

CHAPTER III METHODOLOGY

3.1 Materials and Equipment

3.1.1 Software

- Commercial process simulation software SimaPro version 7.1

3.1.2 Equipment

- Laptop (Intel® core™ i5-3230M, RAM 4 GB, Window 7 and Microsoft Office 2007)

3.2 Experimental Procedures

3.2.1 Research Plan

The objective of this study is to quantify the total greenhouse gas emissions from the organizations and to develop feasible options for reducing the carbon footprint. This chapter describes the methodology to achieve the objectives of this study. The methodology of this study can be divided into seven parts as follows (Janangkakan, 2013):

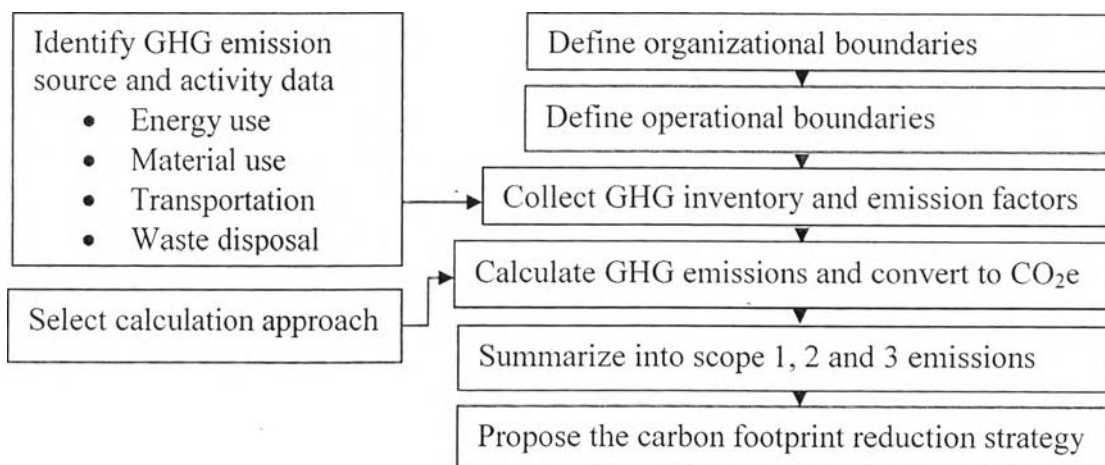


Figure 3.1 Flow diagram of research methodology.

3.2.2 Definition of Organizational Boundaries

The organization may comprise one or more facilities, so we need to define boundaries in the organization what have any units within calculation limits of this project. In this study organizational boundary was set up based on one of the following approaches:

- Control approach: The organization shall be responsible for emissions where it owns or has control over it, which this study set the organizational boundary as control approach as well.
- Equity share approach: The organization shall be responsible for emissions which their does not own or has control over it but share them with other units in that organization.

The Petroleum and Petrochemical College and the Office of the President, were selected as teaching and research and administration unit for this work. Which the Petroleum and Petrochemical college has 8th floor and the most activities is study, laboratory, offices activities and meeting, the area has 750 m²/floor and 650 persons of staff also has 207 of students.

The Chamcuri⁴ building or the Office of the President, it has 6th floor, the main activities is meeting and offices activities, the area has 608 m²/floor and 42 persons of staff.

3.2.3 Definition of Operational Boundaries

Each organization had its operational boundaries that associate with the organization's operations. This is step is to identify what any activities in the organization boundary is used to calculate the emissions of GHGs. The scopes for delineating direct and indirect emission sources are classified into 3 scopes as follow:

- Scope 1 – Direct emissions: These are emissions that are owned or controlled by the organization.
- Scope 2 – Energy Indirect emissions: These emissions are from activities that occur within the department, but the original sources are owned

or controlled by another department such as an emission from generation of purchased electricity, steam, or heat

- Scope 3 – Other indirect emissions: These emissions cover everything else that is not associated with direct or indirect emissions.

The methodologies for accounting and reporting emissions can refer to the GHG protocol by the World Resources Institute (WRI) in collaboration with the World Business Council for Sustainable Development (WBCSD), ISO 14064-1, and TGO guideline. Table 3.1 shows the examples of standard boundaries scope 1, 2 and 3 emissions as well as the emissions from the organization in each scope.

Table 3.1 GHG inventory and the scope of emission boundaries. (TGO guideline, 2013)

Scope Description	TGO's Standard Boundaries
Scope 1: Direct emission that are owned and controlled by the organization.	Consumption of fuels by vehicles fleet Leakage of refrigerants and other GHGs Use of fire extinguisher Release of GHG's from wastewater operation
Scope 2: Energy indirect emissions that are from the purchase of power	Purchased electricity
Scope 3: Indirect emissions that are a result of activities related to the organization, but are not owned or controlled by the organization	Use of chemicals clean by contact service Use of tap water Use of office equipment and consumable material such as paper Waste disposal

In each scope, all data on the sources of GHG emissions were gathered from data surveys such as energy use, material use, transportation and waste as

shown in Table 3.2, Table 3.3 and Table 3.4. Each category was then analyzed and determined as the following:

Scope 1 Direct emissions:

Table 3.2 GHG inventory and the scope of emission boundaries in scope 1

The Petroleum and Petrochemical College	The Office of the President, Chulalongkorn University	Source of Data
Vehicles fleet	Vehicles fleet	Record and questionnaire
Refrigerator maintenance	Refrigerator maintenance	N/A
Fire extinguisher	Fire extinguisher	N/A
Wastewater management	Wastewater management	Calculate from water use

Scope 2 Energy indirect emissions:

Table 3.3 GHG inventory and the scope of emission boundaries in scope 2

Petroleum and Petrochemical College	The Office of the President, Chulalongkorn, University	Source of Data
Offices – ceiling light, computers, printers, copiers, air conditioners, fans, and refrigerators	Offices – ceiling light, computers, printers, copiers, air conditioners, fans, and refrigerators	Asking and recorded by myself
classrooms, restrooms, computer room meeting room and library – ceiling light, fans, air conditioners, copy machines, projectors, overheads and others.	restrooms, meeting room – ceiling light, fans, air conditioners, copy machines, projectors, computer, overheads and others	Recorded by myself

Scope 3 Other indirect emissions:

Table 3.4 GHG inventory and the scope of emission boundaries in scope 3

Petroleum and Petrochemical College	The Office of the President, Chulalongkorn University	Source of Data
Use of chemicals clean	Use of chemicals clean	Recorded by myself
Use of tap water	Use of tap water	Collected from the CU website
Use of office equipment and consumable material such as paper	Use of office equipment and consumable material such as paper	Asking and recorded by myself
Waste disposal –solid waste	Waste disposal –solid waste	Count it by myself and it will estimated by No. of populations

3.2.4 Calculation of GHG Emission

Calculation of the GHG emissions for the organization was separated into use, transportation, material use, and waste from the department. The equation (greenhouse gases protocol by the WRI in collaboration with the WBCSD, ISO 14064-1, and TGO guideline) for calculating greenhouse gas emissions from all activities in the this organization is shown in Equation (1)

$$\text{Carbon footprint of a given activity (CO}_2\text{)} = \text{Activity (mass/volume/kWh/km)} \times \text{Emission factor (CO}_2\text{e per unit)} \quad (1)$$

Where

Carbon footprint of a given activity = sum of all energy use, transportation material use, and waste across all activities multiplied by their emission factors

Activity data = all materials and energy amount throughout the product's life cycle

Emission factor = the amount of greenhouse gases emitted per unit of activity data

3.2.5 Impact assessment

Assessing the potential human and ecological effects of energy, water, and material usage and the environmental releases identified in the inventory analysis.

3.2.6 Report Preparation

3.2.7 Presentation of Work Progress

3.2.8 Submission of Report