the Mitigation Monitoring Report are shown in Table 3-9.
- The Mitigation Implementing Entity calculates the GHG emission reductions for the mitigation action to MRV once a year using the data contained in the Monitoring Sheets and GHG calculation sheet.
- The Mitigation Implementing Entity submits the Mitigation Monitoring Report to the Sectoral Oversight Unit by the end of January (once a year).

In case the mitigation action is implemented by the Sectoral Oversight Unit, the Sectoral Oversight Unit should carry out the above activities related to GHG emission calculation.

1) Prepare Mitigation Monitoring Report

Basic contents of the Mitigation Monitoring Report are as follows, and the format of the report is attached in Annex IV. However, the format and contents of the Mitigation Monitoring Report may be modified once the Vietnamese Government issues a guidance on MRV.

On behalf of the Mitigation Implementing Entity, the Sectoral Oversight Unit can prepare the entire or certain parts of the Mitigation Monitoring Report, in case the Mitigation Implementing Entity does not have enough capacity to complete the report.

Table 3-9 Contents of Mitigation Monitoring Report

I. Monitoring period
II. Emission reductions of the monitoring period
III. Processes of the emission reduction calculation

- **General guides to complete Mitigation Monitoring Report**

I. Monitoring period

Give the months of the year when monitoring activity was conducted and the period which the Mitigation Monitoring Report covers.

II. Emission reductions of the monitoring period

Give the result of GHG emission reduction calculation for the monitoring period using the applied methodology(ies). At the end of the monitoring period (December unless the project ends in another month of the year), the Mitigation Implementing Entity enters all the monitored data into the prepared GHG emission reduction calculation sheet.

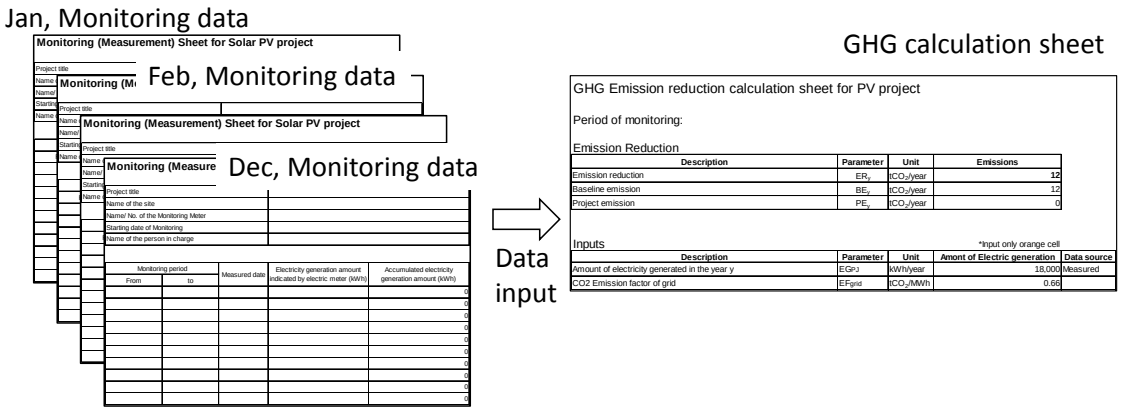


Figure 3- 4 Image of data input to GHG emission reduction calculation sheet

III. Processes of the emission reduction calculation

Describe the processes of GHG emission reduction calculation using the applied methodology(ies) for the monitoring period.

2) Submit Mitigation Monitoring Report

The Mitigation Implementing Entity submits the Mitigation Monitoring Report to the Sectoral Oversight Unit by the end of January (once a year).

3-2-3. Review and submit Sectoral Monitoring Report

Procedure

Responsible organization: **Sectoral Oversight Units**

- The Sectoral Oversight Unit thoroughly reviews the submitted Mitigation Monitoring Reports. Following elements should be considered in examining the reports:
  - Whether there is a lack of information in the submitted Mitigation Monitoring Report
  - Whether there is a big gap between the MRV plan and the submitted Mitigation Monitoring Report
- The Sectoral Oversight Unit requests the Mitigation Implementing Entity to modify and re-submit the Mitigation Monitoring Reports if they are not complete or sufficiently written in accordance with the above items.
- The Sectoral Oversight Unit compiles the Mitigation Monitoring Reports to develop the Sectoral Monitoring Report and then submits it to the MRV Management Unit by the end of February (once a year).

The Sectoral Oversight Unit reviews the Mitigation Monitoring Reports submitted by the Mitigation Implementing Entities by the end of February (once a year).

If there are any points that need to be clarified in the Mitigation Monitoring Report, the Sectoral

Oversight Unit should request the Mitigation Implementing Entity to revise and re-submit if necessary.

After reviewing the Mitigation Monitoring Reports, the Sectoral Oversight Unit compiles all the Mitigation Monitoring Reports into one Sectoral Monitoring Report and submits it to the MRV Management Unit.

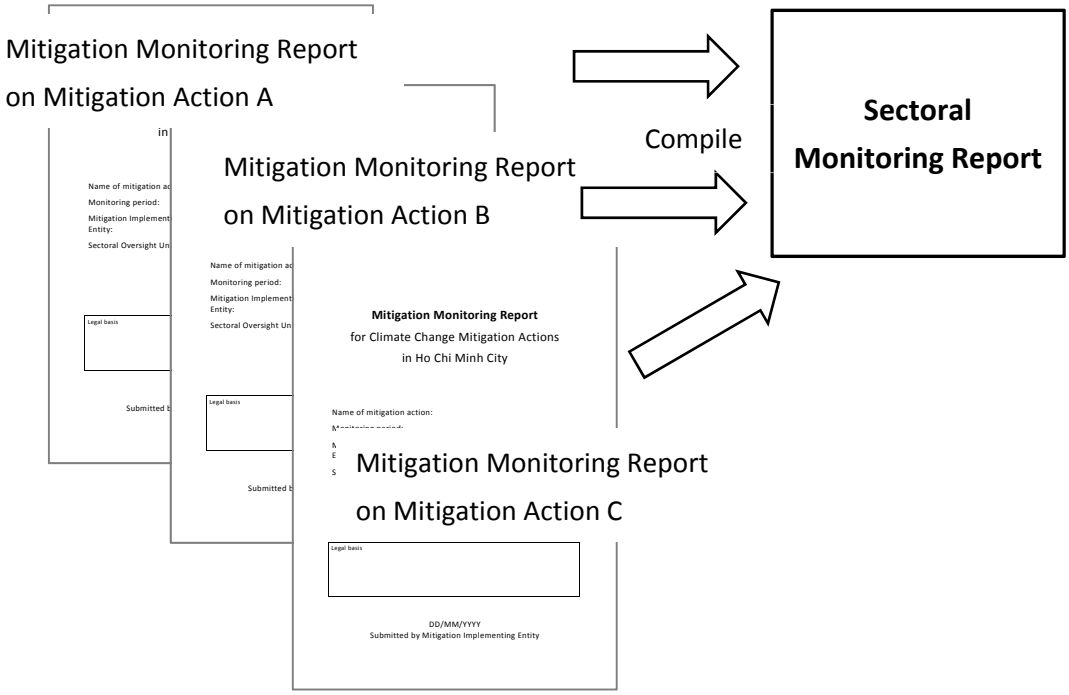


Figure 3-5 Image of compilation of Mitigation Monitoring Reports

3-3. Approve MRV result

At this final process of MRV, the result of measurements and reporting activities that were implemented by the Mitigation Implementing Entity and reviewed by the Sectoral Oversight Unit is further examined for official approval by the MRV Authorization Unit of the city.

3-3-1. Compile Sectoral Monitoring Reports

Procedure

Responsible organization: **MRV Management Unit**

- The MRV Management Unit thoroughly examines the Sectoral Monitoring Reports submitted by the Sectoral Oversight Units of all sectors. The following elements should be considered in examining the reports:
  - Whether there is a lack of information/ data in the submitted Sectoral Monitoring Report
  - Whether the MRV for the approved mitigation actions has been adequately implemented in accordance with the approved MRV Plan
  - Whether GHG emission reduction is accurately calculated in accordance with the approved MRV Plan and whether appropriate data is applied for the calculation.
- The MRV Management Unit requests the Sectoral Oversight Units to modify and re-submit the Sectoral Monitoring Reports if they are not complete or sufficiently written in accordance with the above items.
- The MRV Management Unit compiles the Sectoral Monitoring Reports of the year submitted by all Sectoral Oversight Units into the MRV Report.
- By the end of March, the MRV Management Unit submits the MRV Report to the MRV Authorization Unit with a recommendation for approval.

In this step, the MRV Management Unit examines and compiles all of the reports submitted by the Sectoral Oversight Units in the city into the MRV Report. This examination and approval process will function similarly to verification (V) of MRV activities. The MRV Management Unit should communicate with the Sectoral Oversight Units to assist them complete and submit their Sectoral Monitoring Report promptly.

In examining the submitted Sectoral Monitoring Reports, the MRV Management Unit should pay attention to the completeness of the report as well as to the consistency with the approved MRV plan of each mitigation action. If a submitted report is lacking certain required information or if it contains unclear or apparently false information, the MRV Management Unit needs to communicate and clarify with the responsible Sectoral Oversight Unit.

Examination of the report also involves technical review, in which the MRV Management Unit checks and confirms whether the GHG calculation was adequately done. Adequacy of measured

activity data and selected emission factors for the GHG emission reduction calculation should be confirmed to the extent possible. The MRV Management Unit may seek technical support from third parties such as academic institutions, research institutions or private consultants.

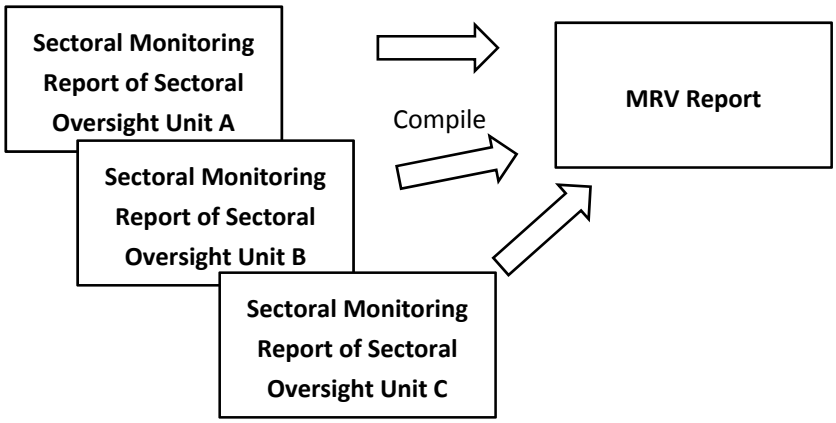


Figure 3-6 Image of compilation of Sectoral Monitoring Reports

In consolidating multiple Sectoral Monitoring Reports into one MRV Report, each city may design the contents of the MRV Report based on the current reporting practice of the city; however, it is advised the MRV Report should contain at least the following information:

- Sector category
- Name of the mitigation action
- Sectoral Oversight Unit(s) and Mitigation Implementing Entity(ies)
- Classification of MRV or Non-MRV
- Emission reductions achieved by the mitigation action during the year

Table 3-10 Example of MRV Report

No.	Sector	Name of mitigation action	Sectoral Oversight Unit	Mitigation Implementing Entity	MRV/ Non-MRV	GHG emission reductions (tCO_2e)
1	Energy		Unit AA	Entity A	MRV	
2					MRV	
3					Non-MRV	
4				Entity B	MRV	
5					MRV	
-		Sub-total				
6	Transport		Unit BB	Entity C	MRV	
7					Non-MRV	
8				Entity D	MRV	
9					Non-MRV	
-		Sub-total				
10	Waste		Unit CC	Entity E	MRV	
11					MRV	
12				Entity F	MRV	
…					Non-MRV	
-		Sub-total				

3-3-2. Approve MRV Reports

Procedure

Responsible organization: **MRV Authorization Unit**

- By the end of May, the MRV Authorization Unit receives the MRV Report with a recommendation for approval from the MRV Management Unit and approves the MRV Report.
- By the end of June, MRV Report is notified through the MRV Management Unit to relevant entities in the city as well as to the MONRE.

The MRV Authorization Unit approves the MRV Report submitted by the MRV Management Unit. The MRV Authorization Unit either approves the MRV Report or rejects it for further improvement by the MRV Management Unit.

Upon official approval of the MRV Report, the report is dispatched to all relevant entities in the city and to the MONRE through the MRV Management Unit of the city.

3-3-3. Update database on mitigation actions to MRV

Procedure

Responsible organization: **MRV Management Unit**

- The MRV Management Unit updates the database on mitigation actions with information contained in the approved MRV Report including attained GHG emission reductions.

The MRV Management Unit updates the database on climate change mitigation, which was developed at Step A-5 (Section 3-1-5) “Update database on mitigation actions to MRV” by adding information on the result of MRV activities of the previous year.

Annex I Case Studies on MRV

1. Installation of solar PV system on the roof top of the public buildings
2. Introduction of air conditioning system with inverters to the offices
3. Replacement CFL with LED for the small street lamps
4. Replacement to high energy efficient boilers at a dairy factory
5. Introduction of CNG buses
6. Promotion of eco-driving
7. Introduction of Bus Rapid Transit (BRT)
8. Introduction of urban railway
9. Collection and utilization of landfill gas at final disposal site
10. Recycling of municipal solid waste
11. Production of organic fertilizer
12. Collection of animal manure for biogas generation

Note: Case studies included in this Annex contain examples of MRV Plan, Mitigation Monitoring Report and emission reduction calculation sheet. Case studies are based on either of the following project;

i) An actual on-going project,

ii) A project at construction or planning stage, or

iii) A hypothetical project which can be implemented in Vietnam in the future.

Case Study 1: Installation of Solar PV system on the roof top of the public buildings

MRV Plan

Note: Case study 1 is based on the actual on-going project.

I. General information on the mitigation action

a) Name of the mitigation action

Installation of Solar PV system on the roof top of the public buildings

b) Involved organizations and their roles

Department of Science and Technology (DOST): Sectoral Oversight Unit.
Energy Conservation Center (ECC): Mitigation Implementing Entity. Responsible for installation and operation of the solar PV system. Also responsible for monitoring the electricity generation of each Solar PV system, calculation of GHG emission reductions, and preparation of the Mitigation Monitoring Report. The Mitigation Monitoring Report will be submitted to DOST.

c) Objectives

HCMC has a target of achieving 1.74% of electricity use from renewable energy. In order to promote renewable energy generation, HCMC set the program named the "Pilot program for supporting mechanisms of solar PV investment in Ho Chi Minh City" to provide incentives to households and buildings that are willing to install the solar photovoltaic (PV) system on their rooftop. The solar PV system (20kW) is installed on the roof top of the DOST's building under this program.

d) Technology introduced under the mitigation action

The solar PV system is an electricity generation system which converts sunlight into electricity by using PV modules. In general, the system also includes ancillary equipment such as inverters in order to change the electrical current from direct current (DC) to alternating current (AC).

e) Target GHG type

CO_2

f) Location

DOST's office building in HCMC

g) Timeframe

Started on January 1st 2016.

h) Cost of mitigation action

800 million VND

i) Benefits of mitigation action and contribution to sustainable development

Social benefits: Stimulation of the utilization of renewable energy

Economic benefits: reduction of the electricity cost

Environmental benefits: reduction of air pollutants from the electricity generation plants using fossil fuels

j) Source of funding and supporting financial scheme

HCMC supports the investment cost including equipment costs and installation cost under the program "Pilot program for supporting mechanisms of solar PV investment in Ho Chi Minh City."

k) Information on international market mechanisms

No international market mechanism is applied.

II. Emission reduction calculation, monitoring and reporting

a) Logic of GHG emission reduction

The electricity generated by the solar PV system is used as a substitute for the electricity from the grid. The electricity generated by the solar PV system does not emit any CO_2. On the other hand, thermal power plants connected to the power grid are using fossil fuels and emitting CO_2. Therefore, utilizing the electricity generated by solar PV system results in CO_2 emission reductions.

b) Methodology to calculate GHG emission reduction

A simple methodology was applied for this project as below, based on a basic emission calculation formula provided in the approved CDM methodology, "AMS-I.A: Electricity generation by the user."

$$\boldsymbol{ER_y = BE_y - PE_y}$$

$$\boldsymbol{BE_y = EG_{p,y} \times EF_{grid}}$$

BE_y	Baseline emissions in year *y* (tCO_2/year)
$EG_{p,y}$	Annual generated electricity by solar PV system (kWh)
EF_{grid}	Emission Factor of the grid (tCO_2/kWh)

$$\boldsymbol{PE_y = EG_{p,y} \times EF_{PV}} = 0$$

PE_y	Project emissions in year *y* (tCO_2/year)
$EG_{p,y}$	Annual generated electricity by solar PV system (kWh)
EF_{PV}	Emission Factor of the solar PV system (tCO_2/kWh) = 0

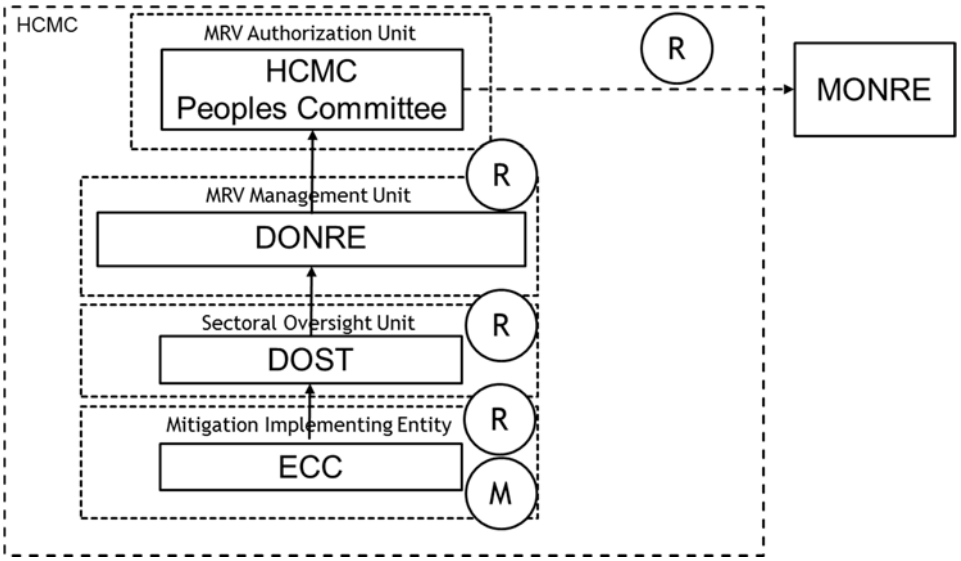
Monitoring parameters are as follows:

EF_{grid}	Emission Factor of the grid (tCO_2/kWh)
$EG_{p,y}$	Annual generated electricity by solar PV system (kWh)

c) Estimated GHG emission reduction

11 tCO_2/year

d) Organizational structure for monitoring and reporting



e) Monitoring period

From January 1st 2016 to December 31st 2016

f) Monitoring methods

Monitoring parameters

Parameter	Monitoring method	Person/position in charge	Site
$EG_{p,y}$ Annual generated electricity by solar PV system (kWh)	· The value of the electric meter is read and recorded monthly. · Recorded data is accumulated for 12 months and used for the GHG emission reduction calculation.	Staff of ECC	DOST's building
EF_{grid} Emission factor of grid (tCO_2/kWh)	· Default value in the official document by the MONRE is applied. · Updated value will be checked every year and the latest value will be applied where appropriate.	Staff of ECC	N/A

Mitigation Monitoring Report

Note: The following descriptions are based on the actual on-going project.

a) Monitoring period

From January 1st 2016 to December 31st 2016 (12 months)

b) Emission reductions of the monitoring period

12 tCO_2/year

c) Processes of the emission reduction calculation

The amount of generated electricity by the solar PV systems was monitored as designated in the MRV Plan. The accumulated electricity generation amount was 20,764.40 (kWh).

Grid emission factor of the grid is 0.66 tCO_2/MWh, referred the latest official EF published by the MONRE in May 2016.

Emission reductions for 12 months are calculated as follows:

$$\boldsymbol{BE_y = EG_{p,y} \times EF_{grid}}$$
$$= 20{,}764.40\ (\text{kWh}) \times 0.66\ (\text{tCO2/MWh})$$
$$= 13.7\ \text{tCO}_2\text{/year}$$

$$\boldsymbol{PE_y = EG_{p,y} \times EF_{PV}}$$
$$= 0\ \text{tCO}_2\text{/year}$$

$$\boldsymbol{ER_y = BE_y - PE_y}$$
$$= 13.7 - 0 = 13.7\ \text{tCO}_2\text{/year}$$

Data for electricity generation provided by ECC

Monitoring period		Monitoring date	Electricity generation indicated by electric meter (kWh)	Accumulated electricity generation amount (kWh)
From	To			
1-Jan-16	31-Jan-16	31-Jan-16	1,810.48	1,810.48
1-Feb-16	29-Feb-16	29-Feb-16	1,812.49	3,622.97
1-Mar-16	31-Mar-16	31-Mar-16	2,016.81	5,639.78
1-Apr-16	30-Apr-16	30-Apr-16	1,821.87	7,461.65
1-May-16	31-May-16	31-May-16	1,757.80	9,219.45
1-Jun-16	30-Jun-16	30-Jun-16	1,512.80	10,732.24
1-Jul-16	31-Jul-16	31-Jul-16	1,786.83	12,519.07
1-Aug-16	31-Aug-16	31-Aug-16	1,701.74	14,220.81
1-Sep-16	30-Sep-16	30-Sep-16	1,570.40	15,791.21
1-Oct-16	31-Oct-16	31-Oct-16	1,621.46	17,412.67
1-Nov-16	30-Nov-16	30-Nov-16	1,887.52	19,300.20
1-Dec-16	31-Dec-16	31-Dec-16	1,464.20	20,764.40

Emission Reduction Calculation Sheet

GHG Emission reduction calculation sheet for PV project

Period of monitoring:

Emission Reduction

Description	Parameter	Unit	Emissions
Emission reduction	ER_y	tCO_2/year	**13**
Baseline emission	BE_y	tCO_2/year	13
Project emission	PE_y	tCO_2/year	0

Inputs

Description	Parameter	Unit	Amont of Electric generation	Data source
Amount of electricity generated in the year y	EG_{PJ}	kWh/year	20,764	Measured
CO2 Emission factor of grid	EF_{grid}	tCO_2/MWh	0.66	

Case Study 2: Introduction of air conditioning system with inverters to the office

MRV Plan

Note: Case study 2 is a hypothetical project. The data, name of organizations, and other descriptions contained in this case study are not based on the actual information.

I. General information on the mitigation action

a) Name of the mitigation action

Introduction of air conditioning system with inverters to the office

b) Involved organizations and their roles

Department of Industry and Trade (DOIT): Sectoral Oversight Unit.

District C: Mitigation Implementing Entity. Responsible for installation and operation of the air conditioning system. Also responsible for monitoring the electricity consumption by the air conditioning systems, calculation of GHG emission reductions, and preparation of the Mitigation Monitoring Report. The monitoring report will be submitted to DOIT.

c) Objectives

The objective is to replace the conventional air conditioners that are not equipped with an inverter with new and high energy efficiency air conditioners that are equipped with an inverter at the district office. The project aims to reduce the electricity consumption of air conditioning systems in the office.

d) Technology introduced under the mitigation action

An inverter is an apparatus to control the speed of the compressor in line with different load demand. Conventional air-conditioning system does not contain an inverter so that the electricity consumption is larger than the air-conditioning system with inverters.

e) Target GHG type

CO_2

f) Location

This project takes place in one district office in HCMC

g) Timeframe

Started from January 1st 2016 until December 31st 2016

h) Cost of mitigation action

750,000,000 VND

h) Benefits of mitigation action and contribution to sustainable development

Social benefits: provision of better working environment for district officers

Economic benefits: Reduce electricity cost, lengthening operational life time of air conditioners; decreasing maintenance cost for the air conditioning systems
Environmental benefits: Reduce emissions of air pollutants through reduction of electricity consumption

i) Source of funding and supporting financial scheme

District's own budget

j) Information on international market mechanisms

No international market mechanism is applied.

II. Emission reduction calculation, monitoring and reporting

a) Logic of GHG emission reduction

Electricity consumption of the air conditioner with an inverter is less than the conventional air conditioner without an inverter. Replacing the conventional air conditioner without inverter to the air conditioner with inverter results in reduction of electricity consumption. That results in CO_2 emission reductions.

b) Methodology to calculate GHG emission reduction

A simple methodology was applied for this project as below, based on a basic emission calculation formula provided in the approved JCM methodology, "JCM_VN_AM006_ver01.0."

$$\boldsymbol{ER_y = BE_y - PE_y}$$

$$\boldsymbol{BE_y = \sum_i \left\{ EC_{PJ,i,y} \times \left(COP_{PJ,i} \div COP_{BE,i} \right) \right\} \times EF_{grid}}$$

BE_y	Baseline emissions in year *y* (tCO_2/year)
$EC_{PJ,y}$	Annual electricity consumption (kWh)
$COP_{PJ,i}$	Coefficient Of Performance (COP) of project air conditioning system i (-)
$COP_{BE,i}$	COP of baseline air conditioning system i (-)
EF_{grid}	Emission Factor of the grid (tCO_2/kWh)

$$\boldsymbol{PE_y = \sum_i EC_{PJ,i,y} \times EF_{grid}}$$

PE_y	Project emissions in year *y* (tCO_2/year)
$EC_{PJ,y}$	Annual electricity consumption (kWh)
EF_{grid}	Emission Factor of the grid (tCO_2/kWh)

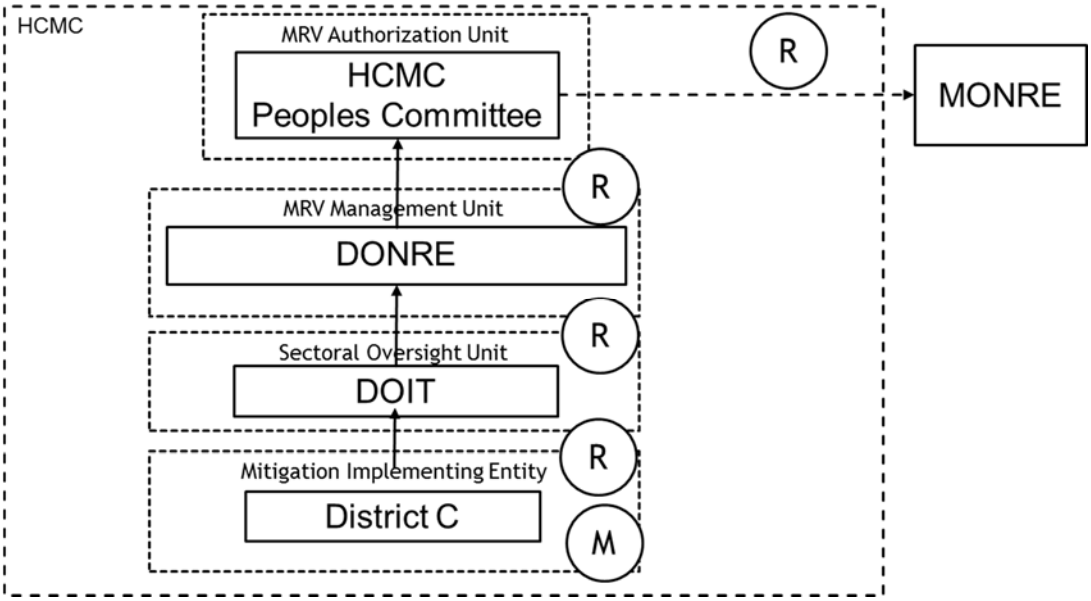
Monitoring Parameters:

EF_{grid}	Emission Factor of the grid (tCO_2/kWh)
$EC_{p,y}$	Annual electricity consumption by air-conditioning system (kWh)

c) Estimated GHG emission reduction

40 tons CO_2/year

d) Organizational structure for monitoring and reporting



e) Monitoring period

From January 1st 2016 to December 31st 2016

f) Monitoring methods

Monitoring parameters

Parameter	Monitoring method	Person/position in charge	Site
$EC_{PJ,y}$ Annual electricity consumption (kWh)	· The electric consumption meter is set for each air conditioner. · The value of electric consumption meter is read and recorded monthly. · Recorded data is accumulated for 12 months and used for the GHG emission reduction calculation.	Staff of the district	District office
EF_{grid} Emission factor of grid (tCO_2/kWh)	· Default value officially published by the MONRE is applied. · Updated value will be checked every year and the latest value will be applied where appropriate.	Staff of the district	N/A

Fixed parameters

Parameter	Source	Value
$COP_{BE,i}$ COP of baseline air conditioning system i (-)	This value is provided by the supplier of the air conditioning system.	2.7
$COP_{PJ,i}$ COP of project air conditioning system i (-)	This value is provided by the supplier of the air conditioning system.	3.5

Mitigation Monitoring Report

Note: The project is a hypothetical one

a) Monitoring period

From January 1st 2016 to December 31st 2016 (12 months)

b) Emission reductions of the monitoring period

31 tCO_2/year

c) Processes of the emission reduction calculation

The data of electricity consumption was monitored and recorded by the District.

COP of the project air conditioning system was 3.5 and COP of baseline air conditioning system is 2.7.

Grid emission factor of the grid is 0.66 tCO_2/MWh, referred the latest official EF provided by the MONRE in May 2016.

Emission reductions for 12 months are calculated as follows:

$$\boldsymbol{BE_y = \sum_i \{EC_{PJ,i,y} \times (COP_{PJ,i} \div COP_{BE,i})\} \times EF_{grid}}$$

= 157,212 (kWh) x (3.5 / 2.7) x 0.66 (tCO_2/MWh) /10000

= 134.50 tCO_2

$$\boldsymbol{PE_y = \sum_i EC_{PJ,i,y} \times EF_{grid}}$$

= 157,212 (kWh) x 0.66 (tCO_2/MWh) /1000

= 103.76 tCO_2

$$\boldsymbol{ER_y = BE_y - PE_y}$$

= 134.50 – 103.76 = 30.74 (tCO_2/year)

Data for electricity consumption for the air conditioning system provided by District

Monitoring period		Monitoring date	Electricity consumption (kWh)	Accumulated Electricity consumption (kWh)
From	To			
1-Jan-16	31-Jan-16	31-Jan-16	13,200	13,200
1-Feb-16	29-Feb-16	29-Feb-16	17,160	30,360
1-Mar-16	31-Mar-16	31-Mar-16	18,480	48,840
1-Apr-16	30-Apr-16	30-Apr-16	15,840	64,680
1-May-16	31-May-16	31-May-16	10,560	75,240
1-Jun-16	30-Jun-16	30-Jun-16	11,880	87,120
1-Jul-16	31-Jul-16	31-Jul-16	11,220	98,340
1-Aug-16	31-Aug-16	31-Aug-16	9,240	107,580
1-Sep-16	30-Sep-16	30-Sep-16	10,032	117,612
1-Oct-16	31-Oct-16	31-Oct-16	11,880	129,492
1-Nov-16	30-Nov-16	30-Nov-16	13,200	142,692
1-Dec-16	31-Dec-16	31-Dec-16	14,520	157,212

Emission Reduction Calculation Sheet

GHG Emission reduction calculation sheet for introduction of air conditioning system with inverters to the office

Period of monitoring:

Emission Reduction

Description	Parameter	Unit	Emissions
Emission reduction	ER_y	tCO_2/year	**31**
Baseline emission	BE_y	tCO_2/year	134
Project emission	PE_y	tCO_2/year	103

Inputs

Description	Parameter	Unit	Value	Data source
COP of old air conditioning system	-	-	2.7	specific data from supplier
COP of new air conditioning system	-	-	3.5	specific data from supplier
Emission factor of grid	EF_{fuel}	tCO_2/MWh	0.66	default value
Annual electricity consumption	FC_p	MWh/year	157,212	Monitored

Case Study 3: Replacement CFL with LED for the small street lamps

MRV Plan

Note: Case study 3 is a hypothetical project. The data, name of organizations, and other descriptions contained in this case study are not based on the actual information.

I. General information on the mitigation action

a) Name of the mitigation action

Replacement compact fluorescent lamp (CFL) with light emitting diode (LED) of the small street lamps

b) Involved organizations and their roles

DOIT: Sectoral Oversight Unit.

Districts and/or wards: Mitigation Implementing Entity. Install and maintenance the LED lamps. Monitor the electricity consumption by the LED lamps and other lamps, calculate GHG emission reductions, and prepare the monitoring report. The monitoring report will be sent to DOIT.

c) Objectives

The objective is to reduce the electricity consumption of small street lamps in of HCMC and also to brighten the street. 2,100 CFL lamps are replaced with LEDs.

d) Technology introduced under the mitigation action

An LED lamp is a lighting device using a semiconductor device that emits visible light when an electric current passes through it. Electricity consumption of LED is lower than conventional light, and life time of LED is longer than conventional lighting devices.

e) Target GHG type

CO_2

f) Location

Small streets in some districts of HCMC

g) Timeframe

From January 1st 2016 until December 31st 2022

h) Cost of mitigation action

Approximately 1,090 million VND

h) Benefits of mitigation action and contribution to sustainable development

Social benefits: Brighten the street, Secure safety in the night;

Economic benefits: Reduce electricity cost, Long operational life time;

Environmental benefits: Eco-friendly (free of toxic chemicals), Reduce air pollutants from the electric generation plant using fossil fuels:

i) Source of funding and supporting financial scheme

HCMC supports the investment cost including the equipment cost and the installation cost.

j) Information on international market mechanisms

No international market mechanism is applied.

II. Emission reduction calculation, monitoring and reporting

a) Logic of GHG emission reduction

Electricity consumption of LED is less than CFL. Replacing CFL with LED results in reduction of electricity consumption. That results in CO_2 emission reductions.

b) Methodology to calculate GHG emission reduction

A simple methodology was applied for this project as below, based on a basic emission calculation formula provided in the approved CDM methodology, "AMS-II.L, Demand-side activities for efficient outdoor and street lighting technologies."

$$\boldsymbol{ER_y = BE_y - PE_y}$$

$$\boldsymbol{BE_y = \sum_i (R_{BL,i} \times Q_{BL,i,y} \times O_{BL,i,y}) \times EF_{grid}}$$

BE_y	Baseline emissions in year *y* (tCO_2/year)
$R_{BL,i}$	Rated power of the CFL of the group of i lighting devices (kW)
$Q_{BL,I,y}$	Quantity of CFL used in the site (units)
$O_{BL,I,y}$	Annual operating hours for the CFL in year y
EF_{grid}	Emission Factor of the grid (tCO_2/kWh)

$$\boldsymbol{PE_y = \sum_i (R_{PJ,i} \times Q_{PJ,i,y} \times O_{PJ,i,y}) \times EF_{grid}}$$

PE_y	Baseline emissions in year *y* (tCO_2/year)
$R_{PJ,i}$	Rated power of the LED of the group of i lighting devices (kW)
$Q_{PJ,I,y}$	Quantity of LED distributed and installed under the project activity (units)
$O_{PJ,I,y}$	Annual operating hours for the LED in year y
EF_{grid}	Emission Factor of the grid (tCO_2/kWh)

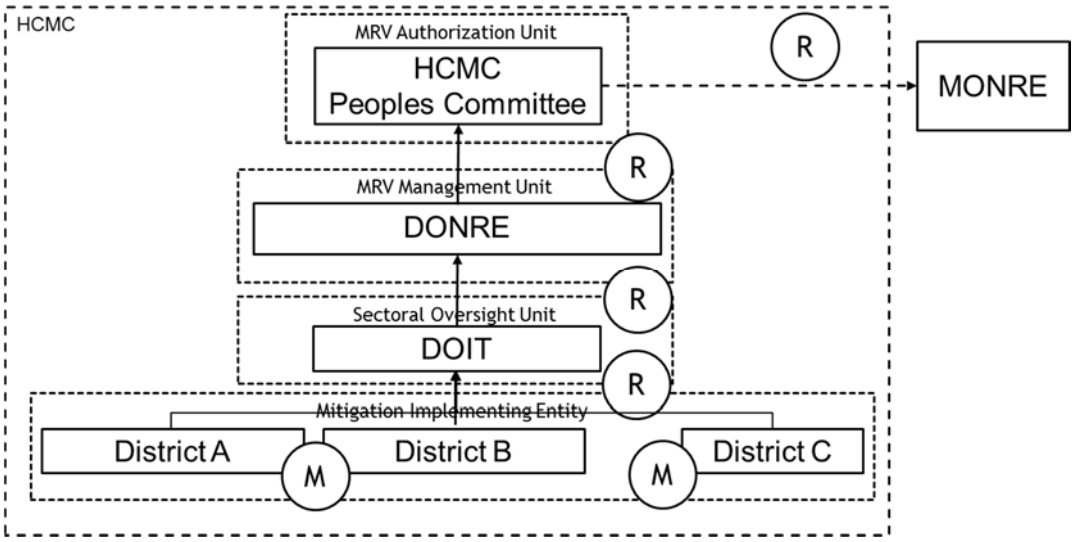
Monitoring Parameter:

EF_{grid}	Emission factor of the grid (tCO_2/kWh)
$Q_{PJ,I,y}$	Quantity of LED distributed and installed under the project activity (units)
$O_{PJ,I,y}$	Annual operating hours for the LED in year y

c) Estimated GHG emission reduction

50 tCO_2/year

d) Organizational structure for monitoring and reporting



e) Monitoring period

from January 1st 2016 until December 31st 2016

f) Monitoring methods

Monitoring parameters

Parameter	Monitoring method	Person/position in charge	Site
$Q_{BL,i}$ Quantity of CFL used in the site (units)	· The staff of the districts counts the quantity of CFL which are used at the site before the project starts.	Staff of the districts	The target small street
$O_{BL,l,y}$ Annual operating hours for CFL in year y (hours)	· A timer is used to count the hours. · The staff of the districts checks and records the setting value before the project starts.	Staff of the districts	Controller of the street lamps
$Q_{PJ,i}$ Quantity of LED distributed and installed under the project activity (units)	· The staff of the districts counts the quantity of installed LED lamps. · These data are recorded for 12 months.	Staff of the districts	The target small street
$O_{PJ,l,y}$ Annual operating hours for the LED in year y (hours)	· A timer is used to count the hours. The staff of the districts checks and records the setting value monthly.	Staff of the districts	Controller of the street lamps
EF_{grid} Emission factor of grid (tCO_2/kWh)	· Default value in official document by the MONRE is applied. · Check updated value every year and apply the latest value where appropriate.	Staff of the districts	N/A

Fixed parameters

Parameter	Source	Value
$R_{BL,i}$ Rated power of the CFL of the group of i lighting devices (W)	This value is provided by the supplier of CFL lamps.	18
$R_{PJ,i}$ Rated power of the LED of the group of i lighting devices (W)	This value is provided by the supplier of LED lamps.	9

Mitigation Monitoring Report

Note: The project is a hypothetical one

a) Monitoring period

From January 1st 2016 to December 31st 2016 (12 months)

b) Emission reductions of the monitoring period

12 tCO_2/year

c) Processes of the emission reduction calculation

The quantity of LED lamps distributed and installed under the project was counted and recorded monthly. And the setting value for operating hours was checked and recorded monthly.
Grid emission factor of the grid is 0.66 tCO_2/MWh, referred the latest official EF provided by the MONRE in May 2016.

Emission reductions for 12 months are calculated as follows:

$$\boldsymbol{BE_y} = \sum_{\boldsymbol{i}} (\boldsymbol{R_{BL,i,y}} \times \boldsymbol{Q_{BL,i,y}} \times \boldsymbol{O_{BL,i,y}}) \times \boldsymbol{EF_{grid}}$$

$$= \sum_i (18\ (kW) \times 250 \times 4{,}015\ (hous)) \times 0.66\ (\mathrm{tCO2/MWh})$$

$$= 152 \times 0.66\ (\mathrm{tCO2/MWh})$$

= 100 t-CO_2/year

$$\boldsymbol{PE_y} = \sum_{\boldsymbol{i}} (\boldsymbol{R_{PL,i,y}} \times \boldsymbol{Q_{PJ,i,y}} \times \boldsymbol{O_{PJ,i,y}}) \times \boldsymbol{EF_{grid}}$$

$$= \sum_i (9\ (kW) \times 250 \times 4{,}015\ (hous)) \times 0.66\ (\mathrm{tCO2/MWh})$$

$$= 76 \times 0.66\ (\mathrm{tCO2/MWh})$$

= 50 t-CO_2/year

$$\boldsymbol{ER_y} = \boldsymbol{BE_y} - \boldsymbol{PE_y}$$

$$= 100 - 50 = 50\ \mathrm{tCO_2/year}$$

Emission Reduction Calculation Sheet

Emission reduction calculation sheet for LED project

Emission Reduction

Description	Parameter	Unit	Emissions
Emission reduction	ER_y	tCO_2/year	**50**
Baseline emission	BE_y	tCO_2/year	100
Project emission	PE_y	tCO_2/year	50

Inputs

Description	Parameter	Unit	value	Data source
Annual operating hours of CFL in the year y	$O_{BL,i,y}$	hours/year	4015	Monitored
Quantity of CFL in year y	$Q_{BL,l,y}$	unit	250	Monitored
Wattage per lamp of CFL category i	$R_{BL,i}$	W	18	Catalog data
Annual operating hours of LED in the year y	$O_{PJ,i,y}$	hours/year	4015	Monitored
Quantity of CFL in year y	$Q_{PJ,l,y}$	unit	250	Monitored
Wattage per lamp of normal lamp category i	$R_{PJ,i}$	W	9	Catalog data
CO2 Emission factor of grid	EF_{grid}	tCO_2/MWh	0.66	

Case Study 4: Replacement to high energy efficient boilers at a dairy factory

MRV Plan

Note: Case study 4 is a hypothetical project. The data, name of organizations, and other descriptions contained in this case study are not based on the actual information.

I. General information on the mitigation action

a) Name of the mitigation action

Replacement to high energy efficient boiler at a dairy factory

b) Involved organizations and their roles

DOIT: Sectoral Oversight Unit.

The dairy factory: Mitigation Implementing Entity. Replace three existing low-efficient boilers with high efficient ones. Monitor the consumption of Compressed Natural Gas (CNG), calculate GHG emission reductions, and prepare the monitoring report. The monitoring report will be sent to DOIT.

c) Objectives

The objectives of the project are:

- to reduce CNG consumption by the boiler system and thus, reduce the energy consumption in the production process,
- to comply with the Law on Energy Conservation and Efficiency by reducing energy consumption,
- to reduce the production cost.

d) Technology introduced under the mitigation action

The high efficient boiler will increase the efficiency of boiler from 83.6% to 95%.

e) Target GHG type

CO_2

f) Location

This project takes place at a dairy factory in HCMC.

f) Timeframe

From January 1st 2017 to December 31st 2026

g) Cost of mitigation action

5,000 million VND

h) Benefits of mitigation action and contribution to sustainable development

Economic benefits: Reduce production cost

Environmental benefits: Reduce the consumption of CNG and thus, reduce the GHG emissions of the boiler system

i) Source of funding and supporting financial scheme

Company's own budget

j) Information on international market mechanisms

No international market mechanism is applied.

II. Emission reduction calculation, monitoring and reporting

a) Logic of GHG emission reduction

CO_2 is emitted by consuming fossil fuels such as CNG. CO_2 emission is reduced through reducing the consumption of CNG. Amount of CO_2 emissions are determined by the emission coefficients of the fuel and amount of fuel consumption.

b) Methodology to calculate GHG emission reduction

$$\boldsymbol{ER_y = BE_y - PE_y}$$

$$\boldsymbol{BE_y = FC_{p,y} \times NPV_{fuel} \times EF_{fuel,B}}$$

BE_y	Baseline emissions (tCO_2/year)
FC_{bl}	Average annual fuel consumption by existing boilers in 2014, 2015, 2016 (ton)
NPV_{fuel}	Net calorific value of CNG (MJ/ton) (IPCC, 2006)
$EF_{fuel,\ BL}$	Emission Factor of the fuel for baseline (tCO_2/MJ)

$$\boldsymbol{PE_y = FC_{p,y} \times NPV_{fuel} \times EF_{fuel,p}}$$

PE_y	Project emissions in year *y* (tCO_2/year)
$FC_{p,y}$	Annual fuel consumption by high efficient boilers (ton)
NPV_{fuel}	Net calorific value of CNG (MJ/ton) (IPCC, 2006)
$EF_{fuel,\ PJ}$	Emission Factor of the fuel for project (tCO_2/MJ)

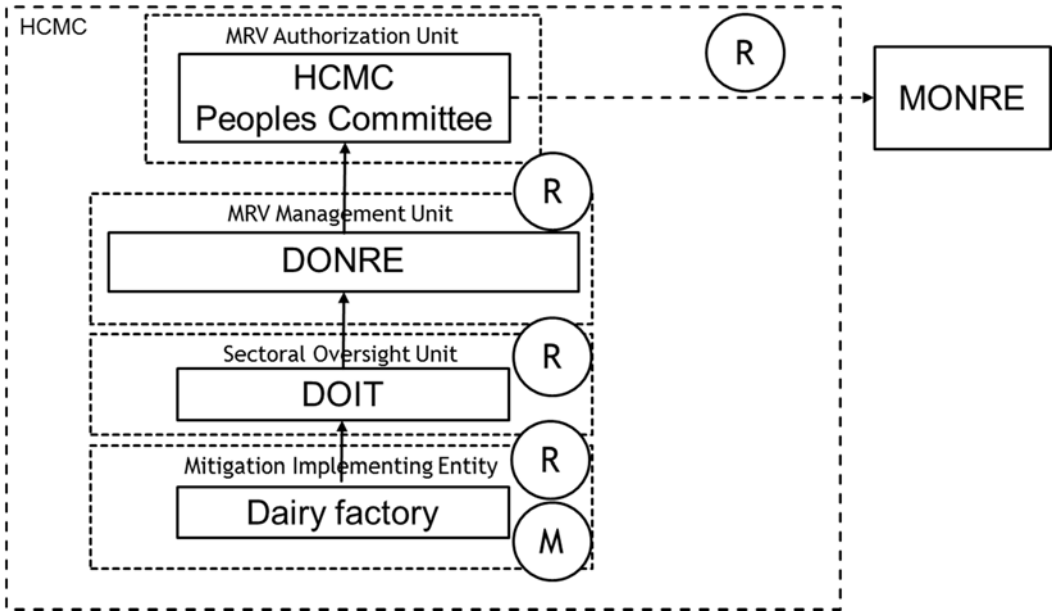
Monitoring Parameter:

EF_{fuel}	Emission Factor of the fuel (tCO_2/ton)
$FC_{p,y}$	Annual fuel consumption by boiler (ton)

c) Estimated GHG emission reduction

308 t-CO_2/year

d) Organizational structure for monitoring and reporting



e) Monitoring period

From January 1st 2017 to December 31st 2026

f) Monitoring methods

Monitoring parameters

Parameter	Monitoring method	Person/position in charge	Site
$FC_{B,y}$ Average annual fuel consumption by existing boilers in past three years (2014, 2015, 2016) (ton)	· The staff of the factory checks the value of the fuel consumption records of the existing boilers in past three years (2014, 2015 and 2016). · Calculate the average value of the annual fuel consumption of three years.	Staff of the factory	Factory
$FC_{p,y}$ Annual fuel consumption by high efficient boilers (ton)	· The staff of the factory reads and records the value of the fuel meter of the fuel tank to identify the fuel consumption monthly. · Recorded data is accumulated for 12 months and used for the GHG emission reduction calculation.	Staff of the factory	Factory

Fixed parameters

Parameter	Source	Value
NCV_{CNG} Net calorific value of CNG (MJ/ton)	Default value of "2006 IPCC Guidelines for National Greenhouse Gas Inventory"	48,000
EF_{CNG} Emission factor of CNG (tCO_2/MJ)	Default value of "2006 IPCC Guidelines for National Greenhouse Gas Inventory"	0.0000561

Mitigation Monitoring Report

Note: The project is a hypothetical one

a) Monitoring period

From January 1st 2017 to December 31st 2017 (12 months).

b) Emission reductions of the monitoring period

290 tCO_2/year

c) Processes of the emission reduction calculation

The CNG consumption was recorded monthly through the control system.

NPV of CNG is 48,000 MJ/ton

Emission factor of CNG is 0.0000561 tCO_2/MJ

Emission reductions for 12 months are calculated as follows:

$$\boldsymbol{BE_y = FC_{p,y} \times NPV_{fuel} \times EF_{fuel,B}}$$

= 800 (tons) x 48,000 (MJ/ton) x 0.0000561 (tCO_2/MJ)

= 2,154.24 (tons CO_2/year)

$$\boldsymbol{PE_y = FC_{p,y} \times NPV_{fuel} \times EF_{fuel,p}}$$

= 692 (tons) * 48,000 (MJ/ton) x 0.0000561 (tCO_2/MJ)

= 1,863.42 (tons CO_2/year)

$$\boldsymbol{ER_y = BE_y - PE_y}$$

= 2,154.24 – 1,863.42

= 290.82 (tCO_2/year)

Data for CNG consumption:

Monitoring period		Monitoring date	CNG Consumption (tons)	Accumulated CNG consumption (ton)
From	To			
1-Jan-17	31-Jan-17	31-Jan-17	150	150
1-Feb-17	29-Feb-17	29-Feb-17	140	290
1-Mar-17	31-Mar-17	31-Mar-17	145	435
1-Apr-17	30-Apr-17	30-Apr-17	156	591
1-May-17	31-May-17	31-May-17	178	769
1-Jun-17	30-Jun-17	30-Jun-17	134	903
1-Jul-17	31-Jul-17	31-Jul-17	152	1,055
1-Aug-17	31-Aug-17	31-Aug-17	150	1,205
1-Sep-17	30-Sep-17	30-Sep-17	160	1,365
1-Oct-17	31-Oct-17	31-Oct-17	173	1,538
1-Nov-17	30-Nov-17	30-Nov-17	145	1,683
1-Dec-17	31-Dec-17	31-Dec-17	180	1,863

Emission Reduction Calculation Sheet

GHG Emission reduction calculation sheet for high efficient boilers introducing project

Period of monitoring:

Emission Reduction

Description	Parameter	Unit	Emissions
Emission reduction	ER_y	tCO_2/year	**291**
Baseline emission	BE_y	tCO_2/year	2,154
Project emission	PE_y	tCO_2/year	1,863

Inputs

Description	Parameter	Unit	Value	Data source
Average annual CNG consumption by existing boiler	FC_{BL}	ton/year	800	historical data
Net Calorific value of CNG	NPV_{fuel}	MJ/ton	48000	default value
Emission factor of CNG	EF_{fuel}	tCO_2/MJ	0.000056	default value
Annual CNG consumption by high efficient boiler	FC_p	ton/year	692	Monitored

Case Study 5: Introduction of CNG buses

MRV Plan

Note: The following descriptions are based on the actual on-going project.

I. General information on the mitigation action

a) Name of the mitigation action

Introduction of CNG Bus for Public Bus Fleet by SaigonBus.

b) Involved organizations and their roles

Department of Transport (DOT): Sectoral Oversight Unit.

Management and Operation Center for Public Transport (MOCPT): Mitigation Implementing Entity. Receive the monitoring data from SaigonBus, calculate GHG emission reductions, and prepare the monitoring report. The monitoring report will be sent to DOT.

SaigonBus: Operate CNG buses and monitor/provide necessary data for GHG emission reduction calculations to MOCPT.

c) Objectives

HCMC invested in 21 new CNG buses for the bus route number 27 which started operation on 1 August 2016. Those CNG buses will promote the reduction of GHG emissions and local air pollutants such as particulate matters.

d) Technology introduced under the mitigation action

The diesel buses were used for the bus route number 27 (with 48 seats and 36 standing, engine is 5,958cc, vehicle weight is 9,880 tons). The CNG buses are used now for this route (with 40 seats and 28 standing, engine is 11,149cc, vehicle weight is 10,780 tons).

e) Target GHG type

CO_2

f) Location

This project takes place in HCMC (specifically, bus route No. 27).

g) Timeframe

Started on August 1st 2016.

h) Cost of mitigation action

N/A

i) Benefits of mitigation action and contribution to sustainable development

Social benefits: encouraging local people to see and use cleaner and safer buses

Economic benefits: Reduction of fossil fuel (diesel), increase clean fuel (CNG), reduce fuel cost,

improve energy condition and technology transfer

Environmental benefits: Reduction of noise, air pollutants: PM, CO.

j) Source of funding and supporting financial scheme

Transport operators invested in CNG fleet with tax incentives from HCMC.

k) Information on international market mechanisms

No international market mechanism was applied.

II. Emission reduction calculation, monitoring and reporting

a) Logic of GHG emission reduction

Main component of CNG is natural gas and it has low carbon content per energy than diesel fuel. Therefore, even though efficiency of the diesel engines is slightly better than that of the CNG engines, CO_2 emission are reduced through replacing diesel buses by CNG buses.

b) Methodology to calculate GHG emission reduction

A simple methodology was developed for this project as below, based on a basic emission calculation formula provided in the IPCC 2006 guidelines.

$$\boldsymbol{BE_y = SFC_{diesel} \times NCV_{diesel} \times EF_{diesel} \times DD_y \times N_{PJ,y}}$$

$$\boldsymbol{PE_y = SFC_{CNG}/CF \times NCV_{CNG} \times EF_{CNG} \times DD_y \times N_{PJ,y}}$$

$$\boldsymbol{ER_y = BE_y - PE_y}$$

BE_y	Baseline emission in year *y* (tCO_2/year)
PE_y	Project emission in year *y* (tCO_2/year)
ER_y	Emission reduction in year *y* (tCO_2/year)

Monitoring Parameters:

DD_y	Annual average distance travelled in year *y* (km/year)
$N_{PJ,y}$	Number of CNG buses in year *y*

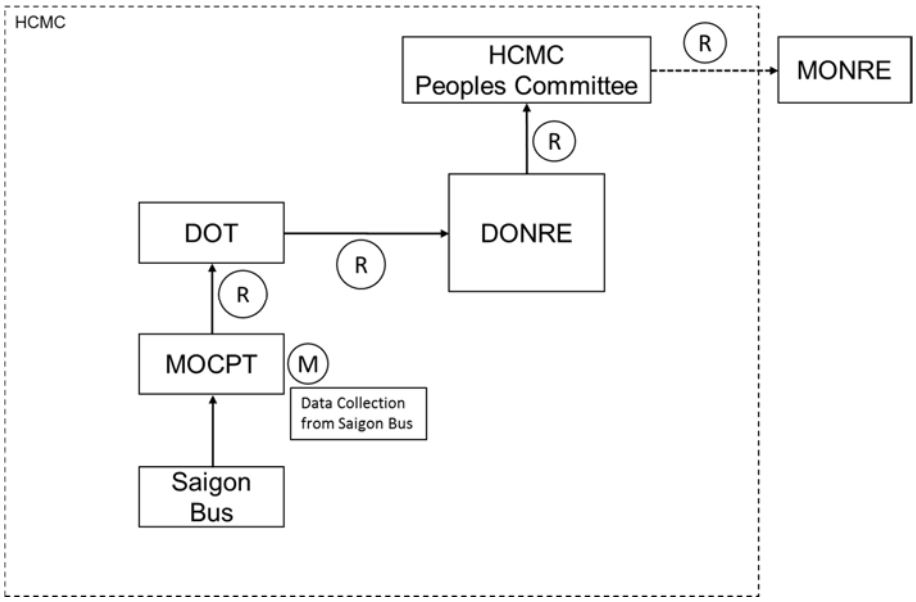
Fixed Parameters:

SFC_{diesel}	Specific fuel consumption of diesel bus (kg/km)
SFC_{CNG}	Specific fuel consumption of CNG bus (kg/km)
NCV_{diesel}	Net calorific value of diesel fuel (MJ/kg)
NCV_{CNG}	Net calorific value of CNG (MJ/kg)
EF_{diesel}	Emission factor of diesel fuel (tCO_2/MJ)
EF_{CNG}	Emission factor of CNG (tCO_2/MJ)
CF	Correction factor for CNG specific fuel consumption

c) Estimated GHG emission reduction

37 tCO_2/year

d) Organizational structure for monitoring and reporting



e) Monitoring period

From August 1st 2016 to December 31st 2016 (The period of the MRV trial)

f) Monitoring methods

Monitoring parameters

Parameter	Monitoring method	Person/position in charge	Site
DD_y Annual average distance travelled in year *y* (km/year)	· The data is provided by SaigonBus. · SaigonBus monitors distances travelled by each bus monthly (This is done as a part of their routine works). · These data are averaged to obtain the monthly average distance of all the buses. · Monthly average distance is calculated for 12 months and sum up these to obtain the annual average distance.	MOCPT receives the data from SaigonBus	N/A
$N_{PJ,y}$ Number of CNG buses in year *y*	· The data is provided by SaigonBus. · SaigonBus checks the number of CNG buses in the bus fleet registry.	MOCPT receives the data from SaigonBus	N/A

Fixed parameter

Parameter	Source	Value
SFC_{diesel} Specific fuel consumption of diesel bus (kg/km)	Determined by SaigonBus.	0.290
SFC_{CNG} Specific fuel consumption of CNG bus (kg/km)	Determined by SaigonBus using the actual driving distance and CNG consumption for all project buses.	0.365
NCV_{diesel} Net calorific value of diesel fuel (MJ/kg)	Default value of "2006 IPCC Guidelines for National Greenhouse Gas Inventory"	43.0
NCV_{CNG} Net calorific value of CNG (MJ/kg)	Default value of "2006 IPCC Guidelines for National Greenhouse Gas Inventory".	48.0
EF_{diesel} Emission factor of diesel fuel (tCO_2/MJ)	Default value of "2006 IPCC Guidelines for National Greenhouse Gas Inventory"	0.0000741
EF_{CNG} Emission factor of CNG (tCO_2/MJ)	Default value of "2006 IPCC Guidelines for National Greenhouse Gas Inventory"	0.0000561
CF Correction factor for CNG specific fuel consumption	Factor is set to correct/adjust fuel consumption between different specifications of baseline and project buses: Ratio of vehicle weight of CNG bus (10,780kg) to diesel bus (9,880kg)	1.09

Mitigation Monitoring Report

Note: The following descriptions are based on the actual on-going project.

a) Monitoring period

From August 1st 2016 to December 31st 2016 (the period of the MRV trial)

b) Emission reductions of the monitoring period

10 tCO_2 (for 5 months)

c) Processes of the emission reduction calculation

Annual average distance travelled (DD_y) is 23,225 km for 5 months, determined based on the monitored data of 20 CNG buses from August 2016 to December 2016.

Specific fuel consumption of the diesel bus (SFC_{RF}) is 0.290, determined based on the fuel consumption of B80 diesel buses 34.5 liter/100km and the density of diesel 0.84 kg/liter.

Specific fuel consumption of the CNG bus (SFC_{PJ}) is 0.365, determined based on the monitored data of 20 CNG buses.

Emission reductions for 5 months are calculated as follows:

$$\boldsymbol{BE_y = SFC_{RF} \times NCV_{diesel} \times EF_{diesel} \times DD_y \times N_{PJ,y}}$$

$$= 0.290 \times 43.0 \times 0.0000741 \times 23225 \times 20$$

$$= 429\ \mathrm{tCO_2/year}$$

$$\boldsymbol{PE_y = SFC_{PJ}/CF \times NCV_{CNG} \times EF_{CNG} \times DD_y \times N_{PJ,y}}$$

$$= 0.365/1.09 \times 48.0 \times 0.0000561 \times 23225 \times 20$$

$$= 419\ \mathrm{tCO_2/year}$$

$$\boldsymbol{ER_y = BE_y - PE_y}$$

$$= 429 - 419 = 10\ \mathrm{tCO_2/year}$$

Data for CNG buses provided by Saigon Bus

August 2016

No.	Travel distance (km/month)	Fuel consumption (kg /month)	No.	Travel distance (km/month)	Fuel consumption (kg /month)
1	5124.8	2,046.76	11	5103.7	1,924.39
2	5273.2	2,046.96	12	4872.5	2,031.96
3	4932.8	1,899.43	13	5020.9	1,882.21
4	4925.6	2,041.70	14	5314.3	2,126.86
5	4309.7	1,690.80	15	4882.8	1,786.52
6	4915.3	1,867.34	16	4760.8	1,761.72
7	4946.7	1,928.23	17	5079.5	2,152.46
8	5209.8	1,922.84	18	4696.9	1,817.53
9	4974.5	1,993.05	19	5153.7	1,906.62
10	4886.4	1,954.79	20	-	-
Total	49,498	19,391	Total	44,885	17,390

September 2016

No.	Travel distance (km/month)	Fuel consumption (kg /month)	No.	Travel distance (km/month)	Fuel consumption (kg /month)
1	4851,4	1.792,71	11	5030,6	1.853,31
2	4910,6	1.819,54	12	5023,4	1.976,46
3	5020,3	1.858,79	13	4592,4	1.725,83
4	5454,9	2.123,20	14	4855	1.793,46
5	4679,4	1.684,89	15	4946,7	1.780,63
6	5058,4	1.857,79	16	4812,8	1.722,59
7	5058,4	1.920,28	17	4089,8	1.633,86
8	4964,2	1.771,54	18	4926,1	1.702,20
9	4549,1	1.647,25	19	5044,5	1.740,73
10	1390,4	500,37	20	1046,4	452,02
Total	45,937	16,976	Total	44,367	16,381

October 2016

No.	Travel distance (km/month)	Fuel consumption (kg /month)	No.	Travel distance (km/month)	Fuel consumption (kg /month)
1	4557,4	1.684,35	11	4476	1.715,92
2	4607,4	1.879,61	12	4820	1.902,06
3	5167,6	1.986,36	13	4599,1	2.010,01
4	4739,7	1.850,54	14	5437,2	1.983,41
5	4838,6	1.775,92	15	4768	1.691,27
6	4795,8	1.844,40	16	4539,9	1.680,74
7	3785,5	1.476,55	17	4178,4	1.673,83
8	4349,3	1.625,09	18	4820	1.741,15
9	4700,5	1.731,80	19	4328,2	1.552,88
10	4543,5	1.762,15	20	5282,9	2.060,70
Total	46,085	17,617	Total	47,249	18,012

November 2016

No.	Travel distance (km/month)	Fuel consumption (kg /month)	No.	Travel distance (km/month)	Fuel consumption (kg /month)
1	4689,7	1.717,78	11	4542,4	1.710,03
2	4349,3	1.732,40	12	4517,5	1.790,07
3	4556,3	1.725,97	13	4693,3	1.945,26
4	4483,8	1.741,21	14	4592,4	1.697,39
5	4559,9	1.650,96	15	4926,8	1.704,48
6	4448,2	1.669,89	16	3729,9	1.358,46
7	4332,9	1.679,62	17	4524,9	1.808,93
8	4552,7	1.662,96	18	4459,6	1.606,91
9	4489,7	1.633,29	19	4559,9	1.632,87
10	4893,6	1.884,48	20	4870,7	1.859,54
Total	45,356	17,099	Total	45,417	17,114

December 2016

No.	Travel distance (km/month)	Fuel consumption (kg /month)	No.	Travel distance (km/month)	Fuel consumption (kg /month)
1	4778,3	1.655,87	11	2248,3	839,04
2	4174,8	1.614,95	12	4907,5	1.853,22
3	5044,5	1.853,92	13	4683	1.978,47
4	5237,6	2.008,72	14	4571,3	1.730,52
5	5242,3	1.879,66	15	5016,7	1.745,02
6	5242,5	1.900,76	16	4634,1	1.636,11
7	4718	1.710,06	17	4058,9	1.574,97
8	4809,7	1.658,23	18	5174,8	1.876,49
9	5077	1.819,79	19	5136,7	1.801,54
10	4711,9	1.715,20	20	4907,5	1.819,26
Total	49,036	17,817	Total	45,539	16,855

Emission Reduction Calculation Sheet

(Draft) Emission reduction estimation sheet for CNG bus project

Period of monitoring:

Emission Reduction

Description	Parameter	Unit	Value
Emission reduction	ER_y	tCO_2 /year	
Baseline emission	BE_y	tCO_2 /year	
Project emission	PE_y	tCO_2 /year	

Inputs

*Input only orange cell

Description	Parameter	Unit	Value	Data source
Annual average distance travelled in year y (km/year)	DD_y	km/year		Monitored
Number of CNG buses in year y	$N_{PJ,y}$	unit		Monitored
Specific fuel consumption of diesel bus	SFC_{diesel}	kg/km		Monitored
Net calorific value of diesel fuel	NCV_{diesel}	MJ/kg		IPCC2006
Emission factor of diesel fuel	EF_{diesel}	tCO_2 /MJ		IPCC2006
Specific fuel consumption of CNG bus	SFC_{CNG}	kg/km		Estimated
Correction factor for CNG specific fuel consumption	CF	-		
Net calorific value of CNG	NCV_{CNG}	MJ/kg		IPCC2006
Emission factor of CNG	EF_{CNG}	tCO_2 /MJ		IPCC2006

Case Study 6: Promotion of Eco-driving

MRV Plan

Note: The project is a hypothetical one, but part of the data and description is based on the actual project, "Eco-Driving by Utilizing Digital Tachograph System" by Nippon Express (Viet Nam) Co., Ltd.

I. General information on the mitigation action

a) Name of the mitigation action

Improvement of fuel efficiency of trucks through eco-driving

b) Involved organizations and their roles

DOT: Sectoral Oversight Unit.

Logistic company A: Operate trucks and monitor necessary data for GHG emission reduction calculations, and prepare the monitoring report to DOT.

c) Objectives

The objective is to improve fuel efficiency of 100 trucks of the logistic company A through eco-driving by installing a digital tachograph system to the trucks.

d) Technology introduced under the mitigation action

Eco-driving is a behavioral change to reduce fuel consumption as well as accidents. It includes driving techniques such as gentle acceleration, early shift up, steady and economic speed, and avoiding idling. In order to support and record these behavioral changes, a digital tachograph system is often used. The system installed in each truck consists of onboard equipment with a feedback indicator, as well as a server that collects and processes all the information received via wireless signal from each vehicle. Sound indicators will warn the drivers in instances of inefficient driving.

e) Target GHG type

CO_2

f) Location

The roads on which the trucks operate.

g) Timeframe

Starts from January 1st 2016

h) Cost of mitigation action

N/A

i) Benefits of mitigation action and contribution to sustainable development

Social benefits: Contributes to reduce traffic accidents because of gentle and mild driving techniques;

Economic benefits: Reduction of fossil fuel, thus contributes to reduce fuel cost;

Environmental benefits: Contributes to reduce noise and air pollutants while stop idling at intersections/car parking.

j) Source of funding and supporting financial scheme

All necessary costs are covered by the company A.

k) Information on international market mechanisms

N/A

II. Emission reduction calculation, monitoring and reporting

a) Logic of GHG emission reduction

CO_2 emissions are reduced through improving fuel efficiency by applying more efficient driving techniques such as stop idling and mild acceleration.

b) Methodology to calculate GHG emission reduction

A simple methodology was developed using approved JCM methodology VN_AM001: Transportation energy efficiency activities by installing digital tachograph systems" as a reference.

$$\boldsymbol{BE_y = SFC_{BL} \times NCV_{diesel} \times EF_{diesel} \times DD_y \times N_{PJ,y}}$$

$$\boldsymbol{PE_y = SFC_{PJ} \times NCV_{diesel} \times EF_{diesel} \times DD_y \times N_{PJ,y}}$$

$$\boldsymbol{ER_y = BE_y - PE_y}$$

BE_y	Baseline emission in year *y* (tCO_2/year)
PE_y	Project emission in year *y* (tCO_2/year)
ER_y	Emission reduction in year *y* (tCO_2/year)

Monitoring parameters:

DD_y	Annual average distance travelled in year *y* (km/year)
$N_{PJ,y}$	Number of trucks in year *y*

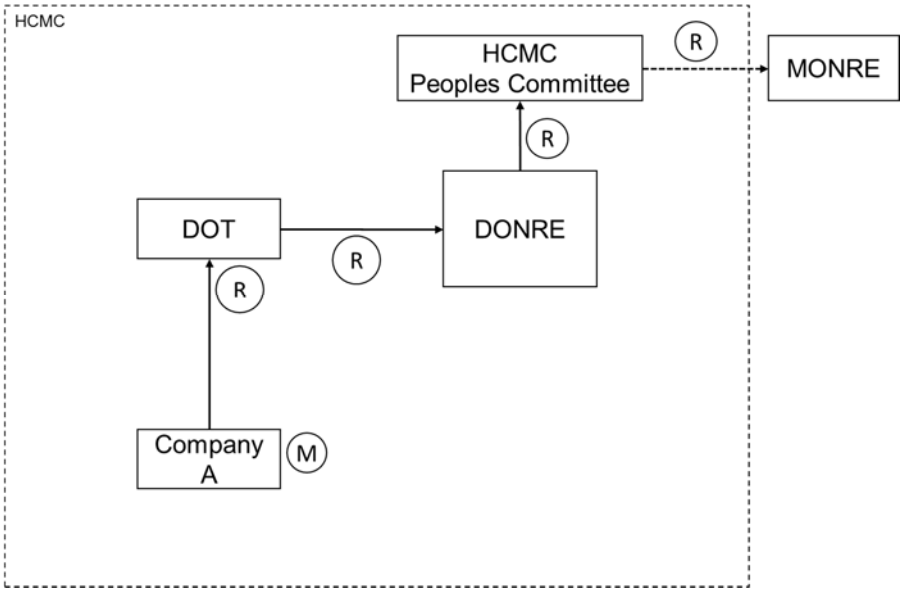
Fixed parameters:

SFC_{BL}	Specific fuel consumption of baseline trucks (without eco-driving) (kg/km)
SFC_{PJ}	Specific fuel consumption of project trucks (with eco-driving) (kg/km)
NCV_{diesel}	Net calorific value of diesel fuel (MJ/kg)
EF_{diesel}	Emission factor of diesel fuel (tCO_2/MJ)

c) Estimated GHG emission reduction

186 tCO_2/year

d) Organizational structure for monitoring and reporting



e) Monitoring period

From January 1st 2016 to December 31st 2016

f) Monitoring methods

Monitoring parameters

Parameter	Monitoring method	Person/position in charge	Site
DD_y Annual average distance travelled in year *y* (km/year)	· The company monitors distances travelled by each truck monthly, through odometer readings or digital tachograph system. · These data are averaged to obtain the monthly average distance of all the trucks. · Monthly average distance is calculated for 12 months and sum up these to obtain the annual average distance.	Technical division of the company A	N/A
$N_{PJ,y}$ Number of trucks in year *y*	· The company checks the number of trucks, in which the digital tachograph system is installed, in the truck fleet registry.	Technical division of the company A	N/A

Fixed parameter

Parameter	Source	Value
SFC_{BL} Specific fuel consumption of baseline trucks (without eco-driving) (kg/km)	· Determined by the company A before the project starts. · Specific fuel consumption is estimated by "fuel consumption during a set period (kg/period)" divided by "distance travelled of the period (km/period)." · The period of the measurement of fuel consumption and traveling distances should be at least 60 days in which the trucks operate in typical conditions.	0.168
SFC_{PJ} Specific fuel consumption of project trucks (with eco-driving) (kg/km)	· Determined by the company A after the project starts. · Specific fuel consumption is estimated by "fuel consumption during a set period (kg/period)" divided by "distance travelled of the period (km/period)." · The period of the measurement of fuel consumption and traveling distances should be at least 60 days in which the trucks operate in typical conditions.	0.160
NCV_{diesel} Net calorific value of diesel fuel (MJ/kg)	Default value of "2006 IPCC Guidelines for National Greenhouse Gas Inventory"	43.0
EF_{diesel} Emission factor of diesel fuel (tCO_2/MJ)	Default value of "2006 IPCC Guidelines for National Greenhouse Gas Inventory"	0.0000741

Mitigation Monitoring Report

Note: The following descriptions are based on hypothetical data for this case study.

a) Monitoring period

From January 1st 2016 to December 31st 2016

b) Emission reductions of the monitoring period

168 tCO_2/year

c) Processes of the emission reduction calculation

Annual average distance travelled (DD_y) is 65,700 km, determined based on the monitored data of 100 trucks from January 1st to December 31st of 2016.

Specific fuel consumption of the baseline trucks (without eco-driving) (SFC_{BL}) is 0.156, determined based on the average fuel consumption of all trucks 5.40 km/liter and the density of diesel 0.84 kg/liter.

Specific fuel consumption of project trucks (with eco-driving) (SFC_{PJ}) is 0.148, determined based

on the monitored data of 100 trucks.

Emission reduction is calculated as follows:

$$\boldsymbol{BE_y = SFC_{BL} \times NCV_{diesel} \times EF_{diesel} \times DD_y \times N_{PJ,y}}$$

$$= 0.156 \times 43.0 \times 0.0000741 \times 65700 \times 100$$

$$= 3266\ \mathrm{tCO_2/year}$$

$$\boldsymbol{PE_y = SFC_{PJ} \times NCV_{diesel} \times EF_{diesel} \times DD_y \times N_{PJ,y}}$$

$$= 0.148 \times 43.0 \times 0.0000741 \times 65700 \times 100$$

$$= 3098\ \mathrm{tCO_2/year}$$

$$\boldsymbol{ER_y = BE_y - PE_y}$$

$$= 3266 - 3098 = 168\ \mathrm{tCO_2/year}$$

Emission Reduction Calculation Sheet

(Draft) Emission reduction estimation sheet for eco-driving project

Period of monitoring:

Emission Reduction

Description	Parameter	Unit	Value
Emission reduction	ER_y	tCO_2 /year	
Baseline emission	BE_y	tCO_2 /year	
Project emission	PE_y	tCO_2 /year	

Inputs

*Input only orange cell

Description	Parameter	Unit	Value	Data source
Annual average distance travelled in year y	DD_y	km/year		Monitored
Number of trucks in year y	$N_{PJ,y}$	unit		Monitored
Specific fuel consumption of baseline trucks (without eco-driving)	SFC_{BL}	kg/km		Monitored
Net calorific value of diesel fuel	NCV_{diesel}	MJ/kg		IPCC2006
Emission factor of diesel fuel	EF_{diesel}	tCO_2 /MJ		IPCC2006
Specific fuel consumption of project trucks (with eco-driving)	SFC_{PJ}	kg/km		Estimated

Case Study 7: Introduction of BRT (Bus Rapid Transit)

MRV Plan

Note: The project is not yet in operation, and the following descriptions are based on discussions with relevant organizations and previous studies.

I. General information on the mitigation action

a) Name of the mitigation action

BRT Line 1 project of Ho Chi Minh City

b) Involved organizations and their roles

DOT: Sectoral Oversight Unit.

MOCPT: Mitigation Implementing Entity. Receive the monitoring data from the BRT operator, calculate GHG emission reductions, and prepare the monitoring report. The monitoring report will be sent to DOT and cc to UCCI.

BRT operator: The project will start construction in 2018, and the BRT operator is not designated yet. Operate BRT and monitor/provide necessary data for GHG emission reduction calculations to MOCPT.

UCCI: Planning department of the BRT

c) Objectives

The project objective is to improve the performance and efficiency of the public transport along a high priority corridor in Ho Chi Minh City.

d) Technology introduced under the mitigation action

Total length of the BRT line is 23 km (An Lac Turnaround (for turning)–Vo Van Kiet Boulevard–Mai Chi Tho Boulevard–Cat Lai T-junction (Rach Chiec Terminal)). The BRT system will use 2 central lanes of the existing road completely separated with other types of vehicle, however, some section of the line will not be separated. CNG bus will be introduced for the BRT system.

e) Target GHG type

CO_2

f) Location

Described in d).

g) Timeframe

Detailed design is expected to be completed in September 2017. Construction is expected to start in mid-2018, while operation will start by the end of 2019.

h) Cost of mitigation action

143.68 million USD (the project cost) Source: Decision No. 602/QD-UBND dated 1st Feb 2016 of HPC.

i) Benefits of mitigation action and contribution to sustainable development

The proposed project addresses the issue of sustainable urban development in the following ways:

Improved urban mobility: The project would provide a viable alternative to using private vehicles, forming the core of a modern, integrated, and affordable public transport system, while increasing the public transport's share of all trips in HCMC (currently only 2 percent of all trips). Selecting BRT rather than light or heavy rail modes for this transit corridor means lower capital investment and operating costs, as well as an earlier inauguration of services.

Increased bus performance will maximize the use of the existing street system, reduce congestion, and reduce vehicle operating costs. More efficient and attractive bus services will also help to make those operations more self-sufficient, reducing the need for government subsidies.

Environmental sustainability: CNG-powered buses will have a significantly smaller environmental footprint than existing public transport options in HCMC, while the shift from motorcycles and other private vehicles to public transport will help to substantially reduce road congestion, pollution, and accidents in the city, with large quantifiable economic benefits.

Source: Ho Chi Minh City Green Transport Development Project, Project Appraisal Document, May 2015, The World Bank

j) Source of funding and supporting financial scheme

The project has a total cost of USD 143.68 million and will be financed by an International Development Association Credit of USD 124.0 million. The project will also be co-financed by the Socialist Republic of Vietnam (USD 19.68 million).

Source: Decision No. 602/QD-UBND dated 1st Feb 2016 of HPC.

k) Information on international market mechanisms

The project does not utilize any international market mechanism.

II. Emission reduction calculation, monitoring and reporting

a) Logic of GHG emission reduction

CO_2 emission is reduced through mode shift of passenger transportation from the existing means of transportation such as private cars and motorcycles to BRT. BRT systems are more efficient than private cars in terms of CO_2 emission per passenger-km.

b) Methodology to calculate GHG emission reduction

A simple methodology was developed for this project as below, by simplifying the CDM methodology "ACM0016 Mass rapid transit projects."

$$BE_y = \sum_i \left(PKM_y \times MS_{i,y} \times EF_{PKM,i} \times 10^{-6} \right)$$

$$PKM_y = P_y \times TD_y$$

$$EF_{PKM,i} = \frac{EF_{KM,i}}{OC_i}$$

$$PE_y = FC_y \times NCV_{CNG} \times EF_{CNG}$$

$$ER_y = BE_y - PE_y$$

BE_y	Baseline emission in year *y* (tCO_2/year)
PE_y	Project emission in year *y* (tCO_2/year)
ER_y	Emission reduction in year *y* (tCO_2/year)

Monitoring Parameters:

PKM_y	Transported volume by BRT in year y (passenger km/year)
P_y	Number of passenger of BRT in year y (passenger/year)
TD_y	Average trip distance of the passenger of BRT in year y (km)
FC_y	CNG consumption by BRT buses in year y (ton/year)
i	1; Passenger car, 2; Bus, 3; Motorcycle, etc.

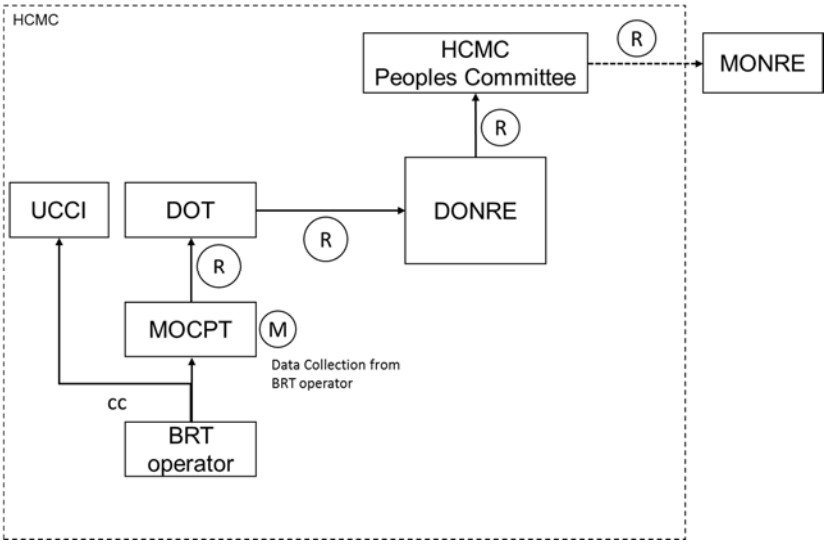
Fixed Parameters:

$MS_{i,y}$	Share of passengers using transport mode i in the baseline in year y
$EF_{PKM,i}$	CO_2 emission factor per passenger kilometer for transport mode i (gCO_2/passenger-km)
$EF_{KM,i}$	CO_2 emission factor of transport mode i (gCO_2/km)
OC_i	Average occupation rate of transport mode i (passenger/vehicle)
NCV_{CNG}	Net calorific value of CNG (MJ/kg)
EF_{CNG}	Emission factor of CNG (tCO_2/MJ)

c) Estimated GHG emission reduction

1,682 tCO_2/year

d) Organizational structure for monitoring and reporting



e) Monitoring period

Starts from January 1st 2021.

f) Monitoring methods

Monitoring parameters

Parameter	Monitoring method	Person/position in charge	Site
PKM_y Transported volume by BRT in year y (passenger km/year)	· The data is provided by the BRT operator. · The operator monitors/analyzes the data daily or monthly through ticketing system such as IC card system (This is done as their routine works). · The daily or monthly data are compiled to obtain the annual transported volume.	MOCPT receives the data from the BRT operator	N/A
P_y Number of passenger of BRT in year y (passenger/year)	· Use this parameter, if PKM_y is not obtained directly · The data is provided by the BRT operator. · The operator monitors/analyzes the data BRT daily or monthly through ticketing system such as IC card system (This is done as their routine works). · The daily or monthly data are summed up to obtain the annual number.	MOCPT receives the data from the BRT operator	N/A
TD_y Average trip distance of the passenger of BRT in year y (km)	· Use this parameter, if PKM_y is not obtained directly. · The data is provided by the BRT operator. · The operator monitors/analyzes the data BRT daily or monthly through ticketing system such as IC card system (This is done as their routine works). · The daily or monthly data are averaged to obtain the annual average trip distance.	MOCPT receives the data from the BRT operator	N/A
FC_y CNG consumption by BRT buses in year y (ton/year)	· The data is provided by the BRT operator. · The operator monitors the consumption through direct measurement (by fuel meter) or invoice from the fuel company monthly. · The monthly data are summed up to obtain the annual consumption.	MOCPT receives the data from the BRT operator	N/A

Fixed parameters

Parameter	Source	Value
$MS_{i,y}$ Share of passengers using transport mode i in the baseline in year y	・Interview survey to passenger of BRT. Necessary number of samples should be taken. For the sample size and questionnaire, the CDM methodology "ACM0016 Mass rapid transit projects[1]" can be referred to. ・Interview survey should be carried out once after the project starts. (Motorbike 41.6%, passenger car 7.9%, coach 8.3%, bus 38.7%, taxi 3.0% (Source: BRT FS report))	See "Source"
$EF_{PKM,i}$ CO_2 emission factor per passenger kilometer for transport mode i (gCO_2/passenger-km)	Motorbike 66, passenger car 142, coach 25, bus 25, taxi 82 (Source: New Mechanism Feasibility Study 2011 – Final Report, New Mechanism Feasibility Study for Development of Mass Rapid Transit (MRT) Systems in Jakarta, Indonesia, and Hanoi and Ho Chi Minh, Viet Nam., Mitsubishi Research Institute, Inc.)	See "Source"
$EF_{KM,i}$ CO_2 emission factor of transport mode i (gCO_2/km)	Use national or local values, in case $EF_{PKM,i}$ are not available.	-
OC_i Average occupation rate of transport mode i (passenger/vehicle)	Use national or local values or carry out a survey, in case $EF_{PKM,i}$ are not available.	-
NCV_{CNG} Net calorific value of CNG (MJ/kg)	Default value of "2006 IPCC Guidelines for National Greenhouse Gas Inventory"	48.0
EF_{CNG} Emission factor of CNG (tCO_2/MJ)	Default value of "2006 IPCC Guidelines for National Greenhouse Gas Inventory"	0.0000561

[1] https://cdm.unfccc.int/methodologies/DB/FXQBDV16UML49NJN03U1QQTEY9J90E

Mitigation Monitoring Report

Note: The following descriptions are based on the hypothetical data for this case study. Actual monitoring will start right after the operation of BRT starts.

a) Monitoring period

The 1st year after the operation starts.

b) Emission reductions of the monitoring period

1,700 tCO_2/year

c) Processes of the emission reduction calculation

Number of the passengers of BRT in the year is 11,026,650 and the average trip distance of the passenger of BRT in the year is 7.5km, thus transported volume by BRT in the year is 82,699,875 passenger-km/year. Share of the passengers using previous transport mode and CNG consumption by BRT buses are same as ex-ante estimation.

Emission reduction is calculated as follows:

$$\boldsymbol{PKM_y = P_y \times TD_y = 1,1026,650 \times 7.5 = 82,699,875}$$

$$\boldsymbol{BE_y = \sum_i \left(PKM_y \times MS_{i,y} \times EF_{PKM,i} \times 10^{-6}\right)}$$

$$= 82{,}699{,}875 \times (0.416 \times 0.000066 + 0.079 \times 0.000412 + 0.083 \times 0.000025 + 0.387 \times 0.000025 + 0.0030 \times 0.000082)$$

$$= \boldsymbol{4,374}$$

$$\boldsymbol{PE_y = FC_y \times NCV_{CNG} \times EF_{CNG}}$$

$$= 993 \times 48{,}000 \times 0.0000561$$

$$= 2{,}674$$

$$\boldsymbol{ER_y = BE_y - PE_y}$$

$$= 1{,}700\ tCO_2/year$$

Emission Reduction Calculation Sheet

(Draft) Emission reduction estimation sheet for BRT project

Emission Reduction

Description	Parameter		Value	Unit
Emission reduction	ER_y			tCO_2/year
Baseline emission	BE_y			tCO_2/year
Project emission	PE_y			tCO_2/year

Inputs

*Input only orange cell

Description	Parameter		Value	Unit	Data source
Number of passenger of the project activity in year y	P_y			passenger/year	
Average trip distance of the passenger of BRT in year y	TD_y			km	
Use of default value of CO_2 emission factor per passenger-km	-		No		
Number of transportation mode in the baseline	-		5		
CO_2 emission factor per passenger kilometer for transport mode i	$EF_{PKM,i}$	Bike		tCO_2/passenger-km	
		Passenger car		tCO_2/passenger-km	
		Minibus		tCO_2/passenger-km	
		Bus		tCO_2/passenger-km	
		Other1		tCO_2/passenger-km	
		Other2		tCO_2/passenger-km	
Share of passengers by transport mode i in the baseline in year y	$MS_{i,y}$	Bike		%	
		Passenger car		%	
		Minibus		%	
		Bus		%	
		Other1		%	
		Other2		%	
CNG consumption by BRT buses in year y	FC_y			t/year	
CO_2 emission factor of CNG	EF_{CNG}			tCO_2/MJ	
Net calorific value of CNG	NCV_{CNG}			MJ/t	

Case Study 8: Introduction of Urban railway

MRV Plan

Note: The project is not yet in operation, and the following descriptions are based on discussions with relevant organizations and previous studies.

I. General information on the mitigation action

a) Name of the mitigation action

MRT Line 1 project in Ho Chi Minh City

b) Involved organizations and their roles

MAUR: Mitigation Implementing Entity. Receive the monitoring data from the MRT operator, calculate GHG emission reductions, and prepare the monitoring report. The monitoring report will be sent to DONRE.

A MRT operator: The project will start operation in 2020, and the MRT operator is not designated yet. Operate MRT and monitor/provide necessary data for GHG emission reduction calculations to MAUR.

c) Objectives

The MRT Line 1 is the first urban railway in Ho Chi Minh City which aims to meet the increasing demand on transport, and to contribute to developing local economy and to improve urban environment through reducing traffic congestions and local pollutions in Ho Chi Minh City urban area.

d) Technology introduced under the mitigation action

Total length of the MRT line 1 is 19.7 km between Ben Thanh and Suoi Tien (2.6 km underground section and 17.1 km elevated section), belonging to Ho Chi Minh City area with part of the line end belonging to Binh Duong Province. 14 stations will be built, of which 3 are underground stations and 11 are elevated stations.

e) Target GHG type

CO_2

f) Location

Described in d).

g) Timeframe

Construction will be completed in 2019 and the service will start in 2020.

h) Cost of mitigation action

Total investment cost: 2,490,800,000 (USD)

Source: Decision No.4480/QD-UBND dated 21/9/2011 of Ho Chi Minh City's PC.

i) Benefits of mitigation action and contribution to sustainable development

The project will provide an affordable public transport system in Ho Chi Minh City where traffic demand is rapidly increasing. Through providing such transport system with high transport capacity, and with punctual and highly reliable operations, shift from private transportation to the MRT will be occurred. Therefore, reduction of traffic congestions, local air pollution and noise, and enhancement of local economy are expected.

j) Source of funding and supporting financial scheme

83% of the total investment cost is covered by JBIC loan and 17 % is covered by the city budget.

Source: Decision No. 1453/QD-UBND dated 6th April 2007 of HPC.

k) Information on international market mechanisms

The project does not utilize any international market mechanism.

II. Emission reduction calculation, monitoring and reporting

a) Logic of GHG emission reduction

CO_2 emission is reduced through mode shift of passenger transportation from the existing means of transportation such as private cars, local conventional buses and motorcycles to MRT. MRT systems are more efficient than private cars in terms of CO_2 emission per passenger-km.

b) Methodology to calculate GHG emission reduction

A simple methodology was developed for this project as below, by simplifying the CDM methodology "ACM0016 Mass rapid transit projects."

$$\boldsymbol{BE_y = \sum_i \left(PKM_y \times MS_{i,y} \times EF_{PKM,i} \times 10^{-6} \right)}$$

$$\boldsymbol{PKM_y = P_y \times TD_y}$$

$$\boldsymbol{EF_{PKM,i} = \frac{EF_{KM,i}}{OC_i}}$$

$$\boldsymbol{PE_y = EC_y \times EF_{grid}}$$

$$\boldsymbol{ER_y = BE_y - PE_y}$$

BE_y	Baseline emission in year *y* (tCO_2/year)
PE_y	Project emission in year *y* (tCO_2/year)
ER_y	Emission reduction in year *y* (tCO_2/year)

Monitoring Parameter:

PKM_y	Transported volume by MRT in year y (passenger km/year)
$MS_{i,y}$	Share of passengers using transport mode i in the baseline in year y
P_y	Number of passenger of MRT in year y (passenger/year)
TD_y	Average trip distance of the passenger of MRT in year y (km)
EC_y	Grid electricity consumption by MRT in year y (MWh/year)
i	1; Passenger car, 2; Bus, 3; Motorcycle, etc.

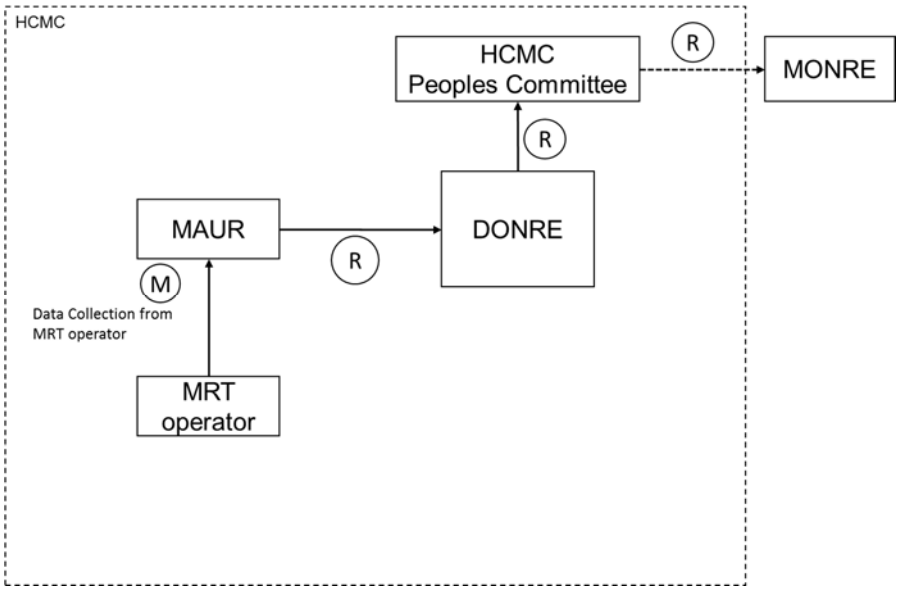
Fixed Parameter:

$EF_{PKM,i}$	CO_2 emission factor per passenger kilometer for transport mode i (gCO_2/passenger-km)
$EF_{KM,i}$	CO_2 emission factor of transport mode i (gCO_2/km)
OC_i	Average occupation rate of transport mode i (passenger/vehicle)
EF_{grid}	CO_2 emission factor of grid electricity (tCO_2/MWh)

c) Estimated GHG emission reduction

110,095 tCO_2/year

d) Organizational structure for monitoring and reporting



e) Monitoring period

Starts from January 1st 2021.

f) Monitoring methods

Monitoring parameters

Parameter	Monitoring method	Person/position in charge	Site
PKM_y Transported volume by MRT in year y (passenger km/year)	· The data is provided by the MRT operator. · The operator monitors/analyzes the data daily or monthly through ticketing system such as IC card system (This is done as their routine works). · The daily or monthly data are compiled to obtain the annual transported volume.	MAUR receives the data from the MRT operator	N/A
P_y Number of passenger of MRT in year y (passenger/year)	· Use this parameter, if PKM_y is not obtained directly · The data is provided by the MRT operator. · The operator monitors/analyzes the data MRT daily or monthly through ticketing system such as IC card system (This is done as their routine works). · The daily or monthly data are summed up to obtain the annual number.	MAUR receives the data from the MRT operator	N/A
TD_y Average trip distance of the passenger of MRT in year y (km)	· Use this parameter, if PKM_y is not obtained directly · The data is provided by the MRT operator. · The operator monitors/analyzes the data MRT daily or monthly through ticketing system such as IC card system (This is done as their routine works). · The daily or monthly data are averaged to obtain the annual average trip distance.	MAUR receives the data from the MRT operator	N/A
EC_y Grid electricity consumption by MRT in year y (MWh/year)	· The data is provided by the MRT operator. · The operator monitors the consumption through direct measurement (by electric power meter) or invoice from the power company monthly. · The monthly data are summed up to obtain the annual consumption.	MAUR receives the data from the MRT operator	N/A

Fixed parameter

Parameter	Source	Value
$MS_{i,y}$ Share of passengers using transport mode i in the baseline in year y	・Interview survey to passengers of MRT. Necessary number of samples should be taken. For the sample size and questionnaire, the CDM methodology "ACM0016 Mass rapid transit projects[2]" can be referred to. ・Interview survey should be carried out once after the project starts. (Motorbike 89.9%, passenger car 2.8 %, bus 7.3 % (Source: New Mechanism Feasibility Study 2011 – Final Report, New Mechanism Feasibility Study for Development of Mass Rapid Transit (MRT) Systems in Jakarta, Indonesia, and Hanoi and Ho Chi Minh, Viet Nam., Mitsubishi Research Institute, Inc.)	See "Source"
$EF_{PKM,i}$ CO_2 emission factor per passenger kilometer for transport mode i (gCO_2/passenger-km)	Motorbike 66, passenger car 142, coach 25, bus 25, taxi 82 (Source: New Mechanism Feasibility Study 2011 – Final Report, New Mechanism Feasibility Study for Development of Mass Rapid Transit (MRT) Systems in Jakarta, Indonesia, and Hanoi and Ho Chi Minh, Viet Nam., Mitsubishi Research Institute, Inc.)	See "Source"
$EF_{KM,i}$ CO_2 emission factor of transport mode i (gCO_2/km)	Use national or local values, in case $EF_{PKM,i}$ are not available.	-
OC_i Average occupation rate of transport mode i (passenger/vehicle)	Use national or local values or carry out a survey, in case $EF_{PKM,i}$ are not available.	-
EF_{grid} CO_2 emission factor of grid electricity (tCO_2/MWh)	The latest official EF provided by MONRE in May 2016.	0.66

[2] https://cdm.unfccc.int/methodologies/DB/FXQBDV16UML49NJN03U1QQTEY9J90E

Mitigation Monitoring Report

Note: The following descriptions are based on hypothetical data just for this case study. Actual monitoring will start right after the operation of MRT starts.

a) Monitoring period

The 1st year after the operation starts.

b) Emission reductions of the monitoring period

121,744 tCO_2/year

c) Processes of the emission reduction calculation

The number of passengers of the MRT in the year is assumed as 116,800,000 and the average trip distance of the passengers of MRT in the year is 20 km, thus transported volume by MRT in the year is 2,336,000,000 passenger-km/year. Share of the passengers using previous transport mode and electricity consumption by MRT are same as the ex-ante estimation.

Emission reduction is calculated as follows:

$$\boldsymbol{PKM_y = P_y \times TD_y = 116,800,000 \times 20 = 2,336,000,000}$$

$$\boldsymbol{BE_y = \sum_i \left(PKM_y \times MS_{i,y} \times EF_{PKM,i} \times 10^{-6}\right)}$$

$$= 2{,}336{,}000{,}000 \times (0.899 \times 0.000066 + 0.028 \times 0.000142 + 0.073 \times 0.000025)$$

$$= 152{,}155$$

$$\boldsymbol{PE_y = EC_y \times EF_{grid}}$$

$$= 46{,}078 \times 0.66$$

$$= 30{,}411$$

$$\boldsymbol{ER_y = BE_y - PE_y}$$

$$= 121{,}744 \ tCO_2/year$$

Emission Reduction Calculation Sheet

(Draft) Emission reduction estimation sheet for MRT project

Emission Reduction

Description	Parameter		Value	Unit
Emission reduction	ER_y			tCO_2/year
Baseline emission	BE_y			tCO_2/year
Project emission	PE_y			tCO_2/year

Inputs

*Input only orange cell

Description	Parameter		Value	Unit	Data source
Number of passenger of the project activity in year y	P_y			passenger/year	
Average trip distance of the passenger of BRT in year y	TD_y			km	
Use of default value of CO_2 emission factor per passenger-km	-		No		-
Number of transportation mode in the baseline	-		6		-
CO_2 emission factor per passenger kilometer for transport mode i	$EF_{PKM,i}$	Bike		tCO_2/passenger-km	
		Passenger car		tCO_2/passenger-km	
		Minibus		tCO_2/passenger-km	
		Bus		tCO_2/passenger-km	
		Other1		tCO_2/passenger-km	
		Other2		tCO_2/passenger-km	
Share of passengers by transport mode i in the baseline in year y	$MS_{i,y}$	Bike		%	
		Passenger car		%	
		Minibus		%	
		Bus		%	
		Other1		%	
		Other2		%	
Annual electricity consumption associated with the operation of the project activity in year y	$EC_{PJ,y}$			MWh/year	
CO_2 emission factor of the grid electricity	EF_{elec}			tCO_2/MWh	

Case Study 9: Collection and utilization of landfill gas at final disposal site

MRV Plan

Note: Case study 9 is based on the actual on-going project.

I. General information on the mitigation action

a) Name of the mitigation action

Electricity Generation at Go Cat Landfill

b) Involved organizations and their roles

HCMC Urban Environment Company Limited (CITENCO): Mitigation Implementing Entity. Measure and collect data, calculate GHG emission reductions, prepare Monitoring Report.
HCMC Department of Natural Resources and Environment (DONRE): Sectoral Oversight Unit
HCMC Management Board for Solid Waste Treatment Complexes (MBS)

c) Objectives

To utilize clean energy source, namely landfill gas that was abandoned and released to the atmosphere. To improve local environmental issues, such as air pollution and odor.

d) Technology introduced under the mitigation action

Recover methane gas from a landfill lot (among 5 lots) at Go Cat landfill site and generate electricity using 3 turbines (2 units of 750 kW 1 unit of 920 kW). Power generated is used onsite for office operation and the remaining electricity is sold to EVN.

e) Target GHG type

CH_4 and CO_2

f) Location

Go Cat landfill site, Ho Chi Minh City

g) Timeframe

2005 – 2025

The landfill site started operation in 2001, and landfill gas recovery activity started in 2005. The landfill site itself was closed and stopped accepting new wastes in 2007 although the biogas recovery is continuing.

h) Cost of mitigation action

39,332,225,059 VNĐ

i) Benefits of mitigation action and contribution to sustainable development

The mitigation action has brought such positive impacts as improvement of air and water quality, easing local odor issues, creation of local jobs, supplying clean energy to the national

grid, introduction of advanced technology.

j) Source of funding and supporting financial scheme

60% grant by the Dutch government

k) Information on international market mechanisms

The mitigation action has not registered to any bilateral or international market mechanism.

II. Emission reduction calculation, monitoring and reporting

a) Logic of GHG emission reduction

- CH_4 emission is avoided, which would be generated by organic decay in landfill, through collecting such methane gas and utilizing it as energy source.
- CO_2 emission is also reduced through producing electricity by using the collected methane gas from landfill that displaces fossil fuel consumption at grid-connected thermal power plants.

b) Methodology to calculate GHG emission reduction

The following approved CDM methodologies were referred to:

- CDM methodology AMS-III.G "Landfill methane recovery" Version 09.0
- CDM methodology AMS-I.D "Grid connected renewable electricity generation" Version 18.0

The applied methodology estimates the amount of CH_4 emissions avoided by using the expected quantity of electricity generated by the plant, rather than using First Order Decay (FOD) model. Applied equations and description of each parameter is as below.

$$\boldsymbol{ER_y = BE_y - PE_y} \quad \text{(Equation 1)}$$

$$\boldsymbol{BE_y = BE_{1,y} + BE_{2,y}} \quad \text{(Equation 2)}$$

$$\boldsymbol{BE_{1,y} = (1 - OX) \times F_{CH4,PJ,y} \times GWP_{CH4}} \quad \text{(Equation 3)}$$

$$\boldsymbol{BE_{2,y} = EG_{PJ,y} \times EF_{grid,y}} \quad \text{(Equation 4)}$$

$F_{CH4,\,PJ,\,y}$	Volume of methane gas collected from landfill (m^3/year)
GWP_{CH4}	Global Warming Potential for methane
$EG_{PJ,y}$	Quantity of electricity generated by the project in year y (MWh/ year)
$EF_{grid,y}$	CO_2 emission factor of electricity grid in year y (t-CO_2/MWh)

$$\boldsymbol{F_{CH4,PJ} = \frac{EG_{PJ,y} \times 3600}{NCV_{CH4} \times EF} \times D_{CH4} \times GWP_{CH4}} \quad \text{(Equation 5)}$$

$EG_{PJ,y}$	Electricity generated by the project in year y (MWh)
D_{CH4}	Density of methane of the landfill gas in year y (ton of methane/m^3 of landfill gas)
GWP_{CH4}	Global Warming Potential (GWP) of methane
NCV_{CH4}	Net calorific value of methane (MJ/Nm^3)
EE_y	Energy Conversion Efficiency

$$PE_y = EC_{PJ,y} \times EF_{grid,y}$$ (Equation 6)

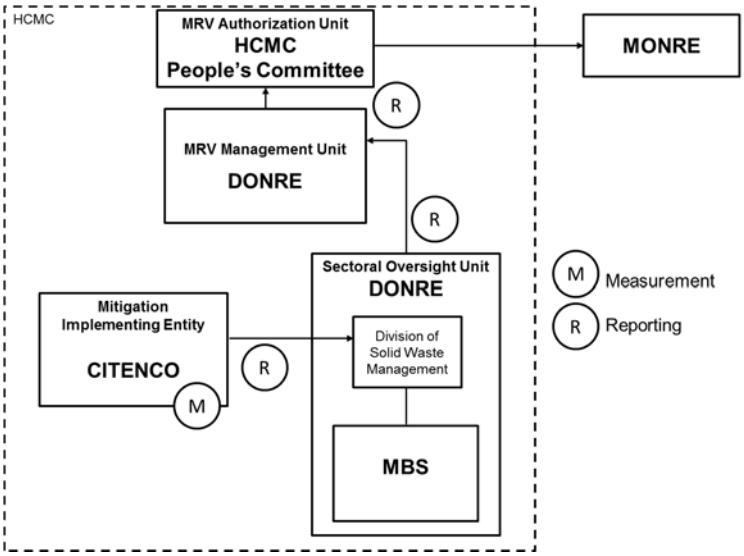
$EC_{PJ,y}$ Quantity of electricity consumed by the project in year y (MWh/year)

c) Estimated GHG emission reduction

462 ton-$CO_{2equivalent}$

d) Organizational structure for monitoring and reporting

Monitoring and reporting structure is shown in the figure below.



An operator of waste-to-energy plant who acts as the Mitigation Implementing Entity conducts all monitoring activities and also initial parts of reporting activities, including calculation of GHG emission reductions and preparation of the Mitigation Monitoring Report. Meanwhile, Department of Natural Resources and Environment (DONRE) is assigned as the Sectoral Oversight Unit for this mitigation action because the mitigation action principally focuses on solid waste management. The DONRE is therefore responsible for the next steps of reporting activities, namely checking the Mitigation Monitoring Report submitted by the operator and submits the checked report to the MRV Management Unit, or the DONRE of HCMC. For the case of municipal solid waste management, HCMC Management Board for Solid Waste Treatment Complexes (MBS) also checks the Mitigation Monitoring Report from the operator.

e) Monitoring period

1 January 2016 to 31 December 2016

f) Monitoring methods

- Monitoring parameters

Parameters listed in the following table will be monitored during the monitoring period.

Monitoring method described below will be applied.

Parameter	Monitoring method	Person/position in charge	Site
$EG_{PJ,y}$ Electricity generated by the project in year y (MWh)	Monitored daily by reading an electricity meter that is equipped at the power plant and records the MWh data on the paper or electronically. Recorded data is shared with head office daily.	Technical staff of the power plant	Onsite (at the project site)
$EC_{PJ,y}$ Quantity of electricity consumed by the project in year y (MWh/yr)	Calculated monthly based on the rated output of all machineries and office equipment that are used for power plant operation. Hours of usage for each equipment are recorded and used for calculation.	Technical staff of the power plant	Onsite (at the project site)

- Fixed parameters

Parameters listed in the following table will not be monitored during the monitoring period.

Fixed value will be applied throughout the project timeframe.

Parameter	Source	Value
$EF_{grid,y}$ CO_2 emission factor of electricity grid in year y (t CO_2 /MWh)	Official data published by MONRE	0.6612 t-CO_2/MWh
OX Oxidation factor	Default value (CDM methodology)	0.1
NCV_{CH4} Net calorific value of methane	Default value (IPCC Guidelines)	35.9 MJ/Nm^3
EE_y Energy Conversion Efficiency of the project equipment	Default value (CDM methodology)	40 %
D_{CH4} Density of methane in the landfill gas (ton/ m3)	Default value (CDM methodology)	0.716 kg/m^3
GWP_{CH4} Global Warming Potential of methane	Default value (IPCC Guidelines)	25

Mitigation Monitoring Report

Note: The following descriptions are based on the actual on-going project.

a) Monitoring period

1 January 2016 to 30 July 2016

(The power plant did not operate from August 2016 until the end of 2016 due to the work associated with upgrading of EVN transmission line)

b) Emission reductions of the monitoring period

249 tons-$CO_{2\text{-equivalent}}$

c) Processes of the emission reduction calculation

Calculation of the GHG emission reductions was performed as below.

$$F_{CH4,PJ} = \frac{EG_{PJ,y} \times 3600}{NCV_{CH4} \times EE_y} \times D_{CH4}$$ (Equation 5)

= (54.737 × 3,600) / (35.9 × 0.4) × 0.716
= 9.83

$$BE_{1,y} = (1 - OX) \times F_{CH4,PJ,y} \times GWP_{CH4}$$ (Equation 3)

= 0.9 × 9.83 × 25
= 221

$$BE_{2,y} = EG_{PJ,y} \times EF_{grid,y}$$ (Equation 4)

= 54,737 × 0.6612
= 36

$$BE_y = BE_{1,y} + BE_{2,y}$$ (Equation 2)

= 221 + 36
= 257

$$PE_y = EC_{PJ,y} \times EF_{grid,y}$$ (Equation 6)

= 12 × 0.6612
= 8

$$\boldsymbol{ER_y = BE_y - PE_y}$$ (Equation 1)=

= 257 - 8
= 249 ton$CO_{2\text{-equivalent}}$ /year

Data monitored by Mitigation Implementing Entity

	$EG_{PJ,y}$	$EC_{PJ,y}$
Jan	34,974	2.4
Feb	11,314	2.4
Mar	2,906	2.4
Apr	-	-
May	4,370	2.4
Jun	1,173	2.4
Total	54,737	12.0

GHG Emission Reduction Calculation Sheet

Emission Reduction

Description	Parameter	Unit	Value
Emission reductions	ER_y	tCO_{2e}/year	**249**
Baseline emissions	BE_y	tCO_{2e}/year	257
Baseline emissions for CH_4	$BE_{1,y}$	tCO_{2e}/year	221
Baseline emissions for CO_2	$BE_{2,y}$	tCO_{2e}/year	36
Project emissions	PE_y	tCO_{2e}/year	8

Inputs

Description	Parameter	Unit	Value	Data source
Electricity generated by the project in year y	$EG_{PJ,y}$	MWh	54.737	Monitored
Quantity of electricity consumed by the project in year y	$EC_{PJ,y}$	MWh/ year	12	Monitored
CO2 emission factor of electricity grid in year y	$EF_{grid,y}$	t-CO2 /MWh	0.661	MONRE
Oxidation factor	OX	-	0.1	Methodology default
Net calorific value of methane	NCV_{CH4}	MJ/Nm3	35.9	IPCC Guidelines
Energy Conversion Efficiency of the project equipment	EE_y	%	40.0	Methodology default
Density of methane in the landfill gas	D_{CH4}	ton/ m3	0.716	Methodology default
Global Warming Potential of methane	GWP_{CH4}	-	25.0	IPCC Guidelines

Case Study 10: Recycling of municipal solid waste

MRV Plan

Note: Case study 10 is based on a hypothetical project. The data, name of organizations, and other descriptions contained in this case study are not based on the actual information.

I. General information on the mitigation action

a) Name of the mitigation action

Recycling of municipal solid waste

b) Involved organizations and their roles

Ho Chi Minh Green Recycling Company: Mitigation Implementing Entity. Recovers and recycles municipal solid wastes.

Division of Solid Waste Management under the DONRE of HCMC: Sectoral Oversight Unit

c) Objectives

To reduce the volume of municipal solid waste in a city that would be dumped to landfill site.

d) Technology introduced under the mitigation action

Recyclable municipal solid waste (excluding hazardous waste), namely plastics and glass are recovered and processed into intermediate products at a processing facility. The project collects and recycles 10 tons of plastic wastes and 100 tons of glass waste every day.

e) Target GHG type

CO_2

f) Location

Binh Chanh district, Ho Chi Minh City

g) Timeframe

2015-2035

h) Cost of mitigation action

5 million USD

i) Benefits of mitigation action and contribution to sustainable development

Social benefits: creation of employment opportunities related to separation and collection of recyclable wastes, operation of a recycling facility

Environmental benefits: reduced size of municipal solid waste to be landfilled

j) Source of funding and supporting financial scheme

HCMC budget

k) Information on international market mechanisms

The mitigation action has not been registered to any international or bilateral market mechanism.

II. Emission reduction calculation, monitoring and reporting

a) Logic of GHG emission reduction

CO_2 emission is reduced through displacing the production of virgin materials, resulting in avoidance of energy use. More specifically, for the production of plastic, CO_2 emissions associated with energy consumption for the production of plastic pellets from virgin plastic materials are reduced. For the production of glass, CO_2 emissions associated with the energy consumption for the production of virgin container glass corresponding to the preparation and mixing of raw materials before the melting stage are reduced.

b) Methodology to calculate GHG emission reduction

Approved CDM methodology AMS-III.AJ. "Recovery and recycling of materials from solid wastes" (version 5.2) is applied.

$$\boldsymbol{ER_y = \left(BE_{plastic,y} + BE_{glass,y}\right) - PE_y} \qquad \text{(Equation 1)}$$

ER_y	Emission reductions in year y (t CO_{2e})
$BE_{plastic,y}$	Baseline emissions in year y associated with the recycling of plastic (t CO_{2e})
$BE_{glass,y}$	Baseline emissions in year y associated with the recycling of glass (t CO_{2e})
PE_y	Project emissions in year y (t CO_{2e})

$$\boldsymbol{BE_{plastic,y} = \sum_i \left[Q_{i,y} \times L_i \times \left(SEC_{Bl,i} \times EF_{el,y} + SFC_{Bl,i} \times EF_{FF,CO2}\right)\right]} \qquad \text{(Equation 2)}$$

$BE_{plastic,y}$	Baseline emissions for plastics recycling in year y (tCO_2/year)
i	Indices for material type i (i = 1,2,3,4 for HDPE, LDPE, PET and PP)
Qi,y	Quantity of plastic type i recycled in year y (t/y)
L_i	Net to gross adjustment factor to cover degradation in material quality and material loss in the production process of the final product using the recycled material (use 0.75)
$SEC_{Bl,i}$	Specific electricity consumption for the production of virgin material type i (MWh/t)
$EF_{el,y}$	Emission factor for grid electricity generation
$SFC_{Bl,i}$	Specific fuel consumption for the production of virgin material type i (GJ/t)
$EF_{FF,CO2}$	CO_2 emission factor for fossil fuel (t CO_2/GJ)

$$BE_{glass,y} = \sum_i \left[Q_{glass,y} \times L_{glass} \times SEC_{Bl,glass} \times EF_{el,y} \right]$$ (Equation 3)

$BE_{glass,y}$	Baseline emissions for glass recycling in year y (tCO_2/y)
$Q_{glass,y}$	Quantity of glass cullet recycled by the project activity in year y (t/y)
L_{glass}	Net to gross adjustment factor to cover degradation in material quality and material loss in the production process of the final product using the recycled material (use 0.88)
$SEC_{Bl,glass}$	Specific electricity consumption for the production of raw materials displaced by the glass recycling (MWh/t)

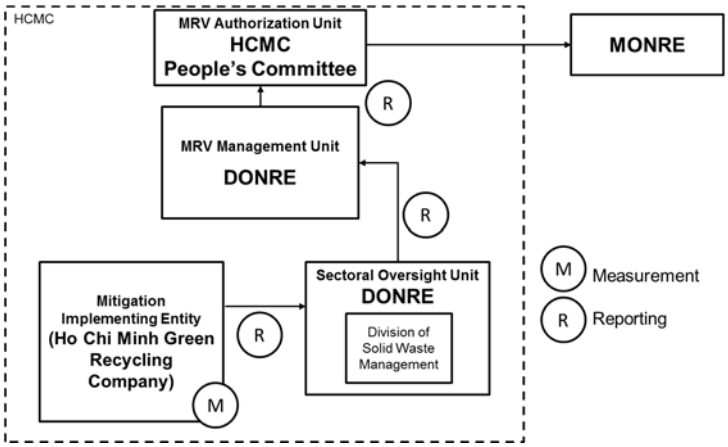
$$PE_y = \sum_i \left[Q_{i,y} \times \left(EC_{i,y} \times EF_{el,y} + FC_{i,y} \times NCV_{FF} \times EF_{FF,CO2} \right) \right]$$ (Equation 4)

PE_y	Project emissions in year y (tCO_2/y)
i	Indices for plastic type i (i = 1,2,3 for HDPE, LDPE, PET and PP) or container glass cullet
$Q_{i,y}$	Quantity of plastic type i or container glass cullet recycled in year y (t/y)
$EC_{i,y}$	Electricity consumption of the recycling facility apportioned to plastic type i or container glass cullet (MWh/t) in year y
$FC_{i,y}$	Fuel consumption of the recycling facility apportioned to plastic type i or container glass cullet (unit mass or volume/t) in year y
NCV_{FF}	Net calorific value of the fossil fuel consumed in the recycling facility in year y (GJ/unit mass or volume)
$EF_{FF,CO2}$	CO_2 emission factor of the fossil fuel consumed at the recycling facility (tCO_2/GJ), use local or national values, or IPCC default values

c) Estimated GHG emission reduction

5,481 tons-CO_{2e}

d) Organizational structure for monitoring and reporting



e) Monitoring period

From January 2016 to December 2016

f) Monitoring methods

- Monitoring parameters

Parameters listed in the following table will be monitored during the monitoring period.

Monitoring method described below will be applied.

Parameter	Monitoring method	Person/position in charge	Site
$Q_{i,y}$ Quantity of plastic type i recycled in year y (t/y)	Direct weighing of wastes or transporting trucks using a weight scale or weigh bridge at the project site. Weighing result is recorded daily on the paper and electronically.	Technical staff of Ho Chi Minh Recycling Company	Onsite (at the entrance of the recycling plant)
$Q_{glass,y}$ Quantity of glass cullet recycled by the project activity in year y (t/y)	Direct weighing of wastes or transporting trucks using a weight scale or weigh bridge at the project site. Weighing result is recorded daily on the paper and electronically.	Technical staff of Ho Chi Minh Recycling Company	Onsite
$EC_{i,y}$ Electricity consumption of the recycling facility (MWh/t) in year y	Monitored daily by reading an electricity meter of the recycling plant and the MWh data is recorded on the paper or electronically. Monitored data will be cross-checked with monthly electricity bill. Recorded data is shared with head office daily.	Technical staff of Ho Chi Minh Recycling Company	Onsite
$FC_{i,y}$ Fuel consumption of the recycling facility apportioned to plastic type i or container glass cullet (unit mass or volume/t) in year y	Direct measurement of weight or volume and density of the fuel. Measured daily and recorded monthly on paper and electronically.	Technical staff of Ho Chi Minh Recycling Company	Onsite

- Fixed parameters

Parameters listed in the following table will not be monitored during the monitoring period. Fixed value will be applied throughout the project timeframe.

Parameter	Source	Value
L_i Net to gross adjustment factor to cover degradation in material quality and material loss in the production process of the final product using the recycled material	Default value specified in the applied methodology	0.75
$SEC_{BI,i}$ Specific electricity consumption for the production of virgin material type i (MWh/t)	Default value specified in the applied methodology	· 0.83 MWh/t (3 GJ/t) and 1.67 MWh/t (6 GJ/t) for HDPE, LDPE · 1.11 MWh/t (4.0 GJ/t) for PET · 0.56 MWh/t (2.0 GJ/t) for PP
$EF_{el,y}$ Emission factor for grid electricity generation	Official data published by MONRE.	0.6612 t-CO_2/MWh
$SFC_{BI,i}$ Specific fuel consumption for the production of virgin material type i (GJ/t)	Default value specified in the applied methodology	· 15 GJ/t for HDPE and LDPE · 15 GJ/t for PET · 11.6GJ/t for PP
$EF_{FF,CO2}$ CO_2 emission factor for fossil fuel (t CO_2/GJ)	IPCC default values	74.1 kg-CO_2/ TJ for diesel oil
L_{glass} Net to gross adjustment factor to cover degradation in material quality and material loss in the production process of the final product using the recycled material	Default value specified in the applied methodology	0.88
$SEC_{BI,glass}$ Specific electricity consumption for the production of raw materials displaced by the glass recycling (MWh/t)	Default value specified in the applied methodology	0.026 MWh/t_{glass}
NCV_{FF} Net calorific value of the fossil fuel consumed in the recycling facility in year y (GJ/unit mass or volume)	IPCC default values	Varies by fuel type

Mitigation Monitoring Report

Note: The following descriptions are based on a hypothetical project.

a) Monitoring period

From January 2016 to December 2016

b) Emission reductions of the monitoring period

3,178 tons of CO_{2e}/ year

c) Processes of the emission reduction calculation

$$\boldsymbol{BE_{plastic,y} = \sum_i \left[Q_{i,y} \times L_i \times \left(SEC_{Bl,i} \times EF_{el,y} + SFC_{Bl,i} \times EF_{FF,CO2} \right) \right]}$$

= 10 tons x 300 days x 0.75 x

(1.11 MWh/t x 0.6612 tCO_2/ MWh + 15 GJ/ t x 74.1 kg-CO_2/ TJ)

= 4,152 ton-CO_2

$$\boldsymbol{BE_{glass,y} = \sum_i \left[Q_{glass,y} \times L_{glass} \times SEC_{Bl,glass} \times EF_{el,y} \right]}$$

= 100 tons x 300 days x 0.88 x 0.026 MWh/t x 0.6612 tCO_2/ MWh

= 454 ton-CO_2

$$\boldsymbol{PE_y = \sum_i \left[Q_{i,y} \times \left(EC_{i,y} \times EF_{el,y} + FC_{i,y} \times NCV_{FF} \times EF_{FF,CO2} \right) \right]}$$

= 2,160 MWh/ year x 0.6612 tCO_2/ MWh

= 1,428 ton-CO_2

$$\boldsymbol{ER_y = \left(BE_{plastic,y} + BE_{glass,y} \right) - PE_y}$$

= 4,152 + 454 – 1,428

= 3,178 ton-CO_2/ year

GHG Emission Reduction Calculation Sheet

Emission Reduction

Description	Parameter	Unit	Value
Emission reductions	ER_y	tCO_{2e}/year	**3,178**
Baseline emissions	BE_y	tCO_{2e}/year	4,606
Baseline emissions for plastic recycling in year y	$BE_{plastic,y}$	tCO_{2e}/year	4,152
Baseline emissions for glass recycling in year y	$BE_{glass,y}$	tCO_{2e}/year	454
Project emissions	PE_y	tCO_{2e}/year	1,428

Inputs

Description	Parameter	Unit	Value	Data source
Quantity of plastic type i recycled in year y	Qi,y	ton/ year	3,000	Monitored
Net to gross adjustment factor to cover degradation in material quality and material loss in the production process of the final product using the recycled material	L_i	-	0.75	Methodology default
Specific electricity consumption for the production of virgin material type i	$SEC_{BI,i}$	MWh/t	1.11	Methodology default
Emission factor for grid electricity generation	$EF_{el,y}$	t-CO_2 /MWh	0.6612	MONRE
pecific fuel consumption for the production of virgin material type i	$SFC_{BI,i}$	GJ/t	15.0	Methodology default
CO_2 emission factor for fossil fuel	$EF_{FF,CO2}$	t CO_2/GJ	74.1	IPCC Guidelines
Quantity of glass cullet recycled by the project activity in year y	$Q_{glass,y}$	ton/ year	30,000	Monitored
Net to gross adjustment factor to cover degradation in material quality and material loss in the production process of the final product using the recycled material	L_{glass}	-	0.88	Methodology default
Specific electricity consumption for the production of raw materials displaced by the glass recycling	$SEC_{BI,glass}$	MWh/t	0.026	Methodology default
Electricity consumption of the recycling facility apportioned to plastic type i or container glass cullet in year y	$EC_{i,y}$	MWh	2,160	Monitored
Fuel consumption of the recycling facility apportioned to plastic type i or container glass cullet in year y	$FC_{i,y}$	unit mass or volume/t	0	Fossil fuel is not used by the project
Net calorific value of the fossil fuel consumed in the recycling facility in year y	NCV_{FF}	GJ/unit mass or volume	N/A	N/A
CO_2 emission factor of the fossil fuel consumed at the recycling facility	$EF_{FF,CO2}$	tCO_2/GJ	N/A	N/A

Case Study 11: Production of organic fertilizer

MRV Plan

Note: Case study 11 is based on a hypothetical project. The data, name of organizations, and other descriptions contained in this case study are not based on the actual information.

I. General information on the mitigation action

a) Name of the mitigation action

Production of organic fertilizer

b) Involved organizations and their roles

Ho Chi Minh Organic Fertilizer Production Company: Mitigation Implementing Entity. Responsible for construction and operation of a compost processing plant, as well as conducting monitoring activity and preparing Mitigation Monitoring Report

Division of Solid Waste Management under the DONRE of HCMC: Sectoral Oversight Unit

c) Objectives

To reduce the volume of organic waste contained in municipal solid waste that will be disposed at the landfill site. To utilize abandoned organic resources that can be used as fertilizer.

d) Technology introduced under the mitigation action

Composting is a process of biodegradation of waste under aerobic (oxygen-rich) conditions. Wastes that can be composted contain solid biodegradable organic materials. Composting converts biodegradable organic carbon to mostly CO_2 and a residue (compost) that can be used as a fertilizer. Other outputs from composting include CH_4 and nitrous oxide (N_2O).

The project uses 100 tons of organic waste (food waste) every day that is collected from local households, markets and shopping malls. Produced compost will be used by HCMC and local residents as a fertilizer for street and garden trees.

e) Target GHG type

CH_4

f) Location

Binh Chanh District, Ho Chi Minh City

g) Timeframe

2017 – 2037

h) Cost of mitigation action

1 million USD

i) Benefits of mitigation action and contribution to sustainable development

Economic benefits: production of economical fertilizer using abandoned organic resources

Environmental benefits: contribution to reduce local air pollution and odor problems surrounding landfill sites

j) Source of funding and supporting financial scheme

HCMC budget

k) Information on international market mechanisms

The project has not registered to any international or bilateral carbon market mechanism.

II. Emission reduction calculation, monitoring and reporting

a) Logic of GHG emission reduction

CH_4 emission is avoided through reducing the volume of organic contents in municipal solid waste that would be disposed to landfill site and decayed in anaerobic condition.

b) Methodology to calculate GHG emission reduction

Approved CDM methodology ACM0022 "Alternative waste treatment processes" (Version 02.0) is applied. Associated CDM Methodological Tools "Project and leakage emissions from composting" (Version 01.0.0) and "Emissions from solid waste disposal sites" (Version 06.0.1) are also applied.

$$\boldsymbol{ER_y = BE_y - PE_y}$$

ER_y	Emission reductions in year y (t CO_{2e})
BE_y	Baseline emissions in year y (t CO_{2e})
PE_y	Project emissions in year y (t CO_{2e})

$$\mathrm{BE_y} = \varphi_y \cdot (1 - \mathrm{f_y}) \cdot \mathrm{GWP_{CH4}} \cdot (1 - \mathrm{OX}) \cdot \frac{16}{12} \cdot \mathrm{F} \cdot \mathrm{DOC_{f,y}} \cdot \mathrm{MCF_y} \cdot \sum_{x=1}^{y} \sum_{j} \mathrm{W_{j,x}} \cdot \mathrm{DOC_j} \cdot e^{-k_j \cdot (y-x)} \cdot \left(1 - e^{-k_j}\right)$$

Φ_y	Model correction factor to account for model uncertainties for year y
f_y	Fraction of methane captured at the landfill site and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year y
GWP_{CH4}	Global Warming Potential of methane
OX	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)
F	Fraction of methane in the landfill gas (volume fraction)
$DOC_{f,y}$	Fraction of degradable organic carbon (DOC) that decomposes under the specific conditions occurring in the landfill site for year y (weight fraction)
MCF_y	Methane correction factor for year y
x	Years in the time period in which waste is disposed at the landfill site, extending from the first year in the time period (x = 1) to year y (x = y)
y	Year of the monitoring period for which methane emissions are calculated (y is a consecutive period of 12 months)

$W_{j,x}$	Amount of organic waste used to produce compost (waste prevented from disposal in the landfill site) in the year x (t)
DOC_j	Fraction of degradable organic carbon in the waste type j (weight fraction)
k_j	Decay rate for the waste type j (1/ yr)
$_j$	Type of residual waste or types of waste in the municipal solid waste

$$\boldsymbol{PE_y = PE_{EC,y} + PE_{FC,y} + PE_{CH4,y} + PE_{N2O,y}}$$

PE_y	Project emissions associated with composting in year y (t CO_{2e}/yr)
$PE_{EC,y}$	Project emissions from electricity consumption associated with composting in year y (t CO_2/yr)
$PE_{FC,y}$	Project emissions from fossil fuel consumption associated with composting in year y (t CO_2/yr)
$PE_{CH4,y}$	Project emissions of methane from the composting process in year y (t CO_{2e}/yr)
$PE_{N2O,y}$	Project emissions of nitrous oxide from the composting process in year y (t CO_{2e}/yr)

$$\boldsymbol{PE_{EC,y} = Q_y \times SEC_{comp,default}}$$

Q_y	Quantity of waste composted in year y (t/yr)
$PE_{EC,y}$	Quantity of electricity consumed for composting in year y (MWh/yr)
$SEC_{comp,default}$	Default value for the specific quantity of electricity consumed per tonne of waste composted (MWh/t)

$$\boldsymbol{PE_{FC,y} = Q_y \times EF_{FC,default}}$$

$PE_{FC,y}$	Project emissions from fossil fuel consumption associated with composting in year y (t CO_2 / yr)
$EF_{FC,default}$	Default emission factor for fossil fuels consumed by the composting activity per tonne of waste (t CO_2/t)

$$\boldsymbol{PE_{CH4,y} = Q_y \times EF_{CH4,y} \times GWP_{CH4}}$$

$PE_{CH4,y}$	Project emissions of methane from the composting process in year y (t CO_{2e} / yr)
$EF_{CH4,y}$	Emission factor of methane per tonne of waste composted valid for year y (t CH_4 / t)
GWP_{CH4}	Global Warming Potential of CH_4 (t CO_{2e} / t CH4)

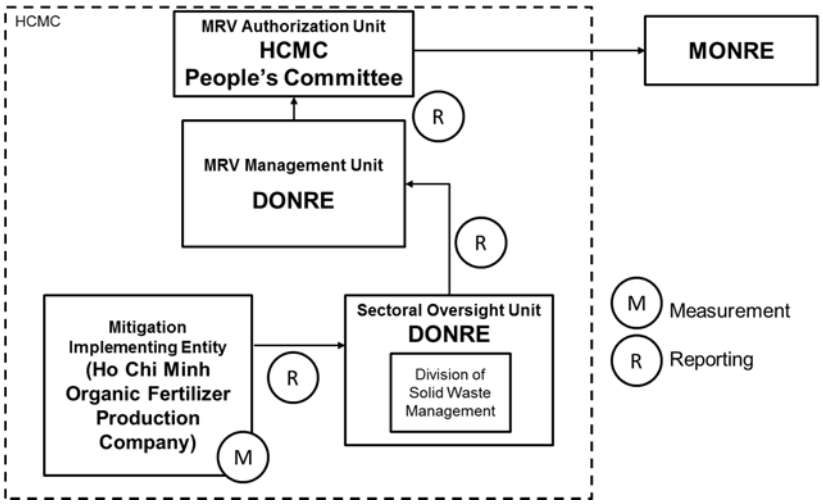
$$\boldsymbol{PE_{N2O,y} = Q_y \times EF_{N2O,y} \times GWP_{N2O}}$$

$PE_{N2O,y}$	Project emissions of nitrous oxide from composting in year y (t CO_{2e} /yr)
$EF_{N2O,y}$	Emission factor of nitrous oxide per tonne of waste composted valid for year y (t N_2O/t)
GWP_{N2O}	Global Warming Potential of N_2O (t CO_{2e}/t N_2O)

c) Estimated GHG emission reduction

7,349 ton-CO_{2e}

d) Organizational structure for monitoring and reporting



e) Monitoring period

From January 2016 to December 2016

f) Monitoring methods

- Monitoring parameters

Parameters listed in the following table will be monitored during the monitoring period.

Monitoring method described below will be applied.

Parameter	Monitoring method	Person/position in charge	Site
f_y Fraction of methane captured at the landfill site and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year y	Once a year, the status of methane capture at the landfill site will be checked through interview with relevant agencies or literature survey.	Manager of Ho Chi Minh Organic Fertilizer Production Company	N/A
$W_{j,x}$ A mount of organic waste (food waste) used to produce compost (organic waste prevented from disposal in the landfill site) in the year x (t)	Direct weighing of organic wastes or transporting trucks using a weight scale or weigh bridge at the project site. Weighing result is recorded daily on the paper and electronically.	Technical staff of Ho Chi Minh Organic Fertilizer Production Company	Onsite (entrance of the compost processing plant)
Q_y Quantity of waste composted in year y (t/yr)	Direct weighing of wastes or transporting trucks using a weight scale or weigh bridge at the project site. Weighing result is recorded daily on the paper and electronically.	Technical staff of Ho Chi Minh Organic Fertilizer Production Company	Onsite (entrance of the compost processing plant)

- Fixed parameters

Parameters listed in the following table will not be monitored during the monitoring period.

Fixed value will be applied throughout the project timeframe.

Parameter	Source	Value
ϕ Model correction factor to account for model uncertainties for year y	Default value specified in the applied methodology and associated tool.	0.85
GWP_{CH4} Global Warming Potential of methane	IPCC default value	25
OX Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)	Default value specified in the applied methodology and associated tool	0.1
F Fraction of methane in the landfill gas (volume fraction)	Default value specified in the applied methodology and associated tool	0.5
$DOC_{f,y}$ Fraction of degradable organic carbon (DOC) that decomposes under the specific conditions occurring in the landfill site for year y (weight fraction)	Default value specified in the applied methodology and associated tool	0.5
MCF_y Methane correction factor for year y	Default values specified in the applied methodology and associated tool	1.0
DOC_j Fraction of degradable organic carbon in the waste type j (weight fraction)	Default value specified in the applied methodology and associated tool	0.5 for food waste
k_j Decay rate for the waste type j (1/ yr)	Default value specified in the applied methodology and associated tool	0.4
$SEC_{comp,default}$ Default value for the specific quantity of electricity consumed per tonne of waste composted (MWh/t)	Default value specified in the applied methodology and associated tool	0.01
$EF_{FC,default}$ Default emission factor for fossil fuels consumed by the composting activity per tonne of waste (t CO_2/t)	Default value specified in the applied methodology and associated tool	0.0207
$EF_{CH4,y}$ Emission factor of methane per tonne of waste composted valid for year y (t CH_4 / t)	Default value specified in the applied methodology and associated tool	0.002
$EF_{N2O,y}$ Emission factor of nitrous oxide per tonne of waste composted valid for year y (t N_2O/t)	Default value specified in the applied methodology and associated tool	0.0002
GWP_{N2O} Global Warming Potential of N_2O	IPCC default value	298

Mitigation Monitoring Report

Note: The following descriptions are based on a hypothetical project.

a) Monitoring period

From January 2016 to December 2016

b) Emission reductions of the monitoring period

6,386 t-CO_{2e}/ year

c) Processes of the emission reduction calculation

$$BE_y = \varphi_y \cdot (1 - f_y) \cdot GWP_{CH4} \cdot (1 - OX) \cdot \frac{16}{12} \cdot F \cdot DOC_{f,y} \cdot MCF_y \cdot \sum_{x=1}^{y} \sum_{j} W_{j,x} \cdot DOC_j \cdot e^{-k_j \cdot (y-x)} \cdot \left(1 - e^{-k_j}\right)$$

= 0.85 x (1 – 0) x 25 x (1 – 0.1) x 16/12 x 0.5 x 0.5 x 1 x 36,500 tons x 0.15 x 1 x (1-0.6703)

= 11,507 t-CO_{2e}/ year

$$PE_{EC,y} = Q_y \times SEC_{comp,default}$$

= 36,500 ton x 0.01

= 365 t-CO_{2e}/ year

$$PE_{FC,y} = Q_y \times EF_{FC,default}$$

= 36,500 ton x 0.0207

= 756 t-CO_{2e}/ year

$$PE_{CH4,y} = Q_y \times EF_{CH4,y} \times GWP_{CH4}$$

= 36,500 ton x 0.002 x 25

= 1,825 t-CO_{2e}/ year

$$PE_{N2O,y} = Q_y \times EF_{N2O,y} \times GWP_{N2O}$$

= 36,500 ton x 0.0002 x 298

= 2,175 t-CO_{2e}/ year

$$PE_y = PE_{EC,y} + PE_{FC,y} + PE_{CH4,y} + PE_{N2O,y}$$

= 365 + 756 + 1,825 + 2,175.40

= 5,121 t-CO_{2e}/ year

$$ER_y = BE_y - PE_y$$

= 11,507 – 5,121

= 6,386 t-CO_{2e}/ year

GHG Emission Reduction Calculation Sheet

Emission Reduction

Description	Parameter	Unit	Value
Emission reductions	ER_y	tCO_{2e}/year	**6,386**
Baseline emissions	BE_y	tCO_{2e}/year	**11,507**
Project emissions	PE_y	tCO_{2e}/year	**5,121**
Project emissions from electricity consumption associated with composting in year y	$PE_{EC,y}$	tCO_{2e}/year	365
Project emissions from fossil fuel consumption associated with composting in year y	$PE_{FC,y}$	tCO_{2e}/year	756
Project emissions of methane from the composting process in year y	$PE_{CH4,y}$	tCO_{2e}/year	1,825
Project emissions of nitrous oxide from the composting process in year y	$PE_{N2O,y}$	tCO_{2e}/year	2,175

Inputs

Description	Parameter	Unit	Value	Data source
Amount of organic waste used to produce compost (waste prevented from disposal in the landfill site) in the year x	$W_{j,x}$	ton/ year	36,500	Monitored
Model correction factor to account for model uncertainties for year y	Φ_y	-	0.85	Methodology default
Fraction of methane captured at the landfill site and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year y	f_y	-	0	Methodology default
Global Warming Potential of methane	GWP_{CH4}	-	25	IPCC Guidelines
Oxidation factor (reflecting the amount of methane from SWDS that is oxidised in the soil or other material covering the waste)	OX	-	0.1	Methodology default
Fraction of methane in the landfill gas	F	-	0.5	Methodology default
Fraction of degradable organic carbon (DOC) that decomposes under the specific conditions occurring in the landfill site for year y	$DOC_{f,y}$	-	0.5	Methodology default
Methane correction factor for year y	MCF_y	-	1.0	Methodology default
Fraction of degradable organic carbon in the waste type j	DOC_j	-	0.2	Methodology default
Decay rate for the waste type j	k_j	1/ yr	0.4	Methodology default
Quantity of waste composted in year y (t/yr	Q_y		36,500	Monitored
Quantity of electricity consumed for composting in year y	$PE_{EC,y}$	MWh/yr	N/A	Monitored
Default value for the specific quantity of electricity consumed per tonne of waste composted	$SEC_{comp,default}$	MWh/t	0.01	Methodology default
Default emission factor for fossil fuels consumed by the composting activity per tonne of waste	$EF_{FC,default}$	t CO2/t	0.0207	Methodology default
Emission factor of methane per tonne of waste composted valid for year y	$EF_{CH4,y}$	t CH4 / t	0.002	Methodology default
Emission factor of nitrous oxide per tonne of waste composted valid for year y	$EF_{N2O,y}$	t N2O/t	0.0002	Methodology default
Global Warming Potential of N2O	GWP_{N2O}	t CO2e/t N2O	298	Methodology default

Case Study 12: Collection of animal manure for biogas generation

MRV Plan

Note: The following descriptions are based on the actual on-going project.

I. General information on the mitigation action

a) Name of the mitigation action

Collection of animal manure for biogas generation

b) Involved organizations and their roles

Livestock Competitiveness and Food Safety Project (LIFSAP) of HCMC: Mitigation Implementing Entity. Responsible for monitoring activity, GHG emission reduction calculation, coordination with data holders (farmers), preparation of Mitigation Monitoring Report.

HCMC Department of Agriculture and Rural Development (DARD): Sectoral Oversight Unit. Responsible for examining the Mitigation Monitoring Report submitted by LIFSAP.

c) Objectives

To increase the production efficiency of household-based livestock producers and to reduce the environmental impact of livestock production such as local water and air pollution by installing bio-digesters that enable environment-friendly animal manure management.

d) Technology introduced under the mitigation action

Bio-digesters installed at livestock farms have the capacity of 7 m^3 or 9 m^3 and collect animal manure to generate biogas. Collected biogas is used by farmers for cooking purpose for 3 hours per day on average. Total number of bio digesters installed is 844 (as of April 2017). Average number of livestock (swine) per household is 45.

e) Target GHG type

CH_4 and CO_2

f) Location

Cu Chi District of HCMC

g) Timeframe

2010 – present

h) Cost of mitigation action

N/A

i) Benefits of mitigation action and contribution to sustainable development

Social benefits: improvement of environmental awareness by local farmers

Economic benefits: improved production of livestock, fuel cost saving by farmers

Environmental benefits: improved local air and water condition

j) Source of funding and supporting financial scheme

Part of the cost for purchasing and installing bio digesters was supported by the World Bank.

k) Information on international market mechanisms

The mitigation action has not been registered to any bilateral or international market mechanism.

II. Emission reduction calculation, monitoring and reporting

a) Logic of GHG emission reduction

CH_4 emission is avoided through collecting and utilizing organic waste (animal manure) that would be abandoned in the field for organic decay.

CO_2 emission is reduced through avoiding the use of fossil fuels for cooking.

b) Methodology to calculate GHG emission reduction

Following approved CDM methodologies were referred to:

- AMS-III.R "Methane recovery in agricultural activities at household/small farm level"
- AMS-III.D "Methane recovery in animal manure management systems"

$$\boldsymbol{ER_y = BE_y - PE_y} \qquad \text{(Equation 1)}$$

ER_y : GHG emissions reduction from the project in year y (ton-CO_{2e}/year)

BE_y : GHG emissions at baseline case without project activity (ton-CO_{2e}/year)

PE_y : GHG emissions from project activity (ton-CO_{2e}/year)

$$\boldsymbol{BE_y = BE_{1,y} + BE_{2,y}} \qquad \text{(Equation 2)}$$

$BE_{1,y}$: GHG emissions (CH_4) at baseline case from disposed animal manure (ton-CO_{2e}/year)

$BE_{2,y}$: GHG emissions (CO_2) at baseline case from the consumption of fossil fuels currently used (ton-CO_{2e}/year)

$$\boldsymbol{BE_{1,y} = \sum \frac{(EF_{(T)} \times N_{(T)})}{10^3} \times GWP_{CH4}} \qquad \text{(Equation 3)}$$

$EF_{(T)}$: Methane emission factor for livestock (kg CH_4/ head/ year)

$N_{(T)}$: Number of head of livestock (swine)

GWP_{CH4} : Global Warming Potential (GWP) of methane =25

$$BE_{2,y} = \sum BG_{PJ,y} \text{x } NCV \times EF_{PJ,y} \times 1/10^6$$ (Equation 4)

BG $_{PJ,y}$: Quantity of fuel consumed by household without using biogas (kg/year)

NCV : Heating value of fuel (MJ/kg)

EF $_{PJ,y}$: CO_2 emission factor of fossil fuel (t-CO_2/MJ)

$$PE_y = 0.1 \times BE_{1,y}$$ (Equation 5)

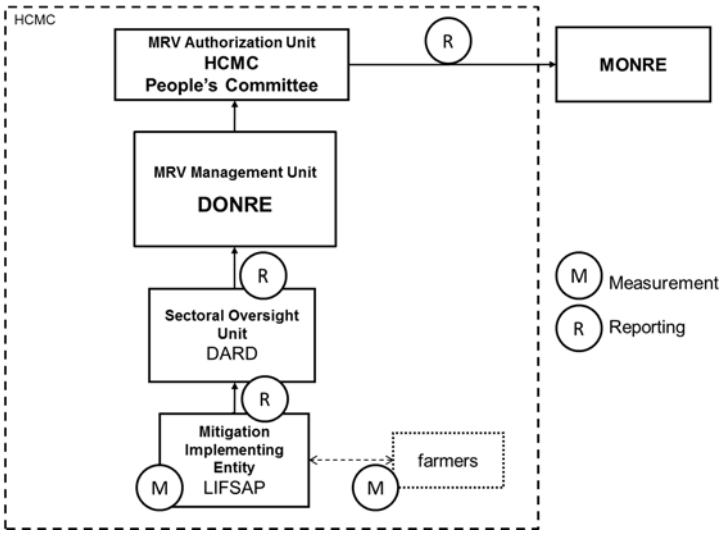
PE_y : GHG emissions from project activity (ton-CO_{2e}/year)

0.1 : Physical leakage of biogas from the animal manure management system to produce, collect and transport the biogas (fraction)

c) Estimated GHG emission reduction

6,862 ton-$CO_{2equivalent}$

d) Organizational structure for monitoring and reporting



e) Monitoring period

From 1 January 2017 to 31 March 2017 (for the MRV trial)

f) Monitoring methods

- Monitoring parameters

Parameters listed in the following table will be monitored during the monitoring period.

Monitoring method described below will be applied.

Parameter	Monitoring method	Person/position in charge	Site
$N_{(T)}$ Number of head of livestock (swine)	Number of head at households is counted by sample livestock farmers to yield average number. Number of samples will be large enough to represent the whole target households. Considering the large size of the target group and difficulty of frequent data collection, above information will be monitored every 3 month	Technical staff of LIFSAP project	Onsite (sample households)
$BG_{PJ,y}$ Quantity of fuel consumed by household instead of using biogas (kg/year)	Calculated based on the average capacity and quantity of cooking device used by target households, and average yearly cooking hours per household. Above information is collected by interview survey from the sufficient number of households that represent the entire target group. Considering the large size of the target group and difficulty of frequent data collection, above information is monitored every 3 month.	Technical staff of LIFSAP project	N/A

- Fixed parameters

Parameters listed in the following table will not be monitored during the monitoring period.

Fixed value will be applied throughout the project timeframe.

Parameter	Source	Value
$EF_{(T)}$ Methane emission factor for livestock (kg CH_4/ head/ year)	Default value (IPCC Guidelines) Value for more than 28C average annual temperature is applied.	7 kg CH_4/ head/ year
GWP_{CH4} Global Warming Potential of methane	Default value (IPCC Guidelines)	25
NCV Net calorific value of fuel that would be used for cooking instead of biogas (MJ/ kg)	Default value (IPCC Guidelines) Value of LPG is applied.	47.3 MJ/ kg
$EF_{PJ,y}$ CO_2 emission factor of fuel that would be used for cooking instead of biogas (t-CO_2/MJ)	Default value (CDM methodology) Value of LPG is applied.	63.1 t-CO_2/MJ

Mitigation Monitoring Report

Note: The following descriptions are based on the actual on-going project.

a) Monitoring period

From 1 January 2017 to 31 March 2017

b) Emission reductions of the monitoring period

1,716 tons-$CO_{2\text{-equivalent}}$

c) Processes of the emission reduction calculation

$$\boldsymbol{BE_{1,y}} = \sum_{T} \frac{\left(\boldsymbol{EF_{(T)}} \times \boldsymbol{N_{(T)}}\right)}{\boldsymbol{10^3}} \times \boldsymbol{GWP_{CH4}}$$ (Equation 3)

= 844 x 7 x 45 / 10^3 x 25

= 6,647

$$\boldsymbol{BE_{2,y}} = \boldsymbol{BG_{PJ,y}} \text{x } \boldsymbol{NCV} \times \boldsymbol{EF_{PJ,y}} \times \boldsymbol{1/10^6}$$ (Equation 4)

= 844 x 349.7 x 47.3 x 63.1 / 10^6

= 881

$$\boldsymbol{PE_y} = \boldsymbol{0.1} \times \boldsymbol{BE_{1,y}}$$ (Equation 5)

= 0.1 x 6,646.5

= 665

$$\boldsymbol{BE_y} = \boldsymbol{BE_{1,y}} + \boldsymbol{BE_{2,y}}$$ (Equation 2)

= 6,647 + 881.03

= 7,527

$$\boldsymbol{ER_y} = \boldsymbol{BE_y} - \boldsymbol{PE_y}$$ (Equation 1)

= 7,527 – 665

= 6,863 (ton-$CO_{2\text{-equivalent}}$/ year)

= 1,716 (ton-CO_{2e}) (during the 3-month monitoring period)

GHG Emission Reduction Calculation Sheet

Emission Reduction

Description	Parameter	Unit	Value
Emission reductions	ER_y	tCO_{2e}/year	**6,863**
Emission reductions (for 3-month monitoring period)	ER_y	tCO_{2e}	**1,716**
Baseline emissions	BE_y	tCO_{2e}/year	**7,527**
Baseline emissions (CH_4) from disposed animal manure	$BE_{1,y}$	tCO_{2e}/year	6,647
Baseline emissions (CO_2) from the consumption of fossil fuels	$BE_{2,y}$	tCO_{2e}/year	881
Project emissions	PE_y	tCO_{2e}/year	**665**

Inputs

Description	Parameter	Unit	Value	Data source
Number of head of livestock (swine)	$N_{(T)}$	head	37,980	Monitored
Quantity of fuel consumed by household instead of using biogas	$BG_{PJ,y}$	kg/year	295,147	Monitored
Methane emission factor for livestock	$EF_{(T)}$	kg CH_4/ head/ year	7	Methodology default
Global Warming Potential of methane	GWP_{CH4}	-	25	IPCC Guidelines
Net calorific value of fuel that would be used for cooking instead of biogas	NCV	MJ/ kg	47.3	IPCC Guidelines
CO_2 emission factor of fuel that would be used for cooking instead of biogas	$EF_{PJ,y}$	t-CO_2/MJ	63.1	IPCC Guidelines (value for LPG)

Annex II Typical Mitigation Actions and Emission Reduction Logic

The basic logic of GHG emissions and emission reductions*

How is carbon dioxide (CO_2) *emitted*?

- CO_2 is emitted by combustion of fossil fuel such as gasoline, diesel, heavy oil and natural gas.
- Use of electricity does not emit CO_2 on that site but it results in CO_2 emissions indirectly, because fossil fuel is combusted at the power plants to generate electricity.

How is CO_2 emission *reduced*?

- By reducing the consumption of fossil fuel and electricity.
  - Fossil fuel: vehicle, motor-bike, factory, commercial building, household, etc.
  - Electricity: office, factory, commercial building, household, etc.
- By substituting fossil fuel with renewable energy such as solar power, solar heat, wind power, geothermal and biomass etc.

How is methane (CH_4) *emitted*?

- CH_4 is emitted through decay of organic contents under anaerobic condition.
  - Agriculture: intestinal fermentation of animals, treatment of livestock manure, paddy field, etc.
  - Waste: anaerobic decay of organic contents contained in waste and untreated wastewater.
  - Fuel: small amount of methane is emitted by combustion of fuel.

How is methane (CH_4) emission *reduced*?

- By recovering and utilizing methane for heat and power generation at manure treatment facility, waste disposal site, or wastewater treatment facility.
- By reducing the volume of organic waste that is landfilled.

<Generation of electricity>

Category	Logic of GHG emission reductions
Renewable energy utilization	- Renewable energy equipment such as a solar PV system, a wind power system and a hydropower system generates electricity. - The electricity generated by the renewable energy equipment can substitute the grid electricity which is generated by using fossil fuels. - CO_2 emission is reduced through reducing the consumption of grid electricity.
Fuel switch for electricity generation	- CO_2 emission is reduced through switching the fuel for electricity generation at the power plants from the high carbon content fuels such as coal to the low carbon content fuels such as natural gas.
Electricity generation efficiency improvement	- Fossil fuel consumption is reduced through improving electricity generation efficiency. - CO_2 emission is reduced through reducing the fossil fuel consumption.
Transmission/ distribution loss improvement	- Electricity is lost due to the transmission/ distribution loss of the transmission/ distribution line. - CO_2 emission is reduced through reducing the transmission/ distribution loss of the transmission/ distribution line.

<Factory>

Category	Logic of GHG emission reductions
Renewable energy utilization	- Renewable energy equipment such as a solar PV system, a micro hydro power, and biomass utilization generates electricity. - The electricity generated by the renewable energy equipment can substitute the grid electricity which is generated by using fossil fuel. - CO_2 emission is reduced through reducing the consumption of grid electricity.
Fuel switch for boiler	- CO_2 emission is reduced through switching the fuel for the boiler from the high carbon content fuels such as diesel/gasoline to the low carbon content fuels such as CNG/LPG/biomass.
Energy efficiency	- Electricity/ fuel consumption is reduced through improving the energy efficiency by higher efficient technology/equipment such as high efficiency boiler, high efficiency refrigerator, LED etc. - Electricity/ fuel consumption is reduced by setting the energy saving standard/ conducting energy saving training to employee. - CO_2 emission is reduced through reducing the consumption of electricity/ fuel.

<Commercial building (hotel, shopping mall, market, etc.)>

Category	Logic of GHG emission reductions
Renewable energy utilization	- Renewable energy equipment such as solar PV system generates electricity using renewable energy. - Solar hot water system can reduce electricity consumption which is used for making hot water. - The electricity generated by renewable energy equipment can substitute the grid electricity which is generated using fossil fuel. - CO_2 emission is reduced through reducing the consumption of grid electricity.
Fuel switch for boiler	- CO_2 emission is reduced through switching the fuel for boiler from high carbon content fuel such as diesel/gasoline to low carbon content fuel such as CNG/LPG/ biodiesel/bioethanol.
Energy efficiency	- Electricity consumption is reduced through improving energy efficiency by the higher efficient technology/equipment such as high-efficiency refrigerator, high-efficiency furnace, high efficiency air-conditioner, LED etc. - Electricity consumption is reduced by installing the energy management system, setting energy saving standard, conducting energy saving training to employee. - CO_2 emission is reduced through reducing the consumption of electricity.

<Household>

Category	Logic of GHG emission reductions
Renewable energy utilization	- Renewable energy equipment such as solar PV system generate electricity. - The electricity generated by renewable energy equipment can substitute grid electricity which is generated using fossil fuel. - Solar hot water system can reduce electricity consumption which is used for making hot water. - CO2 emission is reduced through reducing the consumption of grid electricity.
Energy efficiency	- Electricity consumption is reduced through improving energy efficiency by higher efficient technology/equipment such as high efficiency air-conditioner, LED etc. - CO_2 emission is reduced through reducing the consumption of electricity.

<Car/motorcycle>

Category	Logic of GHG emission reductions
Low emission technology	- High efficiency gasoline/ diesel engines and hybrid/ electric technologies. - CO_2 emission is reduced through vehicles with these low emission technologies which consume less fossil fuel than conventional gasoline/ diesel vehicles.
Fuel switch	- Shift of vehicle fuel from conventional gasoline/ diesel fuel to compressed natural gas (CNG) or biofuels (such as biodiesel and bioethanol). - CO_2 emission is reduced through utilizing CNG which have low carbon content than conventional gasoline/ diesel fuel. - CO_2 emission is reduced through utilizing biofuels which emit less emissions than conventional gasoline/ diesel fuel. However, emission reduction is highly dependent on the type of the feedstock for the biofuel used, and if the land use change from forest is required for the cultivation of the feedstock, emissions are not reduced.
Driving technique	- Eco-friendly driving such as stop idling, mild acceleration and keeping constant driving speed. - CO_2 emission is reduced through improving fuel efficiency by above more efficient driving technique.

<Bus>

Category	Logic of GHG emission reductions
Low emission technology	- High efficiency diesel engines and hybrid/ electric technologies. - CO_2 emission is reduced through vehicles with these low emission technologies which consume less fossil fuel than conventional diesel buses.
Improvement of service	- Development of a new bus route, improvement/ optimization of the existing bus routes/ operation frequency, and also Bus Rapid Transit (BRT). - CO_2 emission is reduced through mode shift of passenger transportation from the existing means of transportation such as private cars to buses or more efficient BRT. Commonly, bus systems are more efficient than private cars in terms of CO_2 emission per passenger-km. - CO_2 emission is reduced through optimization of bus route which leads to the reduction of total drive distances or number of buses in operation.
Fuel switch	- Shift of vehicle fuel from conventional gasoline/ diesel fuel to CNG (compressed natural gas) or biofuels (such as biodiesel and bioethanol). - CO_2 emission is reduced through utilizing CNG which have low carbon content than conventional gasoline/ diesel fuel. - CO_2 emission is reduced through utilizing biofuels which emit less emissions than conventional gasoline/ diesel fuel. (However, emission reduction is highly dependent on the type of the feedstock for the biofuel used, and if the land use change from forest is required for the cultivation of the feedstock, emissions are not reduced.)
Driving technique	- Eco-friendly driving such as stop idling, mild acceleration and keeping constant driving speed. - CO_2 emission is reduced through improving fuel efficiency by above more efficient driving technique.

<Railway >

Category	Logic of GHG emission reductions
Urban railway development	- Metro, LRT, monorail, Automated Guideway Transit (AGT), etc. - CO_2 emission is reduced through mode shift of passenger transportation from the existing means of transportation such as private cars and local buses to urban railways. Commonly, urban railways are more efficient than private cars and local buses in terms of CO_2 emission per passenger-km.
Inter-city railway development	- Local railways between cities. - CO_2 emission is reduced through mode shift of passenger transportation from inter-city buses and aircrafts to inter-city railways, also through enhancing transportation capacity by renovation of rail tracks, and through replacing old locomotives with high fuel efficiency locomotives.
Low emission technology	- Energy efficient railway vehicles such as light weight vehicle, Variable Voltage Variable Frequency (VVVF), regenerative braking system, electric-diesel hybrid railway vehicles. - CO_2 emission is reduced through these low emission technologies which can reduce energy consumption or consume less energy.
Fuel switch	- Shift of vehicle fuel from conventional gasoline/ diesel fuel to CNG (compressed natural gas) or biofuels (such as biodiesel and bioethanol). - CO_2 emission is reduced through utilizing CNG which have low carbon content than conventional gasoline/ diesel fuel. - CO_2 emission is reduced through utilizing biofuels which emit less emissions than conventional gasoline/ diesel fuel. (However, emission reduction is highly dependent on the type of the feedstock for the biofuel used, and if the land use change from forest is required for the cultivation of the feedstock, emissions are not reduced.)
Eco-friendly station	- Stations/ depots utilizing energy efficient appliances and/or renewable energy such as LED and PV system. - CO_2 emission is reduced by saving fossil fuel and/or grid electricity through introducing these technologies for stations/depots.

<Ship/vessel >

Category	Logic of GHG emission reductions
Low emission technology	- High fuel efficiency engines, light weight solution, less resistance for water, etc. - CO_2 emission is reduced through introducing these technologies which consume less fossil fuel than conventional vessels.
Improvement of service	- Development of new river/ canal boat route, improvement/ optimization of existing routes. - CO_2 emission is reduced through mode shift of passenger transportation from existing means of transportation such as private cars or local buses to river/canal boat which has potential to reduce CO_2 emission per passenger-km than private cars or local buses.
Fuel switch	- Shift of vehicle fuel from conventional gasoline/ diesel fuel to CNG (compressed natural gas) or biofuels (such as biodiesel and bioethanol). - CO_2 emission is reduced through utilizing CNG which have low carbon content than conventional gasoline/ diesel fuel. - CO_2 emission is reduced through utilizing biofuels which emit less emissions than conventional gasoline/ diesel fuel. (However, emission reduction is highly dependent on the type of the feedstock for the biofuel used, and if the land use change from forest is required for the cultivation of the feedstock, emissions are not reduced.)

<Traffic management>

Category	Logic of GHG emission reductions
System/software	- ITS technologies such as intelligent traffic signal system and Electronic Toll Collection System (ETC). - CO_2 emission is reduced by improving traffic flow and thus saving total fuel consumption of vehicles of target area or road through introducing these technologies.
Infrastructure	- Bypass, ring-road, fly-over, bridges, tunnels which have potential to improve traffic flow at congested area. - CO_2 emission is reduced by improving traffic flow or reducing driving distances of target area or road through these infrastructures.

<Freight transportation>

Category	Logic of GHG emission reductions
Promotion of shift from road to railway	- Measures such as introduction of new freight car, large size container, renovation of railway tracks, development/ improvement of railway freight terminal. - CO_2 emission is reduced through mode shift of freight transportation from trucks to railways through implementing above measures. Commonly, railways are more efficient than trucks in terms of CO_2 emission per ton-km.
Promotion of shift from road to waterway	- Improvement of river/ sea ports, installation of handling equipment. - CO_2 emission is reduced through mode shift of freight transportation from trucks to waterways through implementing above measures. Commonly, waterways are more efficient than trucks in terms of CO_2 emission per ton-km.
Driving technique	- Eco-friendly driving such as stop idling, mild acceleration and keeping constant driving speed. - CO_2 emission is reduced through improving fuel efficiency by above more efficient driving technique.

<Port/airport>

Category	Logic of GHG emission reductions
Low emission technology	- Introduction of energy efficient cargo handling machinery, energy efficiency chiller container, energy efficiency lighting, renewable energy, e.g. PV system, electricity supply system for ships/aircrafts - CO_2 emission is reduced by saving fossil fuel and/or grid electricity through these technologies.

<Waste treatment>

Category	Logic of GHG emission reductions
Reduction of landfilled organic waste	- Various types of measures that lead to the reduction of organic waste to be landfilled, such as composting of organic waste, incineration of waste, and waste-to-energy. - CH_4 emission is avoided through reducing the volume of organic contents in the waste that would be decomposed at anaerobic landfill.
3R (reduce, reuse, recycle)	- Reduction, reuse or recycling of municipal solid wastes. - CO_2 emission is reduced through reducing, reusing or recycling of solid wastes such as plastic, glass and paper. This is due to displacement of the production of virgin materials, which result in avoidance of energy use.
Waste transportation	- Any measure that improves transportation efficiency related to collection and transportation of wastes or sludge from generation points to final disposal/ treatment sites. Introduction of low-emission trucks, fuel switch of transportation trucks, and change in driving technique or transportation routes are included in this category. - CO_2 emission is reduced by reducing the amount of fossil fuel consumed for waste transportation under the same logics described in <Car/motorcycle>, namely “Low emission technology,” “Fuel switch,” or “Driving technique.”
Waste disposal method	- Various waste disposal/ final treatment methods such as sanitary landfill, semi-aerobic landfill, flaring of landfill gas, and waste-to-energy (collection and utilization of landfill gas for energy generation). - CH_4 emission is avoided through reducing the volume of organic contents in the waste that would be decomposed at anaerobic landfill.CO_2 emission is reduced where landfill gas is collected and used for energy generation. CO_2 is reduced through substituting grid electricity that is generated by fossil fuel.

<Wastewater treatment>

Category	Logic of GHG emission reductions
Introduction of wastewater treatment method	- Any measure that avoids discharge of untreated wastewater into waterways such as rivers and canals. - Construction and operation of central wastewater treatment plants, connection of households, commercial buildings and factories with central wastewater treatment plants, and onsite wastewater treatment facility are included in this measure. - CH_4 emission is reduced through preventing certain volume of untreated wastewater to be discharged into rivers and canals where organic contents in the untreated wastewater are decomposed under anaerobic condition.
Wastewater treatment facility operation	- Energy efficiency improvement in the wastewater treatment plant such as replacement of old equipment with high energy-efficient equipment or operation improvement of energy-consuming equipment such as water pumps and air blowers. - CO_2 emission is reduced through reduction of electricity/ fossil fuel consumption at wastewater treatment plants.
Water reuse	- Reuse of treated wastewater from wastewater treatment plants. - CO_2 emission is reduced through reduced energy consumption at water supply facility or wastewater treatment plant.
Sludge treatment	- Treatment of sludge that is removed or excavated from septic tanks, canals and rivers. - CH_4 emission is reduced through avoiding anaerobic decay of organic contents in sludge that is contained septic tanks, canals, or rivers.

Annex III MRV Plan Form

MRV Plan

for Climate Change Mitigation Actions

in Ho Chi Minh City

Name of mitigation action:

Mitigation Implementing Entity:

Sectoral Oversight Unit(s):

Legal basis

DD/MM/YYYY

Submitted by Mitigation Implementing Entity

History of the document

Version	Date	Revisions

Table of Contents

1. General information on the mitigation action

1.1 Name of the mitigation action

1.2 Involved organizations and their roles

(Describe all major organizations and departments of HCMC involved in implementation of the mitigation action • *Describe name of the entities who are implementing the mitigation action* • *Specify which HCMC department(s) and agency(ies) will be the regulating departments and entities of the mitigation action)*

1.3 Objectives

(Describe objectives of the mitigation action e.g. to utilize unutilized energy source, to cope with local problems such as air pollution and water pollution, etc.)

1.4 Technology introduced under the mitigation action

(Describe the technology(ies) that have been installed to reduce/ avoid GHG emissions. Contain description on the scale of the technology (e.g. how much MW installed, how much MWh generated or saved, how many tons of waste/ wastewater treated, etc.)

1.5 Target GHG type

(*Select what types of GHG are reduced/ avoided through the mitigation action: CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, NF_3)*

1.6 Location

(Describe the location that mitigation action takes place)

1.7 Timeframe

(Describe when the mitigation action started (preparation, construction/ installation, operation) and expected to end))

1.8 Cost of mitigation action

(Describe cost of the mitigation action or mitigation component of the project, including:

- *Initial investment cost (where applicable, describe total cost of the entire project and cost of mitigation component)*

1.9 Benefits of mitigation action and contribution to sustainable development

(Describe what kinds of benefits will be brought to various beneficiaries by implementing the mitigation action, including:

- *Social benefits (e.g. creation of jobs, opportunity for education)*
- *Economic benefits (e.g. contribution to economic growth, improved energy condition, technology transfer)*
- *Environmental benefits (e.g. reduced air pollution and water pollution)*

1.10 Source of funding and supporting financial scheme

(Describe the source(s) of funding to the mitigation action, including:

- *HCMC own budget*
- *Other national budget*
- *Support from donors and international agencies*
- *Others (specify the source))*

1.11 Information on international market mechanisms

(Describe whether the mitigation action has been or will be registered to any carbon market mechanism, such as:

- *International or bilateral carbon market mechanisms*
- *Clean Development Mechanism (CDM)*
- *Joint Crediting Mechanism (JCM)*
- *Others)*

2. Emission reduction calculation, monitoring and reporting

2.1 Logic of GHG emission reduction

(Explain how GHG emissions are reduced by the mitigation action. Describe both baseline GHG emissions (GHG that would be emitted without the mitigation action) and project GHG emissions (GHG that are emitted by implementing the mitigation action))

2.2 Methodology to calculate GHG emission reduction

(Describe only the name of the methodology(ies) applied or referred to in order to calculate GHG emission reductions of the mitigation action. Specify the version number and title of the methodology (e.g. approved small-scale CDM methodology AMS-I.D "Grid connected renewable electricity generation" Version 18.0)

2.3 Estimated GHG emission reduction

Estimated emission reductions:

2.4 Organizational structure for monitoring and reporting

(Describe the name of entities involved in MRV and their roles. A schematic diagram can be prepared to show the relationship among these entities, including responsible divisions/ position of monitoring management, responsible divisions/ position of monitoring of each parameter)

2.5 Monitoring period

2.6 Monitoring methods

(Describe methods of direct measurement and/or data collection of each parameter, data collection interval of each parameter, default values applied and sources of the values)

Annex

Annex I Applied methodology

(Describe details of each methodology applied to the mitigation action. Also describe complete equations for GHG calculation, items to be monitored, and items to be not monitored)

Annex IV Mitigation Monitoring Report Form

Mitigation Monitoring Report

for Climate Change Mitigation Actions

in Ho Chi Minh City

Name of mitigation action:

Monitoring period:

Mitigation Implementing Entity:

Sectoral Oversight Unit(s):

Legal basis

DD/MM/YYYY

Submitted by Mitigation Implementing Entity

Table of Contents

Results of monitoring

1. Monitoring period

(Indicate the period the Mitigation Monitoring Report covers)

2. Emission reductions of the monitoring period

(Describe the result and steps of GHG emission reduction calculation using the applied methodology(ies) for the monitoring period)

3. Processes of the emission reduction calculation

(Describe the processes of GHG emission reduction calculation using the applied methodology(ies) for the monitoring period)

Annex

Annex I Monitored data during the monitoring period

(Include tables of monitored data and fixed (not monitored) data. And include monitoring/ measurement methods/ procedures. Also describe data sources and other supplementary information)

Operational Manual for MRV

on

City-level Climate Change Mitigation Actions

October 2017

Prepared under JICA Technical Cooperation Project

Project to Support the Planning and Implementation of NAMAs in a MRV Manner