The Sustainability of CDM Projects

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Submitted for the degree of Doctor of Philosophy

Heriot-Watt University

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February, 2012

Abstract

This research applies both quantitative and qualitative methods to investigate the sustainable development (SD) benefits of the Clean Development Mechanism (CDM) projects. The results of cluster analysis confirm that the carbon market is separated into two sub-markets: a premium market; and a normal market or may be defined as "*One CER Two Markets*". A willingness to pay study revealed that buyers are willing to pay a price premium of €1.12 per tonne of CO2e for carbon credits with high quality sustainability benefits. 56.4% of the buyers are willing to pay a price premium for Gold Standard carbon credits. The probability of the willingness to pay a price premium is affected positively by the four factors: (i) Buyer's perception of the SD benefits; (ii) Buyer's perception of return on investment (ROI); (iii) An involvement in CDM sustainability label; and (iv) Buyer's attitude towards an importance of CDM sustainability labels.

The CDM's contribution to SD is explored in the context of a biomass (rice husk) case study conducted in Thailand. The results of Analytic Hierarchy Process (AHP) show that stakeholders ranked 'increasing the usage of renewable energy' as the most important SD benefit, whereas they considered air pollution problems associated with dust as the most significant social cost. Qualitative results, suggest that rice husk CDM projects contribute significantly to SD in terms of employment generation, an increase in usage of renewable energy, and transfer of knowledge. However, rice husk biomass projects create a potential negative impact on air quality. Finally, these results indicate that the results of a sustainability assessment conducted by host countries may be inadequate, suggesting an inability of host countries to ensure the sustainability of CDM projects. In order to ensure the environmental sustainability of CDM projects, stakeholders suggest that Thailand should cancel an Environmental Impact Assessment (EIA) exemption for CDM projects with an installed capacity below 10 MW and apply it to all CDM projects.

Acknowledgements

It was the great moment to study here, International Centre for Island Technology (ICIT), Institute of Petroleum Engineering, Heriot-Watt University. All ICIT staffs have provided me warm supports from the first day I arrived Orkney Islands until the day I finished my thesis.

First of all, I would like to express my sincere gratitude and deep appreciation to my supervisor, Dr. Sandy A. Kerr, who kindly gave me valuable advice, guidance, and encouragement throughout and help me shaped up this research with his years of experience. I am also grateful to Professor Dr. Jonathan Side, my co-supervisor, for his guidance, comments, and encouragement. They were never lacking in support and kindness.

This research work is supported by the Ph.D. studentship funded by the Energy Conservation Promotion Fund (ENCON Fund) of the Royal Thai Government, Thailand. Without this studentship, this research would not have been started. Therefore, I would like to express my sincere gratitude to the organization.

I am also wish to acknowledge the meaningful challenges of the creative criticisms for statistical methods provided by Dr. Michael Bell, ICIT. These led to elaborate refinement in all statistical parts of this thesis. I wish to extend my deep gratitude to Dr. Kate Johnson, ICIT, for the critical comments about stakeholder preferences towards the sustainable development (SD). Additionally, I would like to express sincere thanks to all ICIT staffs and friends for their friendship, advices, and encouragement.

Special recognition and thanks are extended to the carbon credit traders; Dr. Tauni Lanier (EcoCapital Ltd.); Mr. Siam Phoolcharoen (South Pole Carbon Asset Management Ltd.); Mr. Boonrod Yaowapruek (Eneco Energy Trade B.V.); and Mr. Narongchai Prapakornwiriya (GDF Suez Energy Services Ltd.), for improving willingness to pay (WTP) questionnaires.

My sincere thanks go to Mr. Payut Kriktanasakul, Head of Regional Energy Coordination Office 6, and Mr. Wichai Laithong, Bannsamednoi Villager, for helping me distributing the pairwise questionnaires. I extend my thanks to my boss, Dr. Gosah Arya and Mrs. Suwatjana Pengjun, who values higher education and also my colleagues at Walailak University for their friendship and encouragement.

I would like to express sincere thanks to my mother, Mrs. Somjai Benjamanukorn, my father, Mr. Benjapon Benjamanukorn, and other family members that cannot be announced to here, for their entirely care and love.

Last, but not least, I am extremely grateful to my wife, Mrs. Wilawan Dungtripop, who resigned from her work and went to Orkney Islands with me, for her everlasting love and care, encouragement, and understanding throughout my studies. All value and benefits of this thesis are sincerely dedicated to those whom I have mentioned.

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Contents

List of Tables

List of Figures

Glossary of Terms and Abbreviations

AEDP	The Alternative Energy Development Plan
AHP	The Analytic Hierarchy Process
CBD	The Convention on Biological Diversity
CCB	The Climate, Community, and Biodiversity Alliance
CDM	The Clean Development Mechanism
CERs	Certified Emission Reductions
CH4	Methane
CO2	Carbon Dioxide
COP	Conferences of the Parties
CSD	The Commission on Sustainable Development
CV	Contingent Valuation
DNA	A Designated National Authority
DOE	A Designated Operational Entity
EB	The Executive Board
EIA	Environmental Impact Assessment
ERUs	Emission Reduction Units
ET	Emissions Trading
EU	The European Union
EU ETS	The European Union Emissions Trading Scheme
GDP	Gross Domestic Product
GEMS	The Global Environment Monitoring System
GHG	Greenhouse Gas
GNP	Gross National Product
GS	The Gold Standard
HFCs	Hydrofluorocarbons
IPCC	The Intergovernmental Panel on Climate Change
IRR	The Internal Rate of Return
JI	Joint Implementation
LFE	Canadian Large Final Emitters system
MA	The Midwest Accord

MAUT	Multi-Attributive Utility Theory
MCA	Multi-criteria Analysis
MGP	Mungcharoen Green Power Project
NGO	Non-governmental Organization
N2O	Nitrous Oxide
OECD	Organization for Economic Co-operation and Development
PDD	Project Design Document
PFCs	Perfluorocarbons
PIN	Project Idea Note
RGGI	The Regional Greenhouse Gas Initiative
ROI	Return on Investment
SD	Sustainable Development
SEP	Surin Electric Project
SF6	Sulphur Hexafluoride
SPSS	Statistical Package for the Social Sciences
TGO	Thailand Greenhouse Gas Management Organization
UN	The United Nations
UNCED	The United Nations Conference on Environment and Development
UNCHE	The United Nations Conference on the Human Environment
UNEP	The United Nations Environmental Programme
UNFCCC	The United Nations Framework Convention on Climate Change
UNSCCUR	The UN Scientific Conference on the Conservation and Utilization of Resources
VIF	The Variance Inflation Factor
WCED	The World Commission on Environment and Development
WCI	The Western Climate Initiative
WSSD	The World Summit on Sustainable Development
WTA	Willingness to Accept
WTP	Willingness to Pay

List of Publications Related to PhD Thesis

[1] P. Parnphumeesup, S.A. Kerr, *Stakeholder preferences towards the sustainable development of CDM projects: Lessons from biomass (rice husk) CDM project in Thailand*, Energy Policy, 39, 3591-3601, (2011)

[2] P. Parnphumeesup, S.A. Kerr, *Classifying carbon credit buyers according to their attitudes towards and involvement in CDM sustainability labels*, Energy Policy, 39, 6271-6279, (2011)

[3] P. Parnphumeesup, S.A. Kerr, *Willingness to pay for Gold Standard carbon credits*, Energy Sources, Part B: Economics, Planning, and Policy, In press, (2011)

Chapter 1

Introduction

1.1 Background and Motivation

Climate change is widely accepted as the most serious environmental problem facing humankind. Not only does climate change directly affects humans, but it also directly affects all other environmental and ecological processes. The scientific community now agrees that the climate change is real and already happening. Ganeshan and Diamond [30] predict that, by 2015, on average over 375 million people per year are likely to be affected by natural disasters resulted by the climate change. This is over 50 per cent more than were affected in an average year during the decade 1998–2007. Moreover, many scientific evidences on climate change, especially the Intergovernmental Panel on Climate Change (IPCC) report, strongly confirm the effect of climate change and contradict the uncertainty in climate change. The IPCC Fourth Assessment Report published in 2007 reveals that:

- World temperature will rise by between 1.1 and 6.4 °C (2.0 and 11.5 °F) during the 21st century. This is a wider range than the 1.4 – 5.8 °C increase given in the 2001 report.
- Sea levels will rise by 18 to 59 cm (7.08 to 23.22 in) during the 21st century.
- There will be an increase in tropical cyclones (typhoons and hurricanes), high tides, droughts and flood.
- There will be an increase in the severity of heat waves and rainfall.

Considering the impact of climate change on the economy, the costs of climate change will increase rapidly because the increase in temperature will lead to an acute increase in extreme weather events such as storms, floods, droughts, and heatwaves (Stern [106]). Stern predicts that UK costs of floods could reach 0.2-0.4% of UK gross domestic product (GDP) if world temperatures rise by 3-4°C.

The climate change problem therefore appears inevitable and there is too late for all humans to avoid this problem. In order to solve the climate change problem the United Nations Framework Convention on Climate Change (UNFCCC) has been created to set the international framework for reducing greenhouse gas emissions. Finally, the third Conferences of the Parties (COP-3) held in Tokyo in 1997 gave birth to the most influential climate change agenda known as the Kyoto Protocol. The objective of the Kyoto Protocol is to establish all legally binding obligations to reduce GHG emissions. However, the costs of reducing greenhouse gas (GHG) emissions vary across countries. In order to achieve the cost effectiveness of emission reductions, the Kyoto Protocol designed the three flexibility mechanisms. These mechanism rely on the important assumption that GHG emission reductions taking place anywhere in the world will have the same environmental effects. The Clean Development Mechanism (CDM) is one of these three flexibility mechanisms aimed at helping Annex I countries meet their emission reduction targets at least cost. The CDM is a project-based mechanism which allows Annex I countries to invest in emission reduction projects in developing countries. Annex I countries will get emission credits which are called *"Certified Emission Reductions (CERs)"* and can directly use CERs to meet their own Kyoto target or sell CERs in the emission trading market. The objectives of CDM projects are defined in Article 12 of the Kyoto Protocol. This Article state that:

"2. The purpose of the clean development mechanism shall be to assist Parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of the Convention, and to assist Parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments under Article 3".

This Article clearly shows the twin objectives of *"ensuring cost-effectiveness of GHG emission reductions"* and *"promoting sustainable development (SD)"*. In order to examine whether CDM projects can attain both twin objectives, a Designated National Authority (DNA) is identified in host countries and tasked with fulfilling this function. This implies that the UNFCCC trusts the capacity of each host country to assess CDM projects. In other words, the UNFCCC believe that each host country can guarantee the sustainability of CDM projects and carbon credits originated from each host country have the same quality in terms of SD benefits. However, it is very difficult for a host country to assess the SD benefits because there are no rules on the host country approval processes and the host country SD criteria. The SD criteria for approval of projects are not clearly defined. This contrasts sharply with GHG emissions monitoring where units of measure and monitoring protocols are clearly defined. Consequently, the host countries' duties to assess the SD benefits of CDM projects are inconsistently applied and SD criteria vary widely.

Burian [10] and Erion [26] have suggested that host countries cannot guarantee the SD benefits of CDM projects. Moreover, Kolshus et al. [59] found that industrial gas projects (including hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and nitrous oxide (N2O) projects) produce fewest SD benefits compared to other types of CDM project. Therefore, these results indicate that the quality of carbon credits should be different in terms of SD benefits, arguing against the original concept of the UNFCCC. A number of articles have argued that the carbon market cannot offer the same quality of CERs in terms of the SD benefits (Grandpre [38], Meyrick [73]). Moreover, the carbon market does not know how the buyers value the quality of CERs in terms of SD benefits. Therefore, it is now necessary to validate the concept of non-homogeneous carbon credits. There is clearly a need for more research to investigate how CER buyers view the SD benefits of CDM projects. This research focuses on the in-depth analysis of the quality of carbon credits in terms of SD benefits.

This research will also investigate the contribution that CDM projects make to SD. Although CDM projects require successful DNA approval, the CDM's contribution to SD is now openly questioned. There are many researchers trying to examine the CDM's contribution to SD, for example, Nussbaumer [79], Sutter [108], and Sutter and Parreno [109] used Multi-Attributive Utility Theory (MAUT) to assess the sustainability of the CDM projects. However, these studies are mostly based on the reviews of the project design documents (PDDs), whereas the in-depth interviews with stakeholders were not widely used for data collection. Moreover, research on stakeholder preferences towards the SD benefits of CDM project is limited to only two small studies. Given this context, there is a need for more research to be done in understanding what the preferences of the stakeholders for the SD of CDM projects are and how CDM projects generate SD benefits at the project level. Therefore, the research presented here aims to shed additional light on the nature of SD benefits of CDM projects.

1.2 Research Objectives, Research Questions, and Research Hypotheses

This research is an attempt to increase the understanding of the sustainable development benefits of CDM projects. The research adopts systematic approach involving CDM stakeholders. Therefore, this study explores the issue of CDM and SD from various perspectives including international stakeholders, national stakeholders, carbon market stakeholders, and local stakeholders. There are five explicit objectives of the research:

1. Create an understanding of the concept of sustainable development applied to CDM projects and the methodology for assessing the sustainability of CDM project.

   This objective is achieved by pursuing two research questions:

- How did the Kyoto Protocol develop?
- How is the sustainable development defined and assessed within the CDM Framework?

2. To classify CER buyers according to their attitudes towards and involvement in CDM sustainability labels.

   This objective is achieved by pursuing two further research questions:

- Is the carbon market comprised of multiple groups based on their attitudes towards and involvement in CDM sustainability labels?
  We can evaluate this research question by formulating a hypothesis:

  Hypothesis 1: CER buyers can be classified into distinct groups based on their attitudes towards and involvement in CDM sustainability labels.

- What are the key characteristics of each buyer cluster?
  We can evaluate this research question by formulating a second hypothesis:
  Hypothesis 2: The buyer clusters are significantly different in: organization type; level of paid up capital; perception of sustainable development benefits; perception of return on investment; perception of image of the sustainability

labeling; participation in the voluntary market; the project priority; knowledge in the sustainability label; attitude towards the host country's duty; and their willingness to pay.

3. Investigate the value of sustainable development benefits generated by CDM projects through the willingness of buyers to pay a price premium for CERs with CDM sustainability label.
   This objective can be achieved by pursuing two research questions:

- Are the buyers willing to pay a price premium for CERs with CDM sustainability label in recognition of the contribution to sustainable development?
  We can evaluate this research question by formulating Hypothesis 3:

  Hypothesis 3: Buyers are willing to pay a price premium for CERs with CDM sustainability label.

- How much are the buyers willing to pay a price premium for CERs with CDM sustainability Label in recognition of the contribution to sustainable development?

4. Identify the factors influencing buyers' willingness to pay a price premium for CERs with CDM sustainability labels.
   This objective can be achieved by pursuing the following research question:

- What are the factors influencing the willingness of CER buyers to pay a price premium for CERs with CDM sustainability label?
  We can evaluate this research question by formulating the following hypothesis:
  Hypothesis 4: Expected sustainable development benefits, expected return on investment, involvement in the Gold Standard label, importance of the Gold Standard label, and the attitude towards the host country's duty are significantly

related to the probability of the willingness to pay a price premium for CERs with CDM sustainability label.

5. Investigate the contribution of the CDM to sustainable development.

This objective can be achieved by pursuing these four research questions:

- Are the expected SD benefits described in the PDD actually realized?
- How does CDM project distribute benefits and social costs to stakeholders?
- What are the preferences of the stakeholder for the sustainable development of CDM projects?
- Are the group's preferences substantially different from each other, on which criteria they differ?

  We can evaluate this research question by formulating the following hypothesis:

  Hypothesis 5: The inter-group preference weights are different.

1.3 Research Methods

The first section aims to provide an up-to-date understanding of the concept of sustainable development applied to CDM projects. Also, this part will also investigate the methodology for assessing the sustainability of CDM project. In this part we will also begin the study of the international and national frameworks for CDM, so we will understand how the international regulators and the host countries interpret the SD benefits of CDM projects. Consequently, this section is based on an extensive literature review to answer question 1.

The second part of the study aims to investigate how the buyers view the SD benefits of CDM projects. In this part quantitative methods will be used to answer question 2, 3, and 4. This analysis is largely based on the data collection from the carbon credit buyers. Online questionnaires were developed and circulated to CER buyers in the primary market. Firstly, this section uses cluster analysis to classify CER buyers according to their attitudes towards and involvement in CDM sustainability labels. Then, discriminant analysis was conducted to statistically test the validity of the cluster solution. Finally, cross tabulation and chi-square analysis were used to investigate whether the clusters are significantly different in a set of additional variables not included in the clustering variables. Moreover, in this part the contingent valuation method (CVM) is applied to quantitatively measure buyers’ willingness to pay (WTP) a price premium for CERs with CDM sustainability labels. Finally, we employ binary regression to investigate which factors might contribute positively and negatively to the probability of the buyers’ WTP a price premium for CERs with CDM sustainability labels.

The final sections aim to investigate how local stakeholders view the SD benefits of CDM projects. In this section both qualitative and quantitative methods are applied in order to investigate the sustainability of CDM projects. Qualitative and quantitative methods are used to answer question 5. Methods used include, in-depth interviews with stakeholders to tell us more about the SD benefits experienced by communities. Moreover, the Analytic Hierarchy Process (AHP) is used to assess the sustainability preferences of CDM stakeholders. Finally, both qualitative and quantitative results will be combined to describe the contribution of the CDM to SD.

1.4 Scope of the Study

As previously noted, the second part aims to investigate how the buyers value the quality of CERs in terms of SD benefits. However, some CERs are worth more (or less) than others in terms of the SD benefits (Meyrick [73]). Therefore, this study has chosen CERs with the Gold Standard label as representative of the high quality CERs in terms of their SD benefits. This is because CERs generated by GS projects generate higher SD benefits than non-labelled projects Nussbaumer [80]. Consequently, the study questionnaire is designed to measure the participants’ perceptions of the GS label. For this analysis the study population is defined as CER buyers in the carbon market, so the questionnaires were sent to these buyers. The lists of CER buyers were taken from the UNEP Risoe CDM/JI Pipeline Analysis and Database. The unit of measurement in this research is the organization, not the individual, so one respondent represents one organization in the carbon market. We asked that participants answer the questions from the perspective of their organization. This market survey was carried out during September to November 2009.

The final part will focus on the contribution of CDM to SD. The issue of CDM’s contribution to local SD will be addressed in the context of a case study conducted in

Thailand. We have selected the biomass CDM project in Surin province, Thailand as a case study. As for qualitative method, all data and information are obtained from the in-depth interviews with 20 stakeholders including experts and local residents. As for quantitative method, face-to-face interviews were carried out by using a pairwise questionnaire. Face-to-face interviews were conducted with 96 stakeholders including experts and local residents. This stakeholder survey was carried out during January to March 2010. However, the possibility to carry out in-dept interviews with CDM consultants in Bangkok was limited by the anti-government protests in Bangkok.

1.5 Structure of the Thesis

This thesis is organized into five parts which follow the research objectives and questions defined above. The first part (chapter 1) presents general background, research objectives, research questions, research hypotheses, research methods, and scope of the study. The second part (chapters 2, 3, 4, 5, and 6) is a literature review which discusses background on climate change regulatory framework, critical perspectives on the CDM, and a methodological approach and framework for sustainability assessment of CDM projects. The third part (chapters 7 and 8) investigates how the CER buyers value the quality of CERs in terms of SD benefits. The fourth part (chapters 9 and 10) examines how the CDM generates local SD benefits and social costs. Finally, the results are discussed and recommendations are made in the fifth part (chapter 11). Study questionnaires are illustrated in the appendices. An outline of each chapter is as follows:

Chapter 1: Background and motivation. Research objectives, research questions, and research hypotheses. Research methods. Scope of the study.

Chapter 2: The open economy and the causes of climate change. The formation of environmental cooperation: from local to global. The international conference on global environmental agenda.

Chapter 3: Background on the Kyoto Protocol. The development of the Kyoto Protocol. The Kyoto mechanisms.

Chapter 4: The regulatory framework for CDM projects. The CDM project cycle. Transaction costs of CDM projects.

Chapter 5: History of sustainable development. A host country's duty to assess the sustainability of CDM projects. The SD criteria applicable for CDM projects. Methodologies for assessing the sustainability of CDM projects. The problem of CDM's contribution to SD. CDM sustainability labels.

Chapter 6: Demand for CERs. Supply of CERs. An analysis of the CDM portfolio.

Chapter 7: A conceptual framework for valuing the SD benefits of CDM projects. Cluster analysis applied to classify CER buyers. An application of contingent valuation for exploring the monetary value of SD benefits of CDM projects. An econometric model of willingness to pay.

Chapter 8: Profile of respondents. Classification of CER buyers by cluster analysis. The key characteristics of each buyer cluster. Willingness to pay a price premium for CERs with Gold Standard label in recognition of its contribution to SD. Reasons for willingness to pay and unwillingness to pay. Factors affecting CER buyers' willingness to pay a price premium for CERs with Gold Standard label.

Chapter 9: The qualitative method for assessing the sustainability of CDM projects. An application of AHP for assess the sustainability preferences of CDM stakeholders. Background on case study. Thailand's energy policy and situation. CDM implementation in Thailand.

Chapter 10: Qualitative analysis and results. Quantitative analysis and results. A synthesis of qualitative and quantitative results.

Chapter 11: Summary of findings. Recommendations for international regulations under the UNFCCC. Recommendations for Thai Government. Recommendations for CDM sustainability labels. Recommendations for further study.

Chapter 2

Globalization of the Environmental Agenda

Prior to discussing the CDM framework, it is first necessary to provide greater background context of international environmental cooperation. This will be done through the literature review. This chapter aim to create an understanding of the development of international environmental cooperation via international environmental organizations and international environmental conferences. Firstly, we will apply the concept of “closed economy” defined by Kenneth E. Boulding (The Economics of the Coming Spaceship Earth) for explaining the causes of climate change. Then the literature review will give an understanding of transformation from national cooperation to international cooperation. The last past of literature review concentrate on international environmental organizations and international environmental conferences related to the climate change regulatory framework.

2.1 The Open Economy, the Economy within a Closed Earth , and the Causes of Climate Change

We will apply the term of “the open economy” and “the economy within a closed earth ” defined by Kenneth E. Boulding in his paper, The Economics of the Coming Spaceship Earth, for explaining the causes of climate change (Boulding [6]). This concept within this work is important foundations to the emerging field of environmental economics in the late 1960s and ecological economics in 1990s. Boulding published The Economics of the Coming Spaceship Earth in 1966. This literature considerably aroused economist to add environmental outputs into economic growth. Until Boulding Growth theory was almost universally accepted by economist. Growth theory measured the economic success by the increase in value of goods and services produced by an economy. Moreover, Growth theory ignores the value of environmental outputs produced by an economy for measuring the economic success. Thus, the primary economic objective of government was to maximize the consumption and production for their economic success. Because of the unconcern for (or lack of value placed upon) environmental outputs, the increased production and consumption lead to more pollution. This old economic concept using Growth theory was named as "the open economy of the past" or "the cowboy economy" in The Economics of the Coming Spaceship Earth. In this essay, Boulding explained "*I am tempted to call the open economy the "cowboy economy," the cowboy being symbolic of the illimitable plains and also associated with reckless, exploitative, romantic, and violent behavior, which is characteristic of open societies*". The cowboy economy wastefully used nonrenewable resources to produce goods and services. Moreover, there were illimitable resources in the concept of cowboy economy. When the cowboy economy maximized consumption and production, the cowboy also maximized the polluted outputs produced by economic activities. Consequently, Boulding suggested that the cowboy economy must ultimately be replaced by "the economy within a closed earth of the future" or "the spaceman economy".

In a closed economy, there are inputs from outside and leakages to outside. The outside of a closed economy refers to the environment. Consequently, society receives inputs from the environment and gives off outputs, often in the form of waste and pollution, to environment. Humans have to receive inputs from outside in the shape of air, food, water, energy, fossil fuels and other natural resources and give off outputs to environment in the form of waste and pollution. Like biological systems, the economy within a closed earth needs to use environmental inputs to transform materials into goods and services. This transformation will also give off outputs to environment in the form of waste and pollution. Consequently, the economy within a closed earth will concentrate on environment. Besides commodity outputs, humans can produce environmental outputs by consuming environmental inputs. Environmental output is the important output affecting human life. Consequently, humans and environment depend on each other. We can see the economy within a closed earth from Figure 2.1:

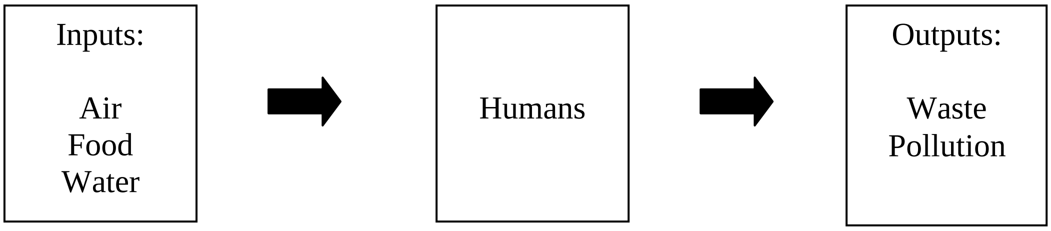

Figure 2.1: The economy within a closed earth

We may use the economy within a closed earth from Figure 2.1 for explaining the causes of climate change. In closed economy, we can minimize negative outputs such as waste, pollution, etc. by minimizing the input consumption. For example, if we minimize the use of forest, we could also minimize the negative outputs including loss of wildlife habitat, loss of open space, and impaired water quality. Why don't people minimize the use of natural resources for the best environment? The answer is that the Growth theory teaches us to maximize the input consumption for maximizing the outputs to our economy. When we can maximize outputs, we can maximize the Gross National Product (GNP) of our economy by the Growth theory which related to the term "the open economy" defined by Boulding.

By contrast, the open economy ignores the term of outside which refers to environment. There are no inputs from outside and no outputs to outside in this concept. Consequently, this economic concept teaches us to maximize inputs and outputs for our economic success. In order to get economic success, we will consume high-level inputs for producing high-level outputs. Finally, the more usage of natural resources will lead to the more environmental problems as we can see from the climate change problem.

The reason for US rejection of the Kyoto Protocol is a clear example of the Growth theory. President George W. Bush announced that he would not ratify the Kyoto Protocol "*because it exempts 80% of the world, including major population centers such as China and India, from compliance, and would cause serious harm to the US economy*" (White House [140]). For another reason, Bush said that the Kyoto Protocol "would cause serious harm to US economy" (White House [140]). Clearly, the US view that the Kyoto commitments will decrease its economic outputs, so its decision on the Kyoto Protocol is based on the Growth theory or the concept of "the cowboy economy".

It is argued that open economy inevitably leads to unsustainable consumption behavior because it ignores environmental costs. The open economy strongly influences human behaviour from the Industrial Revolution Age. People consume more natural resources for maximizing economic outputs. Energy and fossil fuels are one of the main input consumption. Fossil fuel consumption is the primary cause of climate change because the more fossil fuel consumption will create more CO_2 output to environment. Finally, the unsustainable consumption has resulted in the climate change problems including heatwaves, floods, droughts, heavy rains, storms, and sea-level rise. We can conclude the causes of climate change by using the concept of closed economy from Figure 2.2:

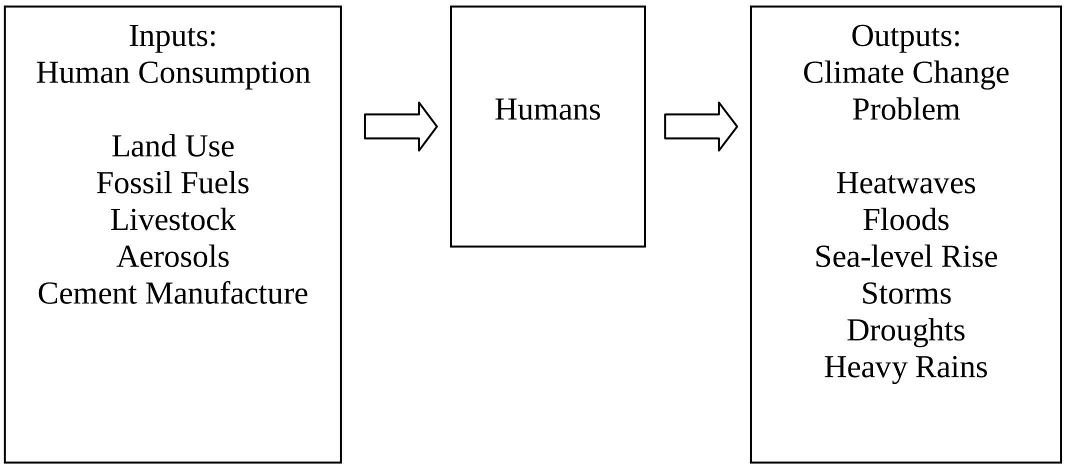

Figure 2.2: The causes of climate change

From Figure 2.2, the climate change problem is caused by the unsustainable pattern of input consumption. Under the concept of closed economy, the unsustainable consumption will create the outputs which are the climate change problems. We may conclude the causes of climate change by consuming the following inputs in the unsustainable manner:

- Land Use: When humans remove trees for agriculture, transportation, and housing, the land clearing will affect climate system. Trees help to reduce greenhouse effect by absorbing CO_2. Because of the removal of trees, this will significantly increase the amount of CO_2 in the climate system, and then this will lead to climate change problem. Consequently, the more humans consume land input, the more humans confront climate change problem.

- Livestock: Livestock, the decomposition of animal manure, and paddy rice farming will significantly release methane into the atmosphere. The use of fertilizers for agricultural activities will also release nitrous oxide into the atmosphere. Both methane and nitrous oxide are main greenhouse gases which lead to climate change problems. Thus, more livestock activities will lead to more climate change problems.
- Fossil Fuels: Currently, fossil fuels are widely used to support our lives. Fossil fuels include coal, oil and gas. Every day we burn large amounts of coal, oil, and gas for transportation, heating, cooling, manufacturing, electricity, and other applications. Burning these fossil fuels will also release tremendous CO_2 into the atmosphere. The use of fossil fuels accounts for 80 to 85% of the CO_2 being added to the atmosphere [110]. At present, we consume more and more fossil fuels as if there are abundant fossil fuels and we can use these fuels indefinitely. This unsustainable consumption makes our environment worse. Consequently, the more humans consume fossil fuels, the more humans confront climate change problem.
- Aerosols: Aerosols are tiny particles suspended in the air. Aerosols originate both from natural and man-made sources. Man-made aerosol particles are produced in industrial areas around the world. The aerosols have been used widely since the end of the Second World War because of the increase in industrial activities. Black carbon, a major component of soot, is an aerosol that has a warming effect on the atmosphere by absorbing sunlight, influencing cloud formation and darkening snow and ice on the ground. Black carbon particles are produced by incomplete combustion in cars and trucks, and by forest fires and some industrial facilities, and are known to have a negative effect on human health (UNEP and WMO [128]). A recent assessment estimated that the warming contribution of 1 gram of black carbon could be anything from 100 to 2000 times that of the same amount of carbon dioxide (UNEP and WMO [128]). Therefore, black carbon can lead to the climate change problem.
- Cement Manufacture: The rise in cement manufacture is largely because of the industrial revolution. Cement-making is responsible for about 2.5% of total

worldwide emissions from industrial sources. CO_2 is produced by the cement manufacturing process. Cement absorbs CO_2 as it matures. Therefore high cement production will lead to the climate change problem.

These above causes of climate change are related to the unsustainable consumption in the economy within a closed earth. Finally, Boulding's literature really changes from old human views on environment to new human views on environment. Firstly, Boulding make people view that natural resources are finite and can be depleted by unsustainable consumption. Secondly, maximizing consumption and production is not the best way to economic success. Thirdly, GNP should be generated by renewable resources. Consequently, Boulding suggested that the economy within a closed earth the consumption and production should be minimized rather than maximized because the spaceman economy should be concerned about polluted outputs produced by economic activities.

In order to solve the environmental problems, humans finally form the environmental cooperation at local, national, and global level. They need to create the rules and regulations for operating the integration body. Therefore, it is necessary to study the evolution of environmental integration via international organization and international conferences. These will be presented in the next topic.

2.2 The Formation of Environmental Cooperation: From Local to Global

Humans start realizing the environmental problems from small points at individual level, and later at local level, so they start forming environmental cooperation at local level for solving local environmental problem. Then, they perceive that the environmental problem affect the whole nation, so the local cooperation transform to national cooperation. In this analysis, the national cooperation is membership organization whose members came from within one nation, whereas, the international cooperation has a membership from more than one nation. We can see many national environmental groups which were founded in the Industrial age. The Sierra Club founded by John Muir and Robert Underwood Johnson is one of the obvious examples of the first environmental groups in Industrial age. Table 2.1 show the examples of other national environmental groups founded in 19th century.

Year	Environmental Group	Country
1843	Manchester Association for the Prevention of Smoke	UK
1865	Commons, Open Spaces and Footpaths Preservation Society	UK
1867	East Riding Association for the Protection of Sea Birds	UK
1870	Association for the Protection of British Birds	UK
1883	American Ornithologists Union	US
1883	Natal Game Protection Association	South Africa
1886	Audubon Society	US
1889	Society for the Protection of Birds	UK
1892	Sierra Club	US
1895	National Trust	UK
1898	Coal Smoke Abatement Society	UK

Table 2.1: The examples of national environmental groups founded in 19th century; (source: McCormick [72])

Most national environmental groups in 19th century were founded to protect birds (see Table 2.1). When the environmental problem affected not only one country but also many countries, the national cooperation had not enough power to solve the international environmental problem. They need an international governing body to solve their mutual environmental problem. Consequently, the international environmental problem drove many nations to create the international environmental organization.

The pollution of the River Rhine in Europe is a simple example of a transboundary environmental problem which through cooperation lead to the formation of international pollution controls (Maler [70]). The River Rhine is one of the longest rivers in Europe. It runs for over 1,300 kilometers from its source in Switzerland. The River Rhine is used for household, industry, and agriculture in the Rhine bordering countries. Bordering countries have faced the problem of water pollution associated with waste discharge since the Industrial Revolution. Consequently, one European nation could not solve the pollution of Rhine on its own. An international cooperation was the best solution for this case. Finally, in 1950 the Rhine bordering countries have formed the International Commission for the Protection of the Rhine against Pollution (ICPR) to solve the Rhine pollution [94]. Therefore, this organization is the most obvious example of international cooperation.

The transformation from national cooperation to international cooperation is traced back to the Pinchot's idea for an international conference on the conservation of natural resources and P.G. Van Tienhoven's idea for the creation of an international organization for the protection of nature (McCormick [72]). Pinchot's idea and the Van Tienhoven's idea strongly drove national cooperation to transform to international cooperation.

P.G. Van Tienhoven is the Netherlands naturalist credited with promoting the international cooperation movement. His interest in international cooperation was inspired by the Boone & Crockett Club members whom he met in his trip to Java, Japan, and the United States in 1917 (Jepson and Whittaker [53]). The Boone & Crockett Club was founded in 1887 by President Theodore Roosevelt. This club was founded to promote the guardianship and provident management of big game and associated wildlife in North America and maintain the highest standards of fair chase and sportsmanship in all aspects of big game hunting. This initiative made Van Tienhoven consider international environmental cooperation and he played an important role in the formation of several international environmental organizations. In 1925, he founded the Netherlands Commission for International Nature Protection which aimed to gather data on endangered species and transmit such data to conservation organizations in other countries. Moreover, he founded elite nature protection committees in the Netherlands, Belgium, and France in 1925. These committees worked together for international wildlife protection.

In 1927, Van Tienhoven went to New York to encourage the Boone & Crockett Club to get more directly involved in international wildlife protection. Ultimately, he made the Boone & Crockett Club to create American Committee for International Nature Protection. Van Tienhoven was the founder or leader of several international environmental organizations which we can see in Table 2.2.

Year	International Environmental Organization
1914	International Consultative Commission for the Protection of Nature
1925	The Netherlands Commission for International Nature Protection
1925	The elite nature protection committees in the Netherlands, Belgium, and France
1928	International Bureau of Information and Correlation on Nature Conservation
1930	American Committee for International Nature Protection (Tienhoven help the Boone & Crockett Club to create this organization)

Table 2.2: The examples of the international environmental organization founded or lead by Van Tienhoven

Van Tienhoven helped make people change from local thinking to global thinking. Furthermore he encouraged national environmental cooperation to transform to international environmental cooperation.

Another key figure in the early development of the international environmental movement was Gifford Pinchot. Pinchot intended to make conservation policy change from local conservation issue to international conservation issue by using an international conference on the conservation of natural resources. He proposed his idea for international conference to Theodore Roosevelt. The key detail of international conference proposed by Pinchot included the creation of an international organization to promote resource conservation, the fair access to raw materials by all countries, and the writing of an inventory of natural resources and a set of principles on their conservation (McCormick [72]). His idea for international conference received a tepid response from the White House, and the project was suspended following Roosevelt's death in April 1945. However, his idea did not die and it was ultimately inspiration for the United Nations (UN) to create the UN Scientific Conference on the Conservation and Utilization of Resources (UNSCCUR) which was the first UN body to address natural resource conservation.

2.3 The International Conference on Global Environmental Agenda

2.3.1 The UN Scientific Conference on the Conservation and Utilization of Resources (UNSCCUR)

The beginning of international conferences on global environmental agenda is traced back to the UNSCCUR which was inspired by the Pinchot's idea. The UNSCCUR was organized by FAO, UNESCO, the World Health Organization, and the International Labour Organization. The UNSCCUR took place at Lake Success, New York, the United States, between 17 August and 6 September 1949. The UNSCCUR was attended by over 530 representatives attending from 49 countries.

This conference was intended to provide an opportunity for experts around the world to exchange ideas and experience on resource conservation techniques. The major theme of this conference was the balance between the demand and supply of natural resources. At the conference, the representatives discussed global resource scarcity, the development of new resources, education in developing countries, and the integrated development of river basins. The representatives made no binding decisions, nor even recommendations to their governments. Although the UNSCCUR did not make any binding agreements, it was the first step towards global environmental policy.

2.3.2 The United Nations Conference on the Human Environment (UNCHE)

The United Nations Conference on the Human Environment (UNCHE) was held in Stockholm, Sweden from 5 to 16 June 1972. The UNCHE marked a turning point in the development of international environmental agenda. The UNCHE was attended by the representatives of 113 countries, 19 inter-governmental agencies, and more than 400 inter-governmental and non-governmental organizations. The UNCHE was a first in 4 respects (Najam and Cleveland [76]):

1. It was the first meeting which took several nations around the world to discuss the future of environment.
2. It was the first UN conference on a single global issue.
3. It was the first global meeting that saw a large presence and influence of nonstate actors.

4. It was the first meeting to seek global policy consensus on issues related to the environment.

The UNCHE agreed that reducing human impact on the environment required international cooperation and should be the responsibility of all countries. The Declaration, the Principles, and an Action Plan are the fruitfulness of the UNCHE. Firstly, the UNCHE created the Declaration to act as an introduction to the Principles and to sketch broad goals and objectives. The Declaration can be concluded as follow:

1. Man is both creature and molder of his environment, which gives him physical sustenance and affords him the opportunity for intellectual, moral, social, and spiritual growth. Both aspects of man's environment, the natural and the man-made, are essential to his well-being and to the enjoyment of basic human rights the right to life itself.
2. The protection and improvement of the human environment is the urgent desire of the peoples of the whole world and the duty of all Governments.
3. Man's capability to transform his surroundings can bring the benefit or loss to peoples, but there is growing evidence of man-made loss in many regions of the earth.
4. In the developing countries most of the environmental problems are caused by under-development. Therefore, the developing countries must direct their efforts to development, bearing in mind their priorities and the need to safeguard and improve the environment. For the same purpose, the industrialized countries should make efforts to reduce the gap themselves and the developing countries.
5. The natural growth of population continuously presents the problems for the preservation of the environment. Therefore, adequate policies and measures should be adopted to face these problems.
6. To defend and improve the human environment for present and future generations has become an imperative goal for mankind-a goal to be pursued together with, and in harmony with, the established and fundamental goals of peace and of worldwide economic and social development.
7. To achieve this environmental goal will demand the acceptance of responsibility by citizens and communities and by enterprises and institutions at every level.

Moreover, the UNCHE created the 26 Principles which could be combined into the key conclusion as follow:

1. The resources of the earth including natural resources, renewable resources, and non-renewable resources must be carefully treated with the following way:
- The natural resources of the earth must be protected for the benefit of present and future generations.
- Man must keep producing the renewable resources of the earth.
- Man must carefully use the non-renewable resources of the earth with the concern of resource depletion and the non-renewable resources must be shared by all mankind.
2. Financial and technological assistance from the industrialized countries, the stability of prices, and adequate earnings for primary commodities and raw materials are essential to environmental management in the developing countries.
3. States have the sovereign right to exploit their own resources pursuant to their own environmental policies, but must not endanger other states.
4. Environmental planning must be applied to obtain maximum social, economic, and environmental benefits. Environmental protection should be done by:
- Using science and technology to control environmental risks and solve environmental problems.
- Promoting education in environmental matters to broaden the concept of environmental protection.
- Promoting the national and multinational scientific research in the context of environmental problems.
- Developing the international law regarding liability and compensation for the victims of pollution and other environmental damage.
- Developing international cooperation through multilateral or bilateral arrangements or other appropriate means for controlling, preventing, reducing, and eliminating the environmental problems.

Finally, the UNCHE developed an Action Plan which is a more comprehensive document consisting of 109 separate recommendations. The 109 recommendations were redistributed into the three components of an Action Plan which included the global environmental assessment program, the environmental management activities, and the supporting measures. Although the global climate change isn't a topic in this conference, the UNCHE can pave the way of further understanding of climate change by the research collaboration proposed in this conference. The UNCHE ultimately lead to the creation of global and regional environmental monitoring networks and the creation of the United Nations Environment Programme (UNEP).

2.3.3 The United Nations Environment Programme (UNEP)

The United Nations Environmental Programme (UNEP) was founded as a result of the UNCHE. The creation of the UNEP was the most tangible outcome of the UNCHE. The mission of UNEP is "*to provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations*".

UNEP is the designated entity of the United Nations system for addressing environmental issues at the global and regional level. UNEP is governed by a Governing Council which include 58 members elected for four-year terms by the General Assembly. The UNEP Governing Council is responsible for assessing the state of the global environment, approving the budget, and developing policy guidelines for the UN environmental programs. The responsibilities of UNEP and the major results of UNEP activities can be shown in the Table 2.3 and 2.4.

The Responsibilities of UNEP	The Major Results of UNEP Activities
• Promoting international cooperation in the field of the environment and recommending appropriate policies. • Monitoring the status of the global environment and gathering and disseminating environmental information • Catalyzing environmental awareness and action to address major environmental threats among governments, the private sector and civil society. • Facilitating the coordination of UN activities on matters concerned with the environment, and ensuring, through cooperation, liaison and participation, that their activities take environmental considerations into account. • Developing regional programs for environmental sustainability. • Helping, upon request, environment ministries and other environmental authorities, in particular in developing countries and countries with transition economy, to formulate and implement environmental policies.	• International arrangements to enhance environmental protection. • Periodic assessments and scientifically sound forecasts to support decision making and international consensus on the main environmental threats and responses to them. • Support for more effective national and international responses to environmental threats, including policy advice to governments, multilateral organizations and others to strengthen environmental protection and incorporate environmental considerations into the sustainable process. • More effective coordination of environmental matters within the UN system. • Greater awareness and capacity for environmental management among governments, the private sector and civil society.

Table 2.3: The responsibilities of UNEP and the major results of UNEP activities; (source: [123])

The Responsibilities of UNEP	The Major Results of UNEP Activities
• Providing country-level environmental capacity building and technology support. • Helping to develop international environmental law, and providing expert advice on the development and use of environmental concepts and instruments.	• Better understanding of the nexus between environment and human security, poverty education, and preventing and mitigating natural disasters.

Table 2.4: The responsibilities of UNEP and the major results of UNEP activities (Cont.); (source: [123])

UNEP has the most notable success in promoting the 1987 Montreal Protocol of the Vienna Convention for the Protection of the Ozone Layer. However, in the first 20 years, UNEP faced four main problems which were shown as follows: (McCormick [72]):

1. Insufficient funds to operate projects.
2. UNEP's management systems were based on bureaucratic approaches rather than on professional approaches.
3. UNEP's location in Nairobi made it difficult to recruit highly qualified staff.
4. UNEP's relations with other UN agencies were poor.

UNEP started studying on the topic of climate change by implementing the Global Environment Monitoring System (GEMS) which is one component of the Stockholm Action Plan. The UNEP use GEMS to set up a network of atmospheric stations in remote areas. These stations are used to determine the status and trends of key environmental issues, including climate change. Moreover, the UNEP and the World Meteorological Organization collaborated to create the Intergovernmental Panel on Climate Change (IPCC) in 1988.

2.3.4 The United Nations Conference on Environment and Development (UNCED)

The United Nations Conference on Environment and Development (UNCED) was held in Rio de Janeiro, Brazil from 3 to 14 June 1992. The UNCED was attended by the representatives of 172 countries (108 countries sent their heads of state or government to attend this conference) and 2,400 representatives of non-governmental organizations (NGOs). After the UNCHE, the global environment continued to deteriorate and there were growing global concerns about global warming, species extinction, and threats to biodiversity. These problems ultimately lead to the UNCED. The principal themes of this conference were the environment and sustainable development.

The primary goals of the UNCED were to come to an understanding of development which would support socio-economic development and prevent the degradation of the environment, and to provide the basis for a global partnership between the developing and the industrialized countries, based on mutual needs and common interests, that would ensure a healthy future for the planet. The UNCED created the five agreements to promote environmental protection and sustainable development - summarized as follow:

I) The United Nations Framework Convention on Climate Change (UNFCCC)

The UNFCCC is the legally binding agreement which was signed by 154 countries in 1992. The UNFCCC was intended to set the international framework for reducing greenhouse gas emissions. The UNFCCC objective is "*to achieve stabilization of greenhouse gas concentrations in the atmosphere at a low enough level to prevent dangerous anthropogenic interference with the climate system*." Greenhouse gas emission reduction was aimed primarily at the industrialized countries. The UNFCCC successfully created a national greenhouse gas inventory which was developed to set strategies and policies for emission reduction and to track the progress of these policies. For example, the countries that are Parties to the UNFCCC must send annual inventories of greenhouse gas emissions by sources and removals by sinks to the UNFCCC. The institutional body of the UNFCCC includes the Conference of the Parties (COP), Secretariat, Subsidiary Body for Implementation (SBI), Subsidiary Body for Scientific and Technological Advice (SBSTA), and Financial Mechanism operated by the Global Environment Facility (GEF). The COP is the main policy-making body. Parties meet annually at the COP to review the implementation of the Convention and access progress in dealing with climate change. The first meeting of COP held in Berlin in 1995 agreed on the need for a binding commitment even after the year 2000. Finally, the third COP held in Tokyo in 1997 lead to the development of the most influential climate change action which was the Kyoto Protocol. By the creation of the UNFCCC, the UNCED evidently make the cornerstone of global cooperation to solve the climate change problem.

II) The Convention on Biological Diversity (CBD)

The Convention on Biological Diversity (CBD) is a similarly legally binding agreement as the UNFCCC adopted at the UNCED. It was signed at the UNCED by 155 countries. However, the United States has not yet ratified the treaty because the CBD posed a threat to the US biotechnology industry and to American jobs. The CBD is developed to sustain the diversity of life on Earth. The definition of biodiversity used by the CBD is "*the variability among living organisms from all sources, including, inter alia, terrestrial, marine, and other aquatic ecosystems, and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems*". The CBD has three main goals which include the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of benefits arising from genetic resources. The treaty used the concept of natural resource scarcity to set out a philosophy of sustainable use. Like the institutional body of the UNFCCC, the COP is the highest decision-making authority. The COP review progress under the Convention, set work plans for member nations, and work together with other international organizations and agreements. Many signatory countries have adopted Biodiversity Action Plans to implement the convention. For example, the European Community adopted the European Community Biodiversity Strategy in 1998 to collectively implement the convention.

III) Agenda 21

Agenda 21 is an international action plan for SD. The Agenda 21 form the basis for SD strategies which was taken globally, nationally, and locally by the UN, governments, businesses, and individuals. Agenda 21 has 40 chapters which can be divided into four sections:

- Social and economic dimensions. This section includes developing countries, poverty, consumption patterns, population, health, human settlements, integrating environment and development.

- Conservation and management of resources. This section includes atmosphere, land, forests, deserts, mountains, agriculture, biodiversity, biotechnology, oceans, fresh water, toxic chemicals, hazardous radioactive and solid waste and sewage.
- Strengthening the role of major groups. This section includes women, children and youth, indigenous peoples, non-governmental organizations, local authorities, workers, business and industry, farmers, scientists and technologists.
- Means of implementation. This section includes finance, technology transfer, science, education, capacity-building, international institutions, legal measures, information.

Agenda 21 also made local communities to develop their action plan for SD which was known as "Local Agenda 21". The main concept of Local Agenda 21 is that the agenda should be set by the community itself rather than by central or local government. It believes that the agenda set by the community is most likely to be successful. By creating Agenda 21, the UNCED successfully implement the concept of SD at global, national, and local level.

IV) The Rio Declaration on Environment and Development

The Rio Declaration on Environment and Development is a series of principle which define the rights of States to development, and their responsibilities to protect the environment. The Rio Declaration was developed by the ideas from the Stockholm declaration at the UNCHE. The Rio Declaration consisted of 27 principles which guided action on environment and development. The 27 principles focus on these following topics:

- The rights of States to exploit their own resources and the rights of States to development
- The concept of SD
- International cooperation in the field of environment and SD
- Promoting SD through exchanges of scientific and technological knowledge
- Encouraging public awareness and participation in environmental issues by making information widely available
- Developing national and international environmental law

- Promoting the internationalization of environmental costs and economic instruments
- The role of women, indigenous people, and local communities in environmental management and development

V) The Forest Principles

The Forest Principles are the first global consensus on forests. The Forest Principles are the non-legally binding statement of principles for sustainable management of forests. These principles were adopted to apply to all types of forests, both natural and planted, in all geographical regions and climate zones. The objectives of the Forest Principles are to contribute to the management, conservation and SD of forests and to provide for their multiple and complementary functions and uses.

These five agreements which include both the non-legally binding agreement and the legally binding agreement can bring the issues of environmental protection and SD into the international agenda. The UNFCCC is the most obvious outcome of the UNCED which can lead to the international climate change action.

2.4 Conclusions

In this chapter we apply the term of “the open economy” and “the economy within a closed earth” defined by Boulding for explaining the causes of climate change. We find that the unsustainable consumption in the economy within a closed earth resulted in the climate change problems. The more natural inputs we consume, the more negative outputs we give to environment. Finally, Boulding suggested that the polluted outputs should be added to measure the economic success and GNP should be generated by renewable resources.

This chapter continued by studying the development of international environmental cooperation via international environmental organizations and international environmental conferences. Finally, we can find that the transformation from national cooperation to international cooperation was inspired early the early work of Pinchot and Van Tienhoven. Van Tienhoven successfully formed the international environmental cooperation by creating national committees for nature protection in several countries. These branches worked together to create international environmental cooperation in several countries. Thus, Tienhoven initiated international environmental cooperation by creating a bottom up networked organization. Pinchot is another key person who promoted international cooperation. He believed that an international conference could encourage environmental cooperation. Which approach determined the global environmental agenda - Tienhoven's or Pinchot's? On balance the answer has to be Pinchot because his idea inspired a series of UN led conferences which have in effect set the global environmental agenda. Thus, we can conclude that the international conference gives birth to the global environmental agenda, particularly the Kyoto Protocol.

The international conference on environmental issues can be traced back to the UNSCCUR. Although the UNSCCUR cannot make a binding agreement on global environmental issue, the UNSCCUR can make local environmental issue become global environmental issue by taking the experts around the world to discuss the global environmental problem. After, the UNSCCUR, the UNCHE made more tangible outcomes than the UNSCCUR because the UNCHE developed an Action Plan and created the UNEP. Then, the UNEP bring us closer to climate change agenda by implementing the Global Environment Monitoring System (GEMS) and creating the Intergovernmental Panel on Climate Change (IPCC). Finally, the UNCED set thet international climate change policy agenda by creating the UNFCCC. The UNFCCC was created to set the international framework for reducing greenhouse gas emissions. The UNFCC ultimately lead to the development of the most influential climate change action which was the Kyoto Protocol.

Chapter 3

The Kyoto Protocol

The climate change problem is now inevitable and it is too late for humanity to avoid this problem (Stern [106]). As this problem is too large to be solved by unilateral national action, we need global cooperation. The principal vehicle for this cooperation is the Kyoto Protocol. The Kyoto Protocol now ratified by almost every country in the world. The question now becomes how this protocol is developed and is implemented. We will investigate these questions in this chapter.

3.1 Background on the Kyoto Protocol

As previously noted, the UNCED gave birth to the climate change agenda by creating the UNFCCC. Then, the UNFCCC create the most influential climate change action which is the Kyoto Protocol. The UNFCCC aims at stabilizing greenhouse gas concentrations for avoiding dangerous anthropogenic interference with the climate system. The UNFCCC was signed by 154 countries on 12 June 1992. Then, the UNFCCC came into force on 21 March 1994. The UNFCCC assigned different mitigation commitments for different signatory nations which can be divided into three groups: Annex I countries, Annex II countries, and Non-Annex I countries. The mitigation commitments under the UNFCCC are concluded as follows:

- Annex I countries:

Annex I countries consist of the industrialized countries that were members of Organization for Economic Co-operation and Development (OECD) in 1992 and countries designated as Economies-in-Transition (the EIT countries). Annex I countries were assigned to adopt national policies and take corresponding measures on the mitigation of climate change by limiting anthropogenic emissions of greenhouse gases and protecting and enhancing its greenhouse gas sinks and reservoirs. In addition, Annex I countries were required to reduce their emissions of CO_2 and other greenhouse gases, which are not governed by the Montreal Protocol, to 1990 levels by the year

2000. Annex I countries were also required to prepare annual GHG inventories and submit to the UNFCCC Secretariat. Moreover, they are required to submit National Communication reports to the COP every three years.

- Annex II countries

Annex II countries consist of the OECD members of Annex I, but not the EIT countries. Annex II countries are required to provide financial and technological assistance to enable developing countries to meet the full costs of preparing GHG inventories and National Communication reports. Moreover, Annex II countries must help developing countries that are vulnerable to climate change impacts to meet the costs of adaptation.

- Non-Annex I countries

Non-Annex I countries are developing countries. Non-Annex I countries were required to prepare GHG inventories and national programs addressing climate change but have no GHG emission reduction obligations. Moreover, they are currently not allowed participating in the international emission trading market.

The UNFCCC created the Conferences of the Parties (COP) serving as the supreme body of the regime. Parties meet annually at the Conferences of the Parties to review the implementation of the Convention and access progress in dealing with climate change. The COP gradually developed the climate change agenda. Ultimately, the third COP (COP-3) held in Tokyo in 1997 lead to the most influential climate change agenda known as the Kyoto Protocol.

3.2 The Development of the Kyoto protocol

The development of the Kyoto Protocol can be divided into three phases: the Pre-Kyoto era, the Mid-Kyoto era, and the Post-Kyoto era. The idea of the Kyoto Protocol was shaped in the Pre-Kyoto era. Later, the Mid-Kyoto era is the periods for paving the way for entry into force of the Kyoto Protocol. The Parties take decision on the unfinished details of the Kyoto Protocol in the Mid-Kyoto era. After its entry into force, the parties continued to negotiate the second commitment period of Kyoto Protocol (2013-2017). Consequently, the Post-Kyoto era will focus on the negotiation on the post-2012 framework.

3.2.1 The Pre-Kyoto Era (From COP-1 to COP-3)

After the creation of the UNFCCC, the Kyoto Protocol was gradually developed from COP-1 to COP-3. Although the Rio Earth Summit recommended the parties to set policy for taking their GHG emissions to their 1990 levels, no signatory was committed to meet any particular target. Therefore, the parties agreed that the commitments in the UNFCCC for Annex I countries were inadequate to solve the climate change problem. Ultimately, the first Conference of the Parties (COP-1) held in Berlin in 1995 agreed on the need for a binding commitment even after the year 2000. COP-1 adopted the Berlin Mandate which was a first step to strengthening the commitments under the Convention. Moreover, the industrialized countries agreed to the negotiation of quantitative CO_2 emission ceilings within specified time frames such as 2005, 2010, and 2020. Importantly, the Berlin Mandate specified that the binding obligations to reduce GHG emissions were assigned to only the industrialized countries, but the developing countries were exempted from the binding obligations. The principle of differentiated responsibilities proposed by the Berlin Mandate ultimately leads to the climate change politics. The principle of differentiated responsibilities was grounded in shared notions of fairness (Harris [44]). According to Harris, there were two reasons for the exemption of developing countries from binding obligations. Firstly, the industrialized countries have been industrializing and emitting greenhouse gases for many more centuries than the developing countries and therefore the industrialized countries should be responsible for historical GHG emissions. Secondly, the industrialized countries have the greater capacity to act on climate change than developing countries.

Another important result of the Berlin Mandate was the development of Joint Implementation (JI) Pilot Phase. The JI Pilot Phase was developed to help the industrialized countries to access cost-effective opportunities to reduce emissions. The Berlin Mandate believed that the GHG emissions could be reduced in a more cost-efficient way through cooperation with the Central and Eastern European or developing countries than through taking measures in an industrialized country (Richels *et al*. [95]). Consequently, the Berlin Mandate developed JI Pilot Phase. The JI Pilot Phase was implemented among Annex I countries and Non-Annex I countries that take an interest in it. During the pilot phase, the party could not be credited with emission reductions achieved through pilot projects in other countries.

The Parties discussed more stringent commitments at the second Conference of the Parties held in Geneva in 1996. COP-2 stated that the parties intended to negotiate a legally-binding protocol or other legal instrument to be approved at the third Conference of the Parties (Giorgetti [34]). The United States changed its view on binding commitments and it took the lead in supporting a timetable of emissions reductions at COP-2. Moreover, COP-2 strongly accepted the scientific findings on climate change done by the Second Assessment Report (SAR) and the IPCC.

Finally, the third Conference of the Parties held in Kyoto in 1997 lead to the Kyoto Protocol. It was attended by over 125 Ministers from several countries. Although there are many conflicts among the Parties at COP-3, COP-3 successfully made the Parties to agree on the legally binding commitments to reduce greenhouse gases within a specific time-frame. The Kyoto Protocol has the same ultimate objective as the UNFCCC, which is the stabilization of atmospheric concentrations of greenhouse gases at a level that would prevent dangerous anthropogenic interference with the climate system. More importantly, the Kyoto Protocol establishes the following principles:

- The GHG Emission Reductions Targets for Annex I Countries

Annex I countries have to reduce their GHG emissions to at least 5% below 1990 levels in the commitments period 2008-2012. This is a collective target for Annex I countries. This emission reduction target cover a basket of six main greenhouse gases which include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF6). Moreover, the Protocol set different individual emission targets for each Annex I country. The different Annex I countries have different emissions targets as shown in Table 3.1.

Country	Target (1990 - 2008/2012)
Eu-15	-8%
US	-7%
Canada, Hungary, Japan, Poland	-6%
Croatia	-5%
New Zealand, Russian Federation, Ukraine	0
Norway	+1%
Australia	+8%
Iceland	+10%

Table 3.1: The example of different individual emission targets for Annex I countries

The Protocol allocates these individual emission targets by the grandfathering method. Under a grandfathering method, the emission targets allocated to any individual country are based on historic emission data. The purpose of applying a grandfathering method to allocate emission targets is to create incentives for large emitting countries to participate in the Protocol (Vesterdal and Svendsen [135]). If any Annex I country fails to meet its Kyoto obligation during the first commitment period, it will be penalized during the second commitment period by having to make up 1.3 times of the excess amount of greenhouse gases they have emitted during first period.

Considering the emission target for the European Union (EU), the EU has not negotiated an individual target for each member state under the protocol, but the EU has decided to negotiate a target for its overall reduction target and then has redistributed this target among its member states through a burden-sharing agreement (Pittock [92]). The burden-sharing agreement is developed from the Triptych Approach which studied the GHG emissions of each member state and the method for setting individual emission targets of member states. The Triptych approach distinguished three emission sectors including the power sector, the sector of energy-intensive industries and the 'domestic' sectors (residential and transport emissions). The Triptych Approach suggests that the national circumstances which include population size and growth, standard of living, economic structure, energy efficiency in power generation, and climate should be taken into account in the settlement of individual emission targets (Marklund and Samakovlis [71]). The Triptych Approach help member states to reach agreement on the initial EU burden-sharing agreement in the March 1997 Environment Council Meeting by providing a technical justification for differentiating targets between member states. In the March 1997 Environment Council Meeting, The environment ministers also agreed to reduce three greenhouse gases (CO_2, CH_4 and N2O) emissions by 15% less than 1990 levels by 2010. However, the initial EU burden-sharing agreement had to be redistributed because of the results of the third COP. In the third COP, the scope of GHG gases was expanded from the three gases proposed by the EU to six gases. Consequently, the EU reduction target was changed to a target of 8% reduction below 1990 levels by 2008 to 2012. The initial EU burden-sharing agreement also had to be adapted to a target of 8% reduction. The final EU burden-sharing agreement was reaffirmed by joint ratification of the Kyoto Protocol on May 31, 2002. The initial and final EU burden-sharing agreements are given in Table 3.2.

Country	Member state targets under the initial EU burden-sharing agreement (%)	Member state targets under the final EU burden-sharing agreement (%)
Austria	-25	-13
Belgium	-10	-7.5
Denmark	-25	-21
Finland	0	0
France	0	0
Germany	-25	-21
Greece	+30	+25
Ireland	+15	+13
Italy	-7	-6.5
Luxembourg	-30	-28
Netherlands	-10	-6
Portugal	+40	+27
Spain	+17	+15
Sweden	+5	+4
United Kingdom	-10	-12.5

Table 3.2: The initial and final EU burden-sharing agreements; (source: Lefevre [66])

The different member states have different emission targets which span from a 28% reduction to a 27% increase. Under the final burden-sharing agreement, Germany and Denmark have to reduce their emissions by 21%, whereas Portugal is allowed to increase its emissions by 27%.

Besides the EU burden-sharing agreement, the member states have their own climate change policies. The UK has a strong climate change policy which aims to reduce CO2 emissions by 20% on 1990 levels by 2010 and by 80% on 2000 levels by 2050. Moreover, France has national objective for 25% reduction from 1990 levels of GHG gases by 2020. Germany and Italy have their national objectives to increase share of electricity from renewable sources. Germany set an objective to increase share of electricity from renewable sources to 20% by 2020, whereas Italy set a 20% increase by 2010 (Stern [106]). More recently, in 2007 EU leaders endorsed an integrated approach to climate and energy policy and committed to transforming Europe into a highly energy-efficient, low carbon economy. They made a unilateral commitment that Europe would cut its emissions by at least 20% of 1990 levels by 2020 (Pew Center on Global Climate Change [91]).

- The Kyoto Mechanisms

The Kyoto Protocol establishes the Kyoto Mechanisms to help Annex I countries to reduce the costs of meeting their emission targets. The Kyoto Mechanisms are divided into three mechanisms: Emissions Trading (ET), Joint Implementation (JI), and Clean Development Mechanism (CDM). The details of these mechanisms will be described in the next topic.

- The Eligibility Requirements for Entering the Protocol into Force

The Kyoto Protocol can enter into force when it meets all the eligibility requirements. These eligibility requirements are:

(i) It must be ratified by more than 55 member countries, and

(ii) It must be ratified by Annex I countries which accounted for at least 55 percent of total carbon dioxide emissions in 1990

The ratification by Russia on 18 November 2004 represented 61.6 percent of total carbon dioxide emissions in 1990, so this ratification brought the Protocol into force. The Kyoto Protocol came into force on 16 February 2005.

Although COP-3 successfully created the Kyoto Protocol, the Kyoto Protocol is not absolutely perfect. In COP-3, the Parties did not discuss how the Parties could meet their Kyoto obligation during the first commitment period. Moreover, many business representatives complained that these reductions under the Protocol were not economically feasible. Consequently, the parties have continued to discuss the Protocol. COP-3 left three serious issues which need to be solved quickly by the Parties. These three serious issues are concluded as follows:

(i) Hot air trading: The Kyoto Protocol set limits on GHG emissions for the commitments period 2008-2012 and the limits of several countries exceed their actual emissions. These countries have excess emission rights which are called "hot air" and they can sell their hot air to other Annex I countries which search for low-cost emissions targets. The bulk of tradable hot air largely comes from Russia and other countries in transition to a market economy. By hot air trading, Annex I countries could get credits without taking any actions to reduce their GHG emissions. Thus, these trades would not lead to actual emission reductions from the baseline (Vrolijk [137]).

(ii) The method for assessing sinks: The sinks refer to a carbon dioxide reservoir on earth. Forests are one of the main natural sinks because they absorb the carbon dioxide from the air as they grow. Consequently, the Kyoto Protocol allows countries that have large areas of forest to deduct a certain amount from their emissions. However, there is no consensus on the best method for assessing sinks in the Kyoto Protocol.

(iii) A basket of main greenhouse gases: There were many arguments against a basket of main greenhouse gases applied to the Kyoto targets (Toth *et al*. [119]). A basket of main greenhouse gases defined in the Protocol include six greenhouse gases (CO_2, CH_4, N2O, HFCs, PFCs, and SF6), but some countries preferred to cover only three greenhouse gases including CO_2, CH_4, and N2O rather than cover all six greenhouse gases. Thus, the Parties continued to discuss whether the Kyoto targets should include CO_2, CH_4, and N2O or just only CO_2, CH_4, N2O.

Although the Kyoto Protocol leave many unresolved issues, the Kyoto Protocol is considered to be the most far-reaching agreement on environment and SD ever adopted because it has been ratified by almost every country around the world. As of November 2007, a total of 175 countries and other governmental entities have ratified the Kyoto Protocol.

3.2.2 The Mid-Kyoto era (From COP-4 to COP-10)

After COP-3, there were many unresolved issues that the Parties continued to discuss. In COP-4 held in Buenos Aires (2-13 November 1998), the Parties expected to get achievement in the resolution of all issues unresolved in COP-3. Unfortunately, it was too difficult to find agreement, and they could still not terminate all unresolved issues.. However, COP-4 created the Buenos Aires Plan of Action which aimed to resolve the outstanding issues, particularly the rules and guidelines for the Kyoto Mechanisms, by the end of 2000, at COP-6. Later, the parties still could not make a decision on the unfinished details of the Kyoto Protocol at COP-5. COP-6 was split into two meetings. COP-6 was firstly held in the Hague, Netherlands. The goal of COP-6 was to reach agreement on all the unfinished details of Kyoto Protocol. The first meeting held in the Hague was unable to reach agreement because of a dispute between the European Union and a group including the United States, Japan, Russia, and Canada over the terms for implementing the Kyoto Protocol. Following this meeting, the United States rejected the Protocol in March 2001. President George W. Bush announced that he would not ratify the Kyoto Protocol "*because it exempts 80% of the world, including major population centers such as China and India, from compliance, and would cause serious harm to the US economy*" (White House [140]). After its rejection of the Protocol, the US government was pressured by other member countries which had ratified the Protocol because the effect of international climate treaty would be limited without the participation by the US which was the largest single emitter of carbon dioxide from the burning of fossil fuels as of 2005.

The second meeting of COP-6 was held in Bonn, Germany. The United States only accepted observer status at this meeting because of its rejection of Kyoto. The meeting successfully culminated in the Bonn Agreements. These key issues resolved by the Bonn Agreements were:

I. *The use of carbon sinks:* The Protocol allows developed countries to receive credit for activities that absorb carbon from atmosphere or store it. These eligible activities include revegetation and the management of forests, croplands and grazing lands.

II. *The Kyoto Mechanisms:* The Protocol allows the developed countries to receive credit through the ET, JI, and CDM. The eligible projects qualified as CDM projects are energy efficiency, renewable energy, and forest sink projects. Importantly, there is no quantitative limit on the credit which the developed countries can claim from the use of these mechanisms. (See 3.3 for more detail)

III. *The Compliance:* At the second part of COP-6, the Parties discussed compliance mechanisms for the Protocol which focused on the functions of the compliance bodies and the penalties for noncompliance. Ultimately, the Parties agreed that a compliance committee should be established. Moreover, the Parties set the penalty on Parties that fail to meet their emissions targets. These Parties would be penalized during the second commitment period by having to make up 1.3 times of the excess amount of greenhouse gases they have emitted during first period. In addition, these Parties were suspended from selling credits under emissions trading until they return to compliance.

IV. *Financing:* The developed countries agreed to provide financial resources to developing countries to help them to limit the growth in their emissions and adapt to climate change impacts. Consequently, the Parties created three new funds to help developing countries. These three new funds are:

- A special climate change fund: This fund was established to finance projects relating to adaptation, technology transfer and capacity building, energy, transport, industry, agriculture, forestry and waste management, and economic diversification.
- A least developed country fund: This fund was established to support National Adaptation Programs of Action in Least Developed Country Parties (LDCs).
- A Kyoto Protocol adaptation fund: This fund was established to finance concrete adaptation projects and programs in developing countries which were Parties to the Kyoto Protocol.

The Bonn Agreements were hugely important because the Agreements covered all unresolved issues. However, the Agreements created only the draft decision on all unresolved issues. The draft decision remained to be ratified and converted into legal texts. Therefore, the Parties need the COP-7 to complete these remaining tasks. The Bonn Agreements can pave the way for completing the Buenos Aires Plan of Action at COP-7 by making the draft decision on all unresolved issues.

COP-7 was held in Marrakech, Morocco from 29 October to 10 November 2001. COP-7 could complete the work of the Buenos Aires Plan of Action. The complete decisions were known as the Marrakech Accords. COP-7 easily translated the draft decision created by the second part of COP-6 into legal texts. Thus, COP-7 could finalize all unresolved issues of the Kyoto Protocol. The COP-7 is the fulfillment of the Kyoto Protocol. Ultimately, the COP-7 successfully paves the way for entry into force of the Kyoto Protocol. The Kyoto Protocol came into force on 16 February 2005

3.2.3 The Post-Kyoto era (From COP-11 to COP-15)

After its entry into force, the parties start negotiating on a new round of emission reduction targets for the second commitment period of Kyoto Protocol (2013-2017). The Post-Kyoto era focus on the negotiation on the post-2012 framework. A process to consider further commitments by Annex I Parties for the post-2012 period must be initiated, in accordance with Article 3.9 of the Kyoto Protocol. Article 3.9 state that "*Commitments for subsequent periods for Parties included in Annex I shall be established in amendments to Annex B to this Protocol, which shall be adopted in accordance with the provisions of Article 21, paragraph 7. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall initiate the consideration of such commitments at least seven years before the end of the first commitment period referred to in paragraph 1 above*." Consequently, the Parties start negotiating on the second commitment at COP-11 held in Montreal, Canada from 28 November to 9 December 2005. In COP-11, the United States still opposed to new process under the Kyoto Protocol. However, the United States was left isolated on COP-11. Importantly, the Parties agreed to extend the treaty on emission reduction targets beyond its 2012 deadline. One of the important goals of COP-11 was to initiate a process to consider a second round of emission reduction target for the second commitment. This process set at COP-11 is responsible for ensuring that there is no gap between the end of the first commitment period (2008-2012) and the start of the second commitment period (2013-2017). Ultimately, COP-11 established the Ad Hoc Working Group on Long-term Cooperative Action under the Convention (AWG) which was responsible for the discussion on the second commitment. However, COP-11 did not set the deadline for completing the negotiation on the second commitment. Another key outcome of COP-11 was the strengthening of the Clean Development Mechanism (CDM). COP-11 strengthened the CDM by enabling developed countries to invest in SD projects in developing countries.

Later, COP-13 was attended by more than 10,000 delegates at Bali, Indonesia from 3 December 2007 to 15 December 2007. COP-13 was intended to pave the way to the second commitment period of Kyoto Protocol. The primary goal of COP-13 was to set the timetable for completing the negotiation on the second commitment. COP-13 established the Bali Roadmap which developed the process to work on the key building blocks of a future climate change regime, including adaptation, mitigation, technological cooperation, and financing the response to climate change. The Bali Roadmap comprised several important elements. The Bali Action Plan recognized that "deep cuts in global emissions will be required to achieve the ultimate objective of the Convention and emphasizing the urgency to address climate change as indicated in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change." The Bali Action Plan provided a two-year process to finalize a binding agreement in 2009. It also set timetable for AWG negotiations. Under the Bali Action Plan, AWG must complete its work in 2009 and present the outcome of its work to COP-15. In COP-13, EU countries wanted to contain a commitment that industrialized nations will cut their emissions by 25-40% compared to 1990 levels by 2020 in the Bali Roadmap, but no specific emission reduction targets were included in the Bali Roadmap. Another fruitfulness of COP-13 is the development of Adaptation Fund which is used to provide funding to the developing countries to help them adapt to the effects of climate change.

COP-14 took place on 1-12 December 2008 in Poznan, Poland. This conference represents the midpoint between Bali (COP-13) and Copenhagen (COP-15). COP-14 made little progress. The clear achievement of conference was the authorization for the Adaptation Fund to begin operations in 2009. This fund comes from a 2% levy on carbon trading under the CDM.

Most recently, COP-15, widely known as the Copenhagen Summit, was held at the Bella Center in Copenhagen, Denmark, between 7 and 18 December 2009. The goal of COP-15 is to establish a legally binding agreement for the period from 2012 when the first commitment period under the Kyoto Protocol expires. Despite widely held expectations that COP-15 would produce a legally binding agreement, the conference was ultimately unsuccessful in reaching an agreement for the post Kyoto period. However, the main outcome of COP-15 was a political agreement known as *"the Copenhagen Accord"*. The Accord was drafted by the US, China, Brazil, India, and South Africa. The Copenhagen Accord recognized that climate change is one of the greatest challenges of the present day and that actions should be taken to keep any temperature increases to below 2°C (UNFCCC [131]). However, this is not legally binding and does not contain any legally binding commitments for reducing CO_2 emissions. Moreover, the Accord agreed to raise $30 billion from 2010 to 2012, to help the developing nations adapt to climate change. Finally, it can be clearly seen that there was little prospect of reaching final agreement on a post-Kyoto agreement at the COP15 meeting.

3.3 The Kyoto Mechanisms

The Kyoto Mechanisms are designed under the concept that GHG emission reductions taking place anywhere in the world will have the same environmental effects. The Global GHG emission mitigation will be less expensive overall if the actual emission reductions are implemented at the regions that have the lowest mitigation costs (Pasoyan [89]). The costs of reducing GHG emissions vary across countries. Annex I countries tend to have higher mitigation costs than developing countries. If Annex I countries implement their GHG emission reduction projects in their own countries, they would face high costs, relative to projects making equivalent reductions in developing countries. Consequently, Kyoto Mechanisms enable Annex I countries to access cost-effective opportunities to reduce emissions, or to remove carbon from the atmosphere, in other countries. The purposes of Kyoto Mechanisms are to reduce the cost incurred by Annex I countries in meeting their targets and to encourage Non-Annex I countries to reduce GHG emissions. There are three Kyoto Mechanisms: (i) Emissions Trading (ET); (ii) Joint Implementation (JI); and (iii) Clean Development Mechanism (CDM). Without the Kyoto Mechanisms, the Parties would not have been able to reach agreement at COP-6. Compared with carbon taxes, the Kyoto Mechanisms are seen as a more effective approach. For example, if the environmental regulator uses carbon taxes to penalize the polluters, some polluters may find it easier to pay carbon taxes rather than reduce emissions. Consequently, the carbon taxes cannot guarantee a predetermined carbon reduction. Annex I countries must meet the following eligibility requirements for participating in the Kyoto Mechanisms.

- They must have ratified the Kyoto Protocol.
- They must have calculated and recorded their assigned amount.
- They must have in place a national system for estimation of greenhouse gas emission and removals of greenhouse gases within their territory.
- They must have in place a national registry.
- They must annually report information on emissions and removals of greenhouse gases

3.3.1 Emission Trading (ET)

Emission Trading is defined in Article 17, Article 3.10, and Article 3.11 of the Kyoto Protocol. These Articles state that:

Article 17:

"*The Conference of the Parties shall define the relevant principles, modalities, rules and guidelines, in particular of verification, reporting and accountability for emissions trading. The Parties included in Annex B may participate in emissions trading for the purpose of fulfilling their commitments under Article 3. Any such trading shall be supplemental to domestic actions for the purpose of meeting quantified emission limitation and reduction commitments under that Article*"

Article 3.10:

"*Any emission reduction units, or any part of an assigned amount, which a Party acquires from another Party in accordance with the provisions of Article 6 or of Article 17 shall be added to the assigned amount for the acquiring Party*"

Article 3.11:

"*Any emission reduction units, or any part of an assigned amount, which a Party transfers to another Party in accordance with the provisions of Article 6 or of Article 17 shall be subtracted from the assigned amount for the transferring Party*"

ET allows Annex I countries to buy and sell excess emissions allowances among themselves to meet their emission reduction targets. The concept of emission trading is simple. The Protocol set a total amount of allowable emissions which are called "the cap" for all Annex I countries. The Protocol also allocates portions of emissions allowances over a given period to each of Annex I countries. The emissions allowance for each Annex I country has been widely known as "an assigned amount" or "a national cap". A national cap represents the right of Annex I country to emit a specific amount. The actual emission of each Annex I country is not allowed to exceed its national cap. If Annex I country emit above its national cap, this country must buy additional emission allowance. The cost of buying emission allowance represents a charge for emitting over the target. On the other hand, if an Annex I country emits below its national cap, this country can sell surplus emission allowance. The revenue of selling emission allowance represents a reward from having reduced emissions. The emission allowances can be traded through international carbon credit market. The countries with low abatement costs will choose to reduce their emissions below their national cap and sell their excess emission allowances, whereas countries with high abatement costs will choose to buy emission allowances. Therefore, ET can bring the lowest emission reduction cost to society. We can see how ET can bring the lowest emission reduction cost to society from following simple example.

We assume that there are two Annex I countries in the world: Country A, and Country B. Country A emits 500 tons of CO_2 each year, and Country B emits 400 tons of CO_2 each year. Thus, there is an annual total of 900 tons of CO_2 in the world. The environmental regulator set a 10 percent reduction for the world. This setting forces the world to reduce its emissions to 810 tons per year. By this setting, both countries must reduce their emissions by 10 percent. Country A must reduce its emissions to 450 tons per year, whereas Country B must reduce its emissions to 360 tons per year. Country A can reduce its emission at a cost of $20 per ton and Country B can reduce its emission at a cost of $40. Without emission trading, Country A must reduce 50 tons per year with a cost of $20 per ton and Country B must reduce 40 tons per year with a cost of $40 per ton. Thus, the world's total emission reduction cost is $2,600. By emission trading, Country B will choose to buy an allowance of 40 tons of CO_2 from Country A because Country B has higher reduction cost than Country A. Country A will reduce 90 tons of CO_2 with a cost of $20 per ton and sell 40 tons of CO_2 to Country B. Thus, the world's total emission reduction cost is $1,800. Finally, ET helps the society to save $800 on emission reduction cost

3.3.2 Joint Implementation (JI)

Joint implementation is defined in Article 6, Article 3.10, and Article 3.11 of the Kyoto Protocol. Article 6 states that "*any Party included in Annex I may transfer to, or acquire from, any other such Party emission reduction units resulting from projects aimed at reducing anthropogenic emissions by sources or enhancing anthropogenic removals by sinks of greenhouse gases in any sector of the economy*".

In other words, under Article 6, JI allows Annex I countries to undertake an emission-reducing project in another Annex I countries where they cost less than at home. The investing country will receive emission credits equal to the amount of emissions that were reduced as a result of JI project, and then apply these credits for its reductions towards its commitment goal. The emission credits generated from JI projects are called "*Emission Reduction Units (ERUs)*" and are issued by the host country. For example, if a UK company invests in an emission-reducing project in Japan, then the emission credits generated from JI project must be allocated to a UK company. Consequently, JI is the project-based mechanism of the Kyoto Protocol. JI was developed from the AIJ pilot phase. AIJ was developed to serve as a learning-by-doing mechanism for investments. The AIJ project focused on the countries in transition to a market economy and the developing countries that lacked experience so far.

Emission reductions are measured from a JI project baseline representing the emissions that would occur in the absence of the JI project. The difference between the actual emission level of JI project and the project baseline is awarded ERUs. The investing country can use ERUs to meet its own Kyoto target. These emission reductions can be claimed for the first commitment period (2008-2012). A project baseline is very important for claiming emission reductions units. If the project baseline is too tough, the investing organizations may be discouraged, but if the project baseline is too mild, the Kyoto target may not be met (OECD [81]).

There are two procedures for JI project. These are called Track 1 and Track 2.

I) Track 1: Track 1 will be applied when the host Party fully meets all the eligibility requirements under the Kyoto Protocol. These eligibility requirements are:

- They must be Annex I parties to the Kyoto Protocol.
- They must have a national system for identification of GHG emissions from sources and storage using sinks.
- They must have a computerized national registry compliant with the international requirements.
- They must have submitted a report for determining their initial assigned amounts.
- They must annually submit a current inventory protocol fully compliant with Kyoto requirements.

Under track 1, the host Party uses its own approaches for setting JI project baselines. Moreover, the host Party uses its own processes to verify reduction in anthropogenic emissions and issue the appropriate quantity of ERUs. The host Party transfers the agreed amount of ERUs through the system of national registry.

II) Track 2: Track 2 will be applied when the host Party does not meet all the eligibility requirements which are set for track 1, but meet all these minimum requirements:

- They must be Annex I parties to the Kyoto Protocol.
- They must have a computerized national registry compliant with the international requirements.
- They must have submitted a report for determining their initial assigned amounts.

Under track 2, the Joint Implementation Supervisory Committee (JISC) set international rules and procedures for baselines, verification of emission reductions, and other procedures. JI track 2 procedures are similar to CDM procedures.

3.3.3 Clean Development Mechanism (CDM)

The clean development mechanism allows Annex I countries to invest in emission reduction projects in developing countries (Non-Annex I countries) which is called "host countries". The investing country will get emission credits which are called "Certified Emission Reductions (CERs)" and can directly use CERs to meet its own Kyoto target or can sell CERs in the emission trading market. CDM projects have twin objectives. Firstly, to assist Non-Annex I countries achieve SD. Secondly, to assist Annex I countries achieve their emission reduction targets in a cost effective way. Similar to JI, the types of project which can be implemented under the CDM project are renewable energy, energy efficiency improvement, fuel switching, transport, afforestation/reforestations, and methane capture and reuse from coal mines, landfills and industrial wastewater. The details of CDM framework will be discussed in the next chapter.

3.4 Conclusions

This chapter studies the development of the Kyoto Protocol which is divided into three phases: the Pre-Kyoto era, the Mid-Kyoto era, and the Post-Kyoto era. Although the Protocol came into force and an emission reduction targets for the first commitment period is implemented, the Parties have continued to negotiate on many issues of the Kyoto Protocol. However, not all COP are successful in reaching the resolution of these issues. The highlight COP and its outcomes are concluded in Table 3.3

Event	Year	Location	Key Outcomes
COP-1	1995	Berlin, Germany	The Berlin mandate: • Assigning the binding obligations to reduce GHG emissions to only the industrialized countries • The development of JI Pilot Phase
COP-3	1997	Kyoto, Japan	• The GHG emission reductions targets (Annex I countries have to reduce their GHG emissions to at least 5% below 1990 levels in the commitments period 2008-2012) • The development of the Kyoto Mechanisms
COP-6	2001	Bonn, Germany	The Bonn Agreements: • The developed countries receive carbon credits through the Kyoto Mechanisms • Setting the penalty on Parties that fail to meet their emission targets • Developing the funds to help the developing countries adapt to the effects of climate change
COP-11	2005	Montreal, Canada	An agreement to extend the treaty on emission reduction targets beyond its 2012 deadline
COP-13	2007	Bali, Indonesia	The development of Adaptation Fund
COP-15	2009	Copenhagen, Denmark	The Copenhagen Accord which propose to keep the global temperature increase below 2°C (not legally binding commitments)

Table 3.3: The highlight COP and its outcomes

In every era of the Kyoto negotiation, the most contentious issue has been the exemption of developing countries from the binding obligations of the Protocol. This issue was a key reason for the United States to deny the ratification of the Kyoto Protocol. The argument in favour of exempting developing countries from binding obligations is based on the principle of fairness. By the principle of fairness, developed countries have emitted the majority of GHG emissions historically and the developing countries get more severe impacts from climate change than the developed countries, so the developed countries should be responsible for historical GHG emissions.

The grandfathering method applied to allocate emission permits is another problem of the Kyoto Protocol. Under a grandfathering method member countries are given emission permits based on historical emission data. If a member country emits below its permits, this country can sell the surplus for generating revenue. On the other hand, if a member country emit above its permits, this country must buy the extra permits. The point of applying a grandfathered system is to create incentives for large emitting countries to participate in the Protocol (Vesterdal and Svendsen [135]). However, the grandfathering method has many disadvantages which include high transaction cost, lack of effectiveness through the update of the historical reference period, and barriers to entry for firms into a market. Consequently, the Parties try to find new method for allocating emission permits in the second commitment period.

Annex I countries face higher abatement costs than developing countries. Consequently, the Kyoto Protocol design the Kyoto Mechanisms to help Annex I countries meet their emission reduction targets at least cost. The Kyoto Mechanisms include ET, JI, and CDM. However, these mechanisms are not absolutely perfect. JI and the CDM have higher transaction costs than ET because JI and the CDM are project-based mechanisms of which the transaction costs will associate with each project. JI and the CDM are limited to reduce emissions in certain sectors such as energy, transport, agriculture, etc., whereas ET can reduce emissions in every sector. Therefore, ET can reduce emission in a wide range of sectors. Finally, the abatement costs will be optimal only in ET (Grazzi [39]). Compared with JI, CDM is more cost efficient than JI because the CDM is applied in developing country where has lower abatement costs than industrialized country.

It is very hard to predict the future of the Kyoto Protocol. The future of negotiation continues to depend mostly on the Protocol's exemption of developing countries.

Chapter 4

The CDM Regulatory Framework

The Kyoto Protocol incorporates three flexibility mechanisms underpinned by the principle that GHG emission reductions anywhere in the world have the same environmental benefits. The Clean Development Mechanism (CDM) is one of these three mechanisms which allows Annex I countries to invest in emission reduction projects in developing countries. As previously noted, CDM projects themselves have twin objectives: (1) to assist Non-Annex I countries achieve Sustainable Development (SD); and (2) to assist Annex I countries achieve their emission reduction targets in a cost effective way. This chapter continues to investigate the implementation of CDM projects. Consequently, the objectives of this chapter are: (1) to examine the CDM governance and regulations; and (2) to examine the key aspect of the CDM project including baseline, additionality, and crediting period.

4.1 Background on the Clean Development Mechanism

Clean development mechanism is defined in Article 12 and Article 3.12 of the Kyoto Protocol. These Articles state that:

Article 12 (Paragraph 2 and 3):

"2.The purpose of the clean development mechanism shall be to assist Parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of the Convention, and to assist Parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments under Article 3."

"3.Under the clean development mechanism:

Parties not included in Annex I will benefit from project activities resulting in certified emission reductions; and

Parties included in Annex I may use the certified emission reductions accruing from such project activities to contribute to compliance with part of their quantified emission *limitation and reduction commitments under Article 3, as determined by the Conference of the Parties serving as the meeting of the Parties to this Protocol."*

Article 3 (Paragraph 12):
"Any certified emission reductions which a Party acquires from another Party in accordance with the provisions of Article 12 shall be added to the assigned amount for the acquiring Party."

In other words, under Article 12.3, the clean development mechanism allows Annex I countries to invest in emission reduction projects in developing countries (Non-Annex I countries) which is called "*host countries*". The investing country will get emission credits which are called "*Certified Emission Reductions*" (CERs) and can directly use CERs to meet its own Kyoto target or can sell CERs in the emission trading market. For example, if a UK company invests in an emission-reducing project in India, then CERs generated from CDM project must be allocated to a UK company. Like JI, the CDM is the project-based mechanism of the Kyoto Protocol. Certified Emission Reduction is calculated by comparing the actual emission level of CDM project with the emission level of a hypothetical baseline scenario (see Figure 4.1). Currently, each CER is equivalent to one tonne of CO_2e. An illustration of CDM project is given in Figure 4.1.

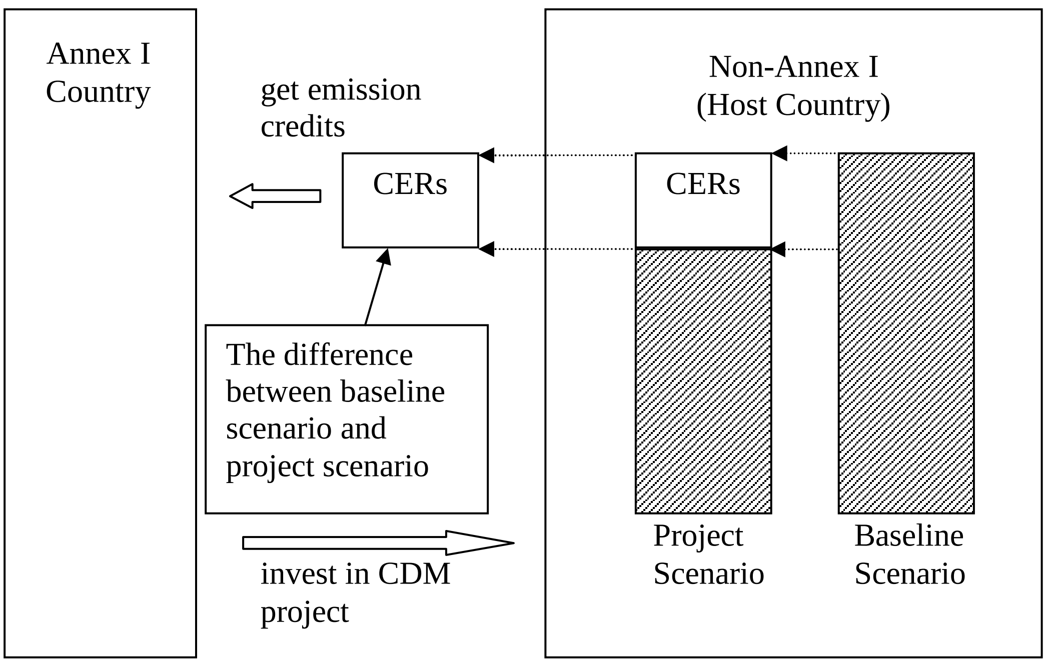

Figure 4.1: Illustration of CDM project

4.2 Institutional Framework of Clean Development Mechanism

CDM projects must be approved by the institutional framework of CDM. Moreover, the institutional framework of CDM project within a country is an important factor for investment decision making in CDM project (Ellis and Kamel [23]). The institution structure of the CDM has several bodies:

4.2.1 The Conferences of the Parties (COP)

The Conferences of the Parties (COP) is the supreme body of the Convention and it is the highest decision-making authority. The COP consists of 10 members comprising: the President, Vice-Presidents, the Chairs of the subsidiary bodies and the Rapporteur. The COP has authority over and provides guidance to the CDM. Moreover, the COP reviews the regional and sub-regional distribution of designated operational entities (DOE), CDM project activities, and annual reports of the CDM Executive Board (EB).

4.2.2 The CDM Executive Board (EB)

The CDM Executive Board (EB) is appointed by the COP. The EB comprise 10 members including: one member from each of the five United Nations regional groups, two other members from the Parties included in Annex I, two other members from the Parties not included in Annex I, and one representative of the small island developing States. The CDM EB elects its own chair and vice-chair. The CDM EB supervises the CDM, under the authority and guidance of the COP. The CDM EB is also responsible for the registration of CDM projects and for the issuance of CERs.

4.2.3 Designated National Authority (DNA)

Designated National Authority (DNA) is appointed by the government of the Parties to UNFCCC. The DNA is responsible for undertaking the review and approval of CDM projects. The DNA of the host country must give the definition of SD criteria to CDM projects and confirm that the CDM project can promote the SD in the host country under the criteria used by the DNA of the host country.

4.2.4 Designated Operational Entity (DOE)

Designated Operational Entity (DOE) is either a domestic legal entity or an international organization accredited and designated, on a provisional basis until confirmed by the COP, by the CDM EB. The DOE validates and subsequently requests registration of a proposed CDM project activity; verifies emission reduction of a registered CDM project activity; and certifies as appropriate and requests the CDM EB to issue CERs accordingly.

4.2.5 Stakeholders

Stakeholders are invited for comments and reviews in the design phase and the validation phase of the CDM project. The project stakeholders are the individuals, groups and communities who are affected by projects such as non-governmental organizations (NGOs), local residents, and employees. In the design phase of the CDM project, the stakeholder participation focuses on the impacts of the CDM project and the project's contribution to SD. In the validation phase of the CDM project, stakeholders comment on whether the project qualifies as a CDM project.

4.3 The CDM Project Cycle

The CDM project cycle is the series of project activity for implementing a CDM project and finally getting CERs from project. All bodies of the institution structure of the CDM will participate in the CDM project cycle. The CDM project cycle can be divided into 7 major stages which can be shown in the flow chart below (Figure 4.2). Each stage will be then described in more detail.

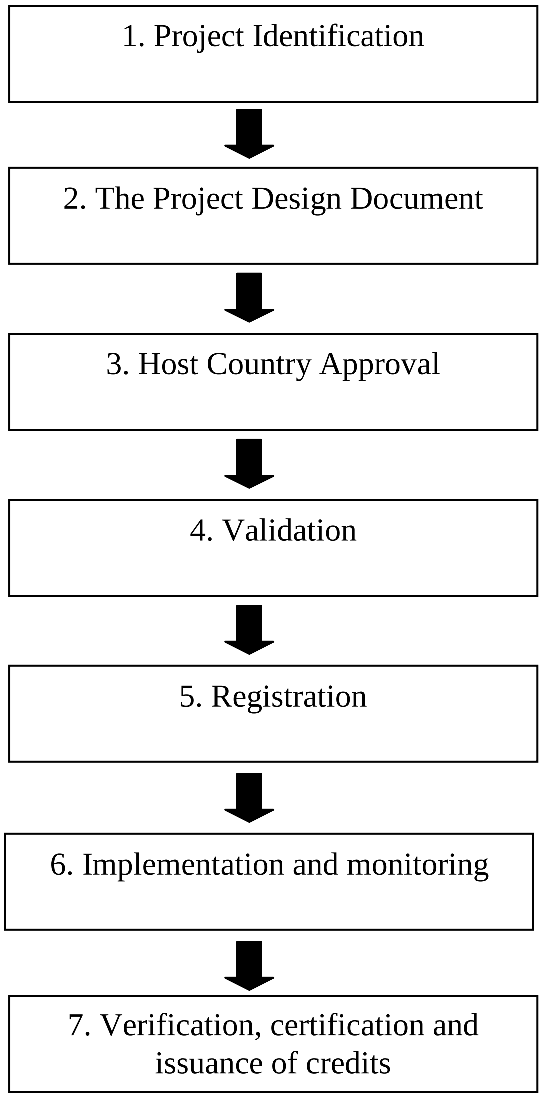

Figure 4.2: The CDM project cycle

Stage 1: Project identification

During the first stage, the project developer will identify a project activity and examine whether the project is eligible under the CDM. Moreover, many project developers search for potential buyers of CERs in this stage. The project developer will also develop a Project Idea Note (PIN) which provides a summary of project description to the potential buyers. The PIN will provide primary information on: type and size of project, the location of project, a first estimate of GHG emission reductions, crediting life time, the anticipated financing plan, the anticipated CERs price, and socioeconomic and environmental benefits of project. The PIN will help the project developer to inexpensively get market feedback without engaging the entire CDM process. The feedback will represent whether or not the project is of interest to potential buyers.

Stage 2: The Project Design Document (PDD)

In this stage, the project developer will develop the PDD which provide comprehensive and accurate information on the CDM project. The project developer must submit the complete PDD to the host country for project approval. The PDD is a key document which will take the CDM project into the approval, the validation, the registration, and the verification. The objectives of the PDD are to demonstrate the GHG emission reductions from project activity and to demonstrate the host country's SD resulted from the CDM project. The common components of the PDD include:

- A general project description
- Baselines methodology
- Assessment of additionality
- SD benefits
- A crediting period
- Monitoring methodology and plan
- Calculation of GHG emissions by sources
- Assessment of environmental impacts
- Stakeholder comments

Stage 3: Host Country Approval

The CDM project must be obtained written approval from the DNA of the host country for the registration by the CDM EB. The DNA will examine whether the CDM project will provide the host country with SD and examine whether the CDM project can help the host country to reduce GHG emissions. However, different countries use the different SD criteria for evaluating the CDM project because there is still no clear definition of the SD in the Kyoto Protocol. The DNA of the host country is responsible for giving the definition of SD criteria to CDM projects and confirming that the CDM project can promote the SD to the host country. Consequently, the project developer must consider the SD criteria defined by the host country and then follow this guideline for developing the CDM project. The issue of SD will be discussed in the next topic. An official letter of approval from the DNA will ultimately represent as an evidence of host country acceptance.

Stage 4: Validation

The DOE is responsible for validation process. The project developer must submit the PDD and an official letter of host country approval to the DOE for validation. This stage will provide assurance that the CDM project comply with all CDM and host country requirement. The DOE will evaluate all relevant documents for the CDM project activity against the requirements for the CDM project. The DOE will examine the following key issues in the validation process:

- Stakeholders are invited to comment on the CDM project, and then stakeholder comments are summarized and reviewed.
- Environmental impact analysis is performed according to the requirements of host country.
- The baseline and monitoring methodologies applied by the CDM project are accurate and reasonable.
- The project activity is in accordance with all other requirements by the UNFCCC, the CDM EB, and host country.

Ultimately, the DOE will decide whether the CDM project can be validated. After the DOE review and approve the project documents for validation, the DOE will prepare a validation report. Then the DOE must submit a validation report together with the PDD, an official letter of host country approval, and a request for project registration to the CDM EB.

Stage 5: Registration

This stage is the process of formal acceptance of the validated CDM project. The CDM EB is responsible for registration process. The project developer is required to pay the registration fee to the CDM EB. Once all documents are sent to the CDM EB by the DOE, the CDM EB will put a validation report and the PDD on the UNFCCC website for 30 days and collect comments from the general public on these documents. The CDM EB will examine whether a validation report is accurate. The registration with the

CDM EB must be final after a maximum of eight weeks after validation and the submission of the project to the CDM EB. Besides the mandatory registration with the CDM EB, some host countries may also require the CDM project to be registered with host country.

Stage 6: Implementation and monitoring

After the CDM project is registered, the CDM project can be implemented. In this stage, the project developer must monitor and record technical project performance which includes GHG emissions from project activity, environmental impacts, and leakage effects of the project. The project developer must submit the monitoring report to the DOE for verification. Finally, the GHG emission reductions from project activity can be calculated and submitted for verification as CERs.

Stage 7: Verification, certification and issuance of credits

The DOE is responsible for verification and certification of the CDM project, whereas the CDM EB is responsible for issuance of credits. For verification, the DOE must verify the authenticity of the data recorded by the project developer according to the monitoring report. The DOE will use the following criteria for verifying the monitoring report.

- The monitoring report must meet the requirements of the registered PDD.
- The monitoring methodologies must be correctly applied.
- The actual GHG emission reductions must be correctly calculated.

The DOE will prepare a verification report and a certification report, both of which will be submitted to the CDM EB for issuance of credits. Certification is the written guaranty by the DOE that the CDM project achieved the GHG emission reductions as stated and verified during the specified time period. Consequently, the verification report will state the verified amount of GHG emission reductions from project activity. Once the CDM EB receive a verification report, a certification report, and a request to issue CERs, the CDM EB will review a verification report and a certification report. If the CDM EB is satisfied with these reports, the CDM EB will issue the certified amount of CERs within 15 days.

The time required for each stage in the CDM project cycle can be shown in Figure 4.3.

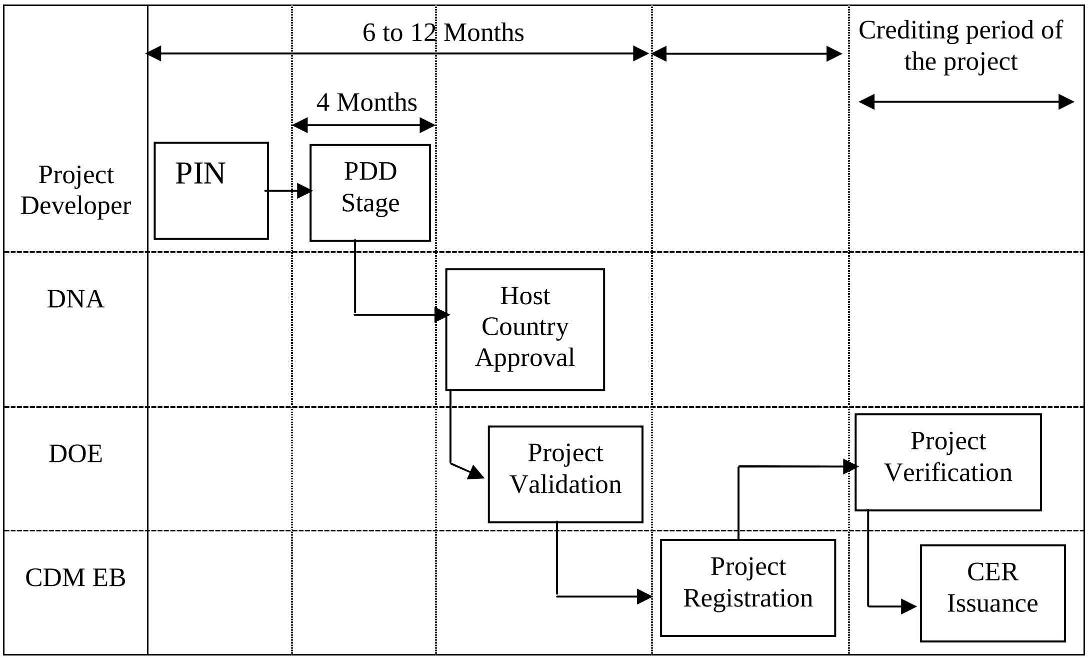

Figure 4.3: The time required for each stage in the CDM project cycle; (source: UNEP-Risoe and EcoSecurities [127])

4.4 The Key Aspect of CDM Projects: Baseline, Additionality, and Crediting Period

4.4.1 Baseline and Additionality

The GHG emission reduction from the CDM project is the important issue for CDM implementation. Article 12.5C states that:

"Emission reductions resulting from each project activity shall be certified by operational entities to be designated by the Conference of the Parties serving as the meeting of the Parties to this Protocol, on the basis of reductions in emissions that are additional to any that would occur in the absence of the certified project activity."

Consequently, the CDM projects must really reduce GHG emissions in the host country. Moreover, the CDM regulator must examine whether the CDM project can really reduce GHG emissions in the host country. If the project developer overestimates the

GHG emission reductions for maximizing its revenues from CERs, this project will lose credibility and ultimately the world could not really get the benefits from the CDM project (Boyd *et al*. [7]). Consequently, the Kyoto Protocol tries to develop methodologies to correctly evaluate the GHG emission reductions from the CDM projects. Finally, a baseline methodology is developed to evaluate the GHG emission reductions from project. A baseline methodology is an important tool for ensuring the credibility of the CDM project. A baseline for the CDM project is defined as "*the scenario that reasonably represents the anthropogenic emissions by sources of greenhouse gases that would occur in the absence of the proposed project activity*" (UNFCCC [129]). In other words, a baseline for the CDM project is the business-as-usual scenario representing the current level of GHG that would be emitted if the proposed CDM project is not implemented. A baseline is also used to determine the volume of GHG emission reductions from project activity. Figure 4.4 show an example of the GHG emission reductions. Our discussion will assume that the baseline emissions slowly decrease overtime because resulting from business-as-usual efficiency improvements. However, the baseline scenario will vary depending on specific circumstances. The GHG emission reductions can be determined by the difference between the emissions in the baseline scenario and the emissions in the project scenario (see Figure 4.4).

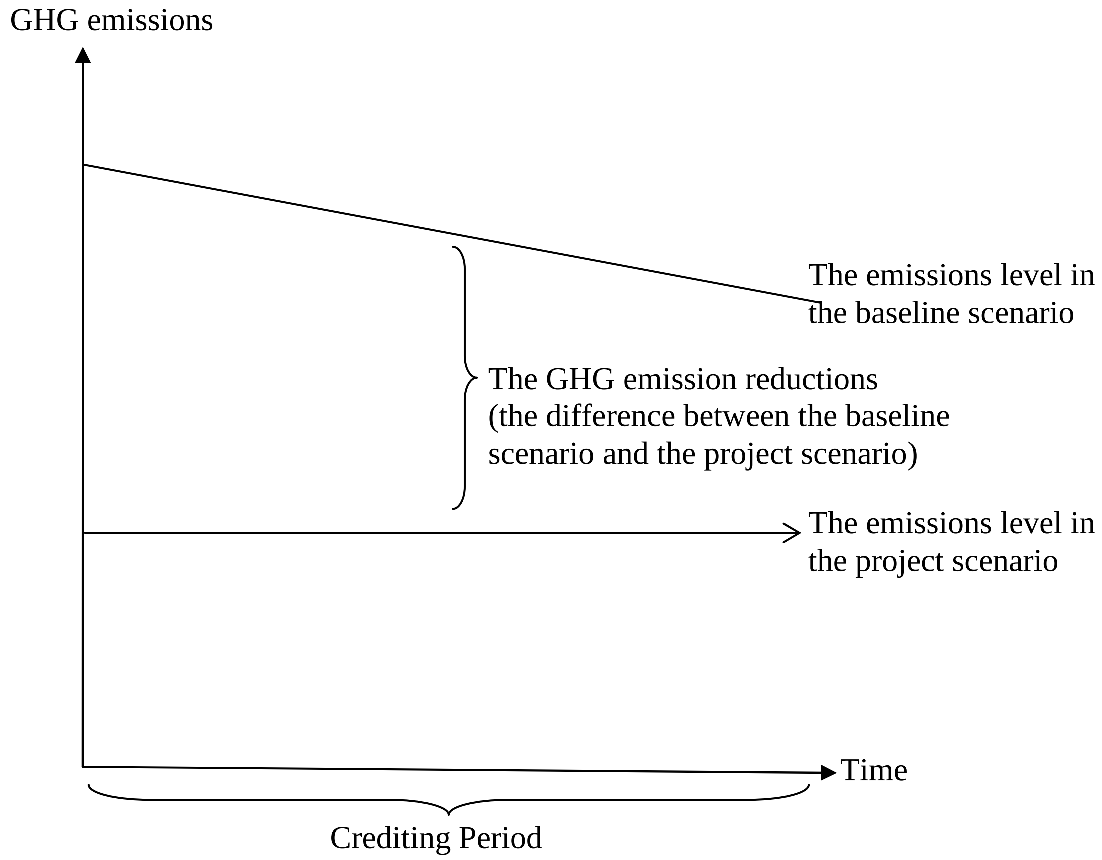

Figure 4.4: The GHG emission reductions

This concept can be rewritten as the equation below:

GHG Emission Reductions = Baseline Emissions – Project Emissions

These emissions reduced through the CDM project are also known as the certified emission reductions (CERs). One CER is equivalent to one tonne of CO_2e reduced through the CDM project. The certified emission reductions can be traded in the carbon market.

The emission reductions must be beyond what would have happened in the absence of the project (Aalders [1]). This basis is called "additionality". Additionality is defined in international rules on CDM as follows: *"A CDM project activity is additional if anthropogenic emissions of greenhouse gases by sources are reduced below those that would have occurred in the absence of the registered CDM project activity (UNFCCC*

[129]).” Additionality is quantified by measuring the change in GHG emissions observed when comparing the emissions in the baseline scenario with the emissions in the project scenario. Additionality is used as criteria to determine whether GHG emission reductions are real, measurable, reasonable, and in addition to what would have happened. Moreover, additionality is also used as criteria to ensure that GHG emission reductions are not counted more than once. We can conclude the relationship between a baseline and additionality as follows (Aalders [1]):

- Additionality is closely related to a baseline. A baseline must be established in order to determine additionality for the CDM project. A baseline is used to determine whether the CDM project activity is additional.
- Project emissions must be lower than baseline emissions.

Consequently, the accuracy of a baseline methodology is the important issue for implementing the CDM project because the GHG emission reductions and additionality are determined by a baseline methodology. The project developer is responsible for establishing a baseline for the CDM project. However, the DOE and CDM EB will examine whether a baseline methodology set by the project developer is accurate and reasonable. The project developer can establish a baseline for the CDM project by using one of three baseline approaches created in the Marrakech Accords. These three baseline approaches are:

i) Existing, actual or historical emissions.

ii) Emissions from technology that represents an economically attractive course of action, taking into account barriers to investment.

iii) The average emissions of similar project activities undertaken in the previous five years, in similar social, economic, environmental and technological circumstances, and whose performance is among the top 20 percent of their category.

Only one in three approaches will be selected to establish a baseline for the CDM project.

Currently, the concept of additionality is one of the most widely debated issues in the aspect of the CDM project because there is no clear definition of additionality in the Kyoto Protocol. However, there are currently two concepts of additionality which are (i) environmental additionality; and (ii) project additionality.

i) Environmental additionality

This concept of additionality covers only environmental additionality. The CDM project will focus only on environmental additionality. According to this concept, a project is additional if the project emissions are lower than the baseline emissions. The environmental additionality can be assessed by comparing the emissions in the baseline scenario with the emissions in the project scenario.

ii) Project additionality

Project additionality is a broader concept than environmental additionality because it covers multiple concepts of additionality. According to this concept, a project is additional if a project meets these three criteria: environmental additionality, financial additionality, and technical additionality. These three criteria can be discussed below:

- *Environmental additionality:* A project is environmentally additional if a project can generate net GHG emission reductions that would not have occurred in the absence of the CDM project (Leining [67]).
- *Financial additionality:* A project is financial additionality if the CERs revenues can turn a project that was not financially viable into a project that is financially viable (Ringius [96]).
- *Technical additionality:* There are three options for defining technology additionality. A project is technical additionality if a project meets only one of the following three options (Leining [67]):

  Option 1: A project is technical additionality if a project employs technologies that were appropriate for non-Annex I countries and met best available technology standards.

  Option 2: A project is technical additionality if a project involve technology transfer that was additional to the non-CDM technology transfer obligations of Annex II countries giving non-Annex I countries access to needed technologies.

Option 3: A project is technical additionality if a project employs technologies that were the best available for the circumstances of the host party.

4.4.2 Crediting Period

Crediting period represent the period over which the project developer will get the emission credits. The crediting period has a direct impact on the value of the CDM project. The crediting period is always different from the project lifetime. Normally, the project lifetime is longer than the crediting period. There are two options for determining the crediting period. These two options are:

i) A fixed crediting period

For a fixed crediting period, the length and starting date of the period is determined once for a project activity with no possibility of renewal or extension once the project activity has been registered. The length of a fixed crediting period can be a maximum of ten years. A fixed crediting period is shown in the figure 4.5.

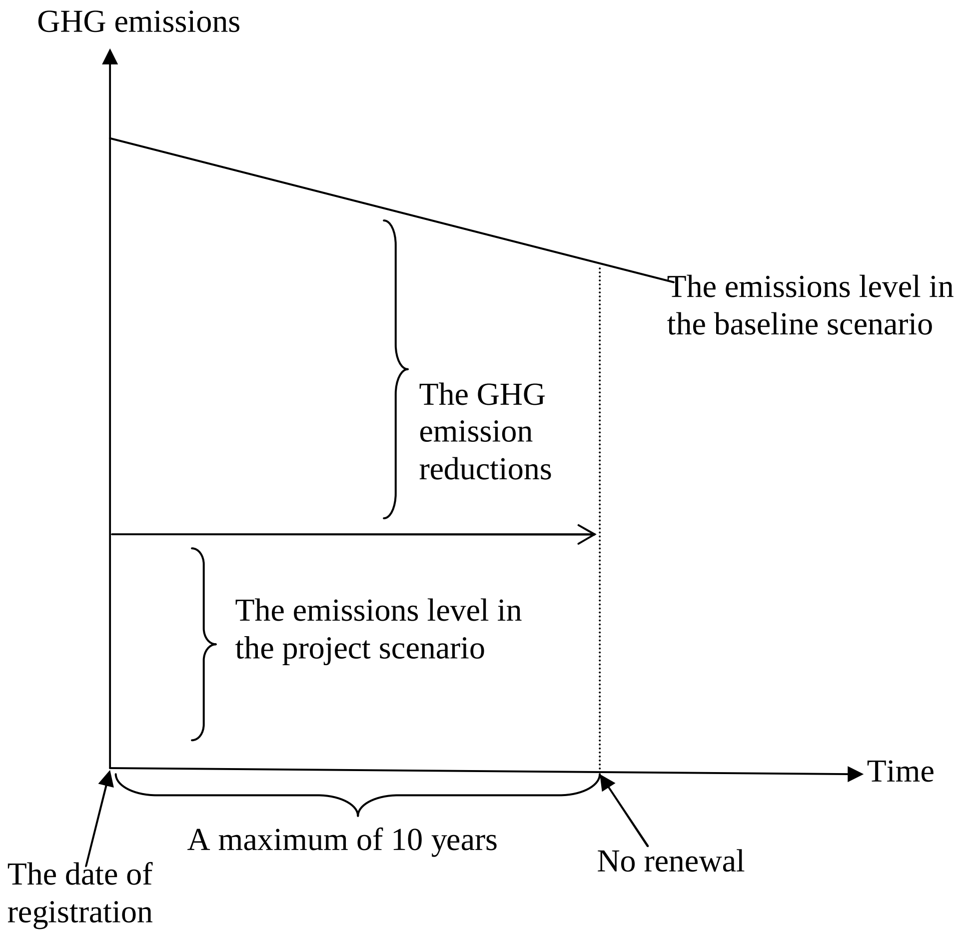

Figure 4.5: A fixed crediting period

ii) A renewable crediting period

For a renewable crediting period, a crediting period can be a maximum of seven years, but a crediting period can be renewed at most two times. For each renewal, the DOE must determine that the original project baseline is still valid or has been updated taking account of new information. A renewable crediting period can be shown in the figure 4.6.

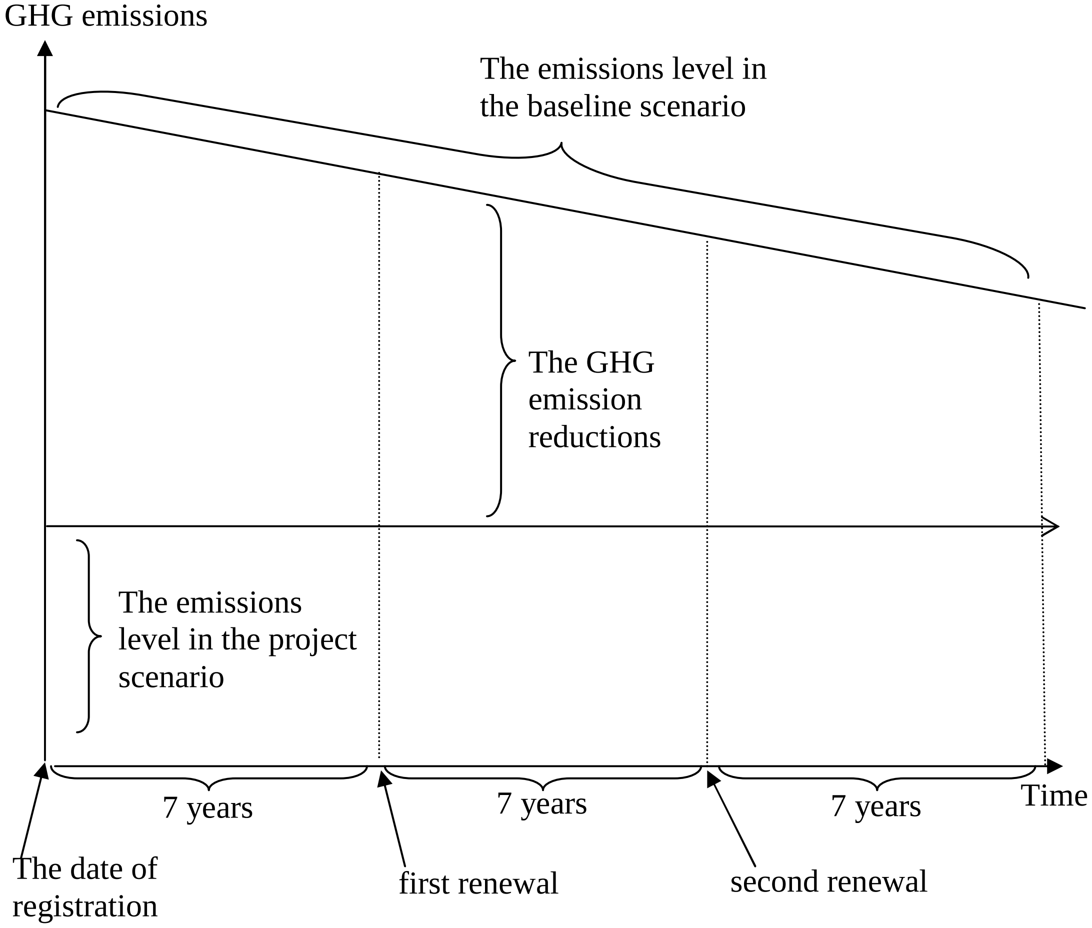

Figure 4.6: A renewable crediting period

4.5 Transaction costs of the CDM project

Transaction costs associated with the CDM project can be incurred in the two phases: the project preparation phase, and the project implementation phase. In the project preparation phase, the transaction costs include:

- Initial assessment costs: These costs are incurred prior to project document preparation. The project developer must conduct preliminary study to ensure that the CDM project would be eligible under international and national guidelines.
- Project design costs: These costs represent the costs for developing a project design document in the CDM project cycle. Project design costs account for the

largest transaction costs which are incurred in the project preparation phase. (See table 4.2)

- Validation costs: The CDM project must be validated by the DOE. These costs are incurred in validation stage in the CDM project cycle.
- Costs for developing the Emission Reduction Purchase Agreement (ERPA): The costs for developing the ERPA involves legal and contractual costs related to drafting of the contract, risk management and negotiations (The Climate Change Projects Office [17]).
- Registration fee: The project developer is required to pay the registration fee to the CDM EB. The registration fee depends on the size of the CDM project. The registration fee can be shown in Table 4.1.

Average tones of CO_2 equivalent reductions per year over the crediting period (estimated/approved)	USD ($)
<= 15,000	5,000
> 15,000 and <= 50,000	10,000
> 50,000 and <= 100,000	15,000
> 100,000 and <= 200,000	20,000
> 200,000	30,000

Table 4.1: Registration fee; (source: Dornau [22])

These five transaction costs for developing a large-scale project and a small-scale project can be concluded in Table 4.2 below.

Transaction costs	Large-Scale	Small-Scale
Initial assessment costs	£5,000-£15,000	£3,000-£4,000
Project design costs	£15,000-£54,000	£6,000-£12,500
Validation costs	£4,000-£18,000	£3,500-£5,500
Costs for developing the ERPA	£3,000-£35,000	£1,500-£5,000
Registration fee	£6,000-£18,000	£3,000
Total transaction costs	£33,000-£140,000	£17,000-£30,000

Table 4.2: Transaction costs incurred in the project preparation phase; (source: The Climate Change Projects Office [17])

The costs of creating a new CDM methodology can be also substantial (if such is required). Moreover, transaction costs are also incurred in the project implementation phase. These costs include:

- *Monitoring and verification costs:* Monitoring and verification must be carried out regularly. The CDM project must be monitored by the project developer, and then it must be verified by the DOE. These costs are incurred in monitoring and verification stage.
- *Costs of the sale of carbon credits:* The sale of carbon credits can be done directly to the buyer or through an intermediary. In the latter case a fee is usually paid and can be based on a certain percentage of the selling value (The Climate Change Projects Office [17]).
- *Adaptation fee:* Adaptation fee aim to help developing countries with weaker economies adapt to adverse effects of climate change. This fee must be paid to UN and it is equivalent to 2% of CERs generated by the CDM project.

These three transaction costs incurred in the project implementation phase can be shown in Table 4.3.

Transaction costs	Estimated costs
Monitoring and verification costs	£3,000-£10,000 (per audit)
Costs of the sale of carbon credits	5%-20%
Adaptation fee	2%

Table 4.3: Transaction costs incurred in the project implementation phase; (source: The Climate Change Projects Office [17])

When project developers, lenders, and investors evaluate the financial viability of the CDM project, they will calculate the overall profitability of the project. Therefore, transaction costs can strongly affect the financial viability of the CDM project. Examples set out below in Table 4.4 demonstrate how transaction costs of the CDM project affect investment decision-making.

Project type	Total Cost (£million)	IRR without CERs	Transaction Costs	Revenues from CERs (£million)	IRR With CERs
Hydro (26MW)	20.2	9.2%	£94,500	2.2	10.4%
Landfill (15MW)	21.8	13.8%	£94,500	4.4	18.7%
Wind (8.6MW)	10.1	9.7%	£79,500	0.3	10.6%

Table 4.4: Impact of transaction costs on the IRR of the CDM project; (source: The Climate Change Projects Office [17])

Table 4.4 shows that different project types will incur different costs and returns on investments. The IRR of a project with CER revenue is higher than the IRR of a project without CER revenue. Thus, CERs can help the energy projects to raise the IRR of the projects. Normally, CERs can help the traditional renewable energy projects (e.g., wind, hydro, biomass) to boost their return by 0.5-2.5 percent, whereas CERs have an even higher financial impact on the methane projects (The Climate Change Projects Office [17]). The methane projects achieve higher financial returns than the renewable energy projects. This is because the methane projects generate more CERs than the renewable energy projects.

4.6 Conclusions

The first step to running CDM projects is the study of the CDM regulations and the institution structure of the CDM. The CDM regulations and the institution structure of the CDM are the heart of CDM project. In every stage of the CDM cycle, the institution structure of the CDM will control and approve CDM projects under the CDM regulations. The CDM regulations also affect the supply of CDM projects directly. There are two key questions related to the CDM cycle: What are the key issues considered in each stage of the CDM cycle? Who is the main responsible person in each stage of the CDM cycle? The answers of these questions are shown in Table 4.5.

From table 4.5, the GHG emission reduction is the key issue which is examined in almost every stage of the CDM cycle, whereas the CDM's contribution to SD is examined in only the third stage (host country approval). This clearly show that the CDM assessment mainly focus on the GHG emission reduction. More clearly, SD benefits are not required to be monitored during the operating period. Host countries are required to conduct only one sustainability assessment of CDM project before the operation of the project. This contrasts sharply with the rigorous monitoring of GHG emission reductions. Consequently, this reflects the weakness of SD assessment.

Moreover, we found that the SD criteria for approval of projects are not clearly defined; in contrast to GHG emissions whose assessment and monitoring protocols are clearly defined. Different countries use the different SD criteria for evaluating the CDM project. Consequently, it is more difficult for the responsible institutions to evaluate the sustainability than to evaluate the GHG emission reductions.

Stage	The main responsible institution	The key issue considered by the responsible institution
Project identification	The project developer	• A general project description • GHG emission reductions • Crediting period • Financing plan • The socioeconomic and environmental benefits
The project design document	The project developer	• A general project description • Baselines methodology • Additionality • Crediting period • Monitoring plan • GHG emission reductions • Environmental impacts
Host country approval	The DNA	• GHG emission reductions • The project's contribution to sustainable development
Validation	The DOE	• Environmental impacts • Baselines methodology • Monitoring plan
Registration	The CDM EB	• The authenticity of a validation report
Implementation and monitoring	The project developer	• GHG emission reductions • Environmental impacts • Leakage effects of the project
Verification, certification and issuance of credits	The DOE The CDM EB	• GHG emission reductions

Table 4.5: The key issues and the responsible institution in each stage of the CDM cycle

Finally, we found that the aspect of SD is not applied to the concept of additionality. The concept of additionality focuses on GHG emission reductions, whereas the SD benefits do not appear in this concept. We found only environmental additionality, financial additionality, and technical additionality addressed in the PDDs, whereas sustainability additionality does not appear in the PDDs. Ultimately, we can conclude that the CDM is facing the problem of SD assessment, so the next chapter will focus on the CDM project’s contribution to SD.

Chapter 5

A Methodological Approach and Framework for Sustainability Assessment of CDM Projects

Currently, the use of CDM projects, as a step towards mitigation of global warming, is growing rapidly. As of April 2008, 1,033 projects were registered as CDM projects and a further 169 projects were in the registration process (UNEP-Risoe [124]). Do all these CDM projects really contribute to SD? The CDM's contribution to SD is one of the two objectives of the CDM project, but uncertainty prevails as to whether the CDM project can really contribute to SD. As previously discussed, we found that CDM projects are facing the problem of SD assessment. Consequently, this chapter will discuss the project's contribution to SD. The objectives of this chapter are: (1) to investigate the concept of SD applied to CDM projects; and (2) to investigate the methods for assessing the sustainability of CDM projects.

5.1 A Brief History of Sustainable Development

The concept of SD sparkle a voluminous and expanding literature. There are different interpretations of SD found in many literatures. However, the SD remains an elusive concept and its implementation has proven difficult (Overton [86], UN [133]). There is no single universally accepted definition of SD. Most people's thoughts about the meaning of sustainability are about human survivability and the avoidance of ecological disaster, but the real meaning of sustainability is complex and technical (Jamieson [51]). For many people, the basic idea of sustainability focuses greatly on the depletion of resources, conservation of nature, environmental and ecological aspects, the aspects of quality of human life, and the human well-being (Kerk and Manuel [56]). The most widely quoted definition of SD is defined by the 1987 report of the World Commission on Environment and Development (WCED), entitled "*Our Common Future*" (also known as the Brundtland Report). The Brundtland Report firstly coined the definition of SD. The Brundtland Report defines SD as "*development that meets the needs for the* *present without compromising the ability of future generations to meet their own needs"* (WCED [144]). This Brundtland's definition of SD contains three key concepts:

- The concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given.
- The idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.
- An equity between generations

At the time of the publication of the Brundtland Report the world faced a meta crisis including the crises of environment, development, security, and energy. The Brundtland Report was one of the outcomes of the WCED which attempted to solve these crises. According to the Brundtland Report, these crises were caused by a mismatch between the capacities of the natural systems of the earth and humanity's ability to fit its activities into this framework. The Brundtland Report suggested that these crises could be solved through SD within a framework of equity.

The Brundtland Report serves as a vital historical marker because it firstly coined the definition of SD and it signals the emergence of "the environment" as a critically important facet of international governance (Sneddon *et al*. [103]). The Brundtland Report recommended urgent action on eight key issues including (1) population and human resources; (2) food security; (3) the urban challenge; (4) energy; (5) industry; (6) species and ecosystems; (7) conflict and environmental degradation; and (8) managing the commons to ensure that the development was sustainable. At the heart of the Brundtland Report is the belief that equity, growth, and environmental maintenance are simultaneously possible with each nation achieving its full economic potential and at the same time enhancing its resource base (Kirkby *et al*. [58]). The Brundtland Report designed a strategy for SD which aimed to promote harmony among human beings and between humanity and nature. This strategy for SD included reviving growth, changing the quality of growth, meeting essential needs for jobs, food, energy, water, and sanitation, ensuring a sustainable level of population, conserving and enhancing the resource base, reorienting technology and managing risk, and merging environment and economics in decision making. Finally, the pursuit of SD requires (WCED [144]):

- a political system that secures effective citizen participation in decision making
- an economic system that is able to generate surpluses and technical knowledge on a self-reliant and sustained basis
- a social system that provides for solutions for the tensions arising from disharmonious development.
- a production system that respects the obligation to preserve the ecological base for development
- a technological system that can search continuously for new solutions
- an international system that fosters sustainable patterns of trade and finance
- an administrative system that is flexible and has the capacity for self-correction

The Brundtland Report ultimately laid the groundwork for the development of Agenda 21 and the development of the Commission on Sustainable Development. Following the Brundtland Report, the idea of SD is widely implemented throughout the world, especially through the development projects.

Later, the UNCED marked the first international attempt to create action plans for SD. The primary goals of the UNCED were to come to an understanding of development which would support socio-economic development and prevent the degradation of the environment, and to provide the basis for a global partnership between the developing and the industrialized countries, based on mutual needs and common interests, that would ensure a healthy future for the planet. The UNCED successfully make the idea of SD become an international action plan by creating Agenda 21. Agenda 21 is an international action plan for SD which is taken globally, nationally and locally. Agenda 21 has 40 chapters which can be divided into four sections:

i) Social and economic dimensions. This section includes developing countries, poverty, consumption patterns, population, health, human settlements, integrating environment and development.

ii) Conservation and management of resources. This section includes atmosphere, land, forests, deserts, mountains, agriculture, biodiversity, biotechnology, oceans, fresh water, toxic chemicals, hazardous radioactive and solid waste and sewage.

iii) Strengthening the role of major groups. This section includes women, children and youth, indigenous peoples, non-governmental organizations, local authorities, workers, business and industry, farmers, scientists and technologists.

iv) Means of implementation. This section includes finance, technology transfer, science, education, capacity-building, international institutions, legal measures, information.

By creating Agenda 21, the UNCED attempted to implement the concept of SD at global, national, and local level.

Most importantly, the UNCED created the three dimensions of SD, namely environmental sustainability, economic sustainability, and social sustainability. The three dimensions of SD are also known as "*the three pillars of sustainable development*". The Declaration of Rio on Environment and Development recognized that the SD was a balance of these three dimensions. These three dimensions are most often used to define the SD. Another fruitfulness of the UNCED is the creation of the Commission on Sustainable Development (CSD). The CSD is responsible for reviewing the progress in the implementation of Agenda 21. In response to Agenda 21's call for developing SD indicators, the CSD ultimately created 58 indicators of SD for decision-making at the national level. These 58 indicators can help country to measure and evaluate the progress towards SD goals. Moreover, these indicators can provide an early warning to a country for preventing economic, social, and environmental damage.

More recently, the World Summit on Sustainable Development (WSSD) held in Johannesburg in 2002 strengthened a multilateral commitment to SD. The WSSD was convened to discuss on a broad range of issues under the heading of SD including energy, resource use, biodiversity, agriculture, global trade, and poverty reduction (INTOSAI WGEA [50]). The key outcomes of the WSSD can be concluded as follows (United Nations [132]):

- The summit reconfirmed SD as a central element of the international agenda
- The summit broaden and strengthen the understanding of SD, especially the linkages between poverty, environment, and the use of natural resources
- The summit support for the creation of a world fund for the eradication of poverty

- The summit agreed to and reconfirmed many actual commitments and targets for action to attain SD objectives effectively
- The summit promoted the concept of partnerships between governments, business, and civil society

Moreover, the WSSD created the Johannesburg Plan of Implementation which set many targets and timetables for the implementation of SD. Some of these targets and timetables include:

- Significantly improving the lives of at least 100 million crowded residents by the year 2020
- Halving the proportion of people who can not access to safe drinking water by the year 2015
- Reducing the rate of biodiversity loss significantly by the year 2010
- Creating integrated water resources management and water efficiency plans by the year 2005
- Implementing the ecosystem approach for the SD of the oceans by the year 2010

Most importantly, the WSSD successfully directed the focus towards integration and linkages between the climate change debate and the SD debate (Olsen [84]). Previous to the WSSD, in spite of the fact that the climate change and SD directly affect human life, the climate change debate and SD debate were largely separated for a long time. The SD debate was framed in the social and human science, whereas the climate change debate was framed in the natural science. Ultimately, the WSSD can combine these two debates into one debate.

5.2 The Concept of Sustainable Development Applied to the CDM Project

As previous discussed in section 5.1, early studies of sustainable development mainly focus on defining the concept, so there are a large number of SD definitions. However, Dobson [21] concluded that there were no SD definitions that were sufficient to capture its broad shape. Dobson suggested that any theory of SD should be able to answer critical questions such as sustainable for how long, at what level, for whom, and under what conditions.

Moreover, the SD assessment should be able to reflect different perceptions of value as well as dynamic socio-economic and environmental surroundings.

How the concept of SD is applied remains as a critical issue for the implementing CDM projects. The CDM's contribution to SD is clearly defined in Article 12.2 of the Kyoto Protocol.

"The purpose of the clean development mechanism shall be to assist Parties not included in Annex I in achieving sustainable development……."

The host country must examine whether the CDM project can really provide the host country with SD. The host country's duty to assess the sustainability is defined in the Bonn Agreement. The Bonn Agreement clearly state that *"The Conference of the Parties agrees to affirm that it is the host Party's prerogative to confirm whether a clean development mechanism project activity assists it in achieving sustainable development"* (UNFCCC [130]). Thus, the host country will define the sustainable criteria used for assessing the CDM project.

According to UNDP [122], there are two interpretations of a CDM project's contribution to SD. The first interpretation is that CDM projects must reduce GHG emission without causing any social, economic, or environmental harm. Another interpretation is that CDM projects must provide positive economic, environmental, and social benefits, not just greenhouse gas emission reductions. According to Dobson's typology UNDP suggest a '*strong*' interpretation of SD (Dobson [21]). The UNDP interpretation implies Pareto efficiency as an appropriate decision criterion, where a project is only acceptable if it does no harm. Alternative, '*weaker*', cost/benefit approaches would accept some negative impacts provided there is a net benefit.

Most often the concept of SD is defined as a multidimensional concept integrating three dimensions, namely environmental sustainability, economic sustainability, and social sustainability. Under each dimensions of SD, SD criteria are created for assessing sustainability. According to Sutter [108], the overall sustainability objective of a CDM project should be divided into environmental, social, and economic objectives. (Some countries pick-out technological issues as an extra objective, so these countries will have four objectives). Moreover, Sutter suggested that these objectives should be translated into a set of sustainability criteria. Finally, these criteria should be translated into quantifiable indicators which can be used to assess individual CDM projects. Figure 5.1 show the structure of SD criteria for assessing CDM projects suggested by Sutter.

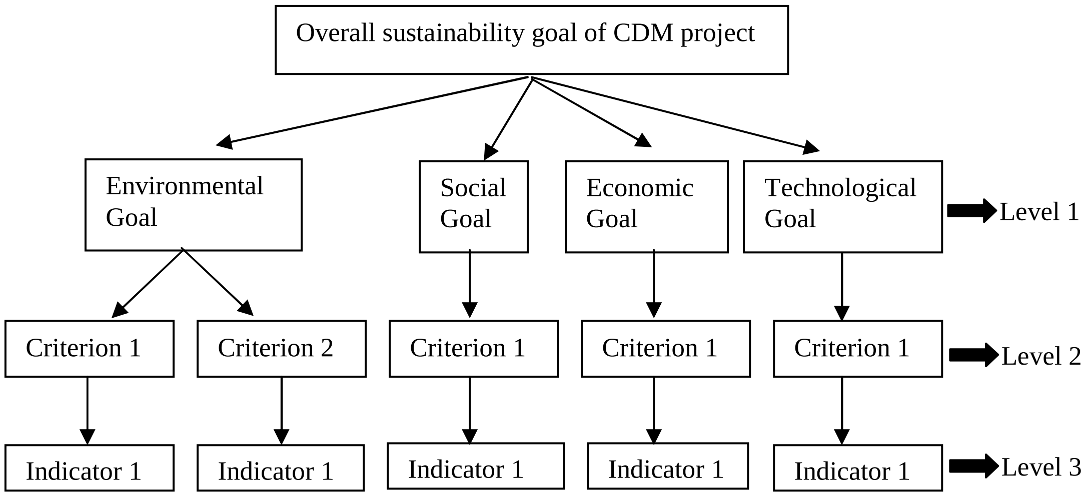

Figure 5.1: The structure of the well defined sustainability criteria

The SD criteria for CDM project should create a linkage between CDM projects and national objectives of SD. There are synergies between CDM projects and national SD objective. If the CDM project can contribute to SD at project level, it will also have a positive impact on SD at the national level. Finally, the United Nations gives examples of potential SD indicators for assessing CDM projects. These SD criteria must encompass the three SD objectives, namely environmental, economic, and social objectives. The SD criteria and indicators suggested by the UN can be concluded as follows (Olhoff *et al*. [83]):

5.2.1 Environmental Criteria

Environmental sustainability (or ecological sustainability) represent the use of natural resources within the earth’s environmental limits and the creation of pollutions and wastes without passing the biodegradation limits of receiving system (Lozano [68]). Environmental sustainability focuses on the natural environment, ecosystem, and environmental preservation. Influenced by a view that natural resources are being used up faster than nature’s ability to replenish. This dimension calls for management of natural resources in such a way that natural productivity is increased and basic human needs are met. We can assess environmental sustainability by using environmental criteria. Environmental criteria for CDM projects suggested by the UN can be shown in Table 5.1.

Criteria	Project level indicator	Measurement standard of indicator
Climate change	GHG emissions	GHG emissions
Air pollution	Local air pollution, particulates	Emissions of SO2, NOx, and particulates
	Environmental health benefits	Monetary value of environmental health benefits
Soil	Exposure to pollutants	Emission in physical units Damages in physical and monetary units
Water	Rivers, lakes, irrigation, drinking water	Emission in physical units Damages in physical and monetary units
Waste	Waste discharge and disposal	Emission in physical units Damages in physical and monetary units
Exhaustible resources	Fossil fuels	The use of fossil fuels (physical units)
Biodiversity	Specific species	Number, monetary values

Table 5.1: Environmental criteria suggested by the UN; (source: Olhoff *et al*. [83])

5.2.2 Economic Criteria

Under the concept of sustainable economic development, economic growth will be sustainable if it can concurrently improve both the quality of life and the quality of environment. For achieving sustainable economic development, the economy will produce maximum outputs with minimum inputs, but in a manner that will not change the stock and quality of natural resources over the time (Overton [86]). Moreover, natural resources should be used up less than or equal to the nature's ability to replenish for achieving sustainable economic development. We can assess economic sustainability by using economic criteria. Economic criteria for CDM projects suggested by the UN can be shown in Table 5.2.

Criteria	Project level indicator	Measurement standard of indicator
Growth	Income generation	Net surplus of income
Employment	Employment	Number of man-years created or lost
Cost effectiveness	Net costs and financial flows	Financial costs and social costs
Investments	Activity in energy sector, industry, agriculture etc.	Foreign exchange requirement ($ and share of investment)
Sectoral development	Technology access and market creation	Physical measures like energy demand and supply, economic measures, energy efficiency and affordability, and energy security
Technological change	Innovation and learning	Number of technology, price of technologies and maintenance, and cost development over time

Table 5.2: Economic criteria suggested by the UN; (source: Olhoff *et al*. [83])

5.2.3 Social Criteria

Social sustainability represents social development that helps people to equitably meet their basic needs without exploiting natural resources more than the nature's ability to replenish. This dimension focuses on meeting people's basic needs, and social equity. Social equity is another basic need right for humans. Within the concept of sustainable social development, social equity represent enabling people to share in environmental, economic, and social benefits; to share damages and costs; and to share governance. We can assess social sustainability by using social criteria. Social criteria for CDM projects suggested by the UN can be shown in Table 5.3.

Criteria	Project level indicator	Measurement standard of indicator
Equity	Distribution of costs and benefits, income distribution, and local participation	Costs and benefits in economic units related to stakeholders, income segments, gender, geographical area etc., income generation adjusted with distributional weights, and Gini coefficient
Legal framework	Regulation and property rights	Physical regulation standards, tax value and revenue, and land area distribution
Governance	Implementation of international agreements, enforcement	Costs of administrating and enforcing agreements and project management, and number of infringements and sanctions
Information sharing	Institutions, markets, formal and informal networks	New institutions created, number of institutional units participating in policy implementation (companies, households, public sector, NGOs, individuals)
Education	Literacy rates, primary and secondary education, and training	Literacy rates, enrolment rates, energy for education, time savings from reduced fuelwood collection used for education, changes in years of training
Health	Life expectancy, infant mortality, major diseases, nutrition	Epidemics, nutrition, energy for clinics, number of sick days
Poverty alleviation	Income or capabilities created for poor people	Change in the number of people below poverty limit, income created to poor people, energy services provided to poor people (energy units)

Table 5.3: Social criteria suggested by the UN; (source: Olhoff *et al*. [83])

5.3 An Example of CDM Sustainability Criteria Used by Asia-Pacific Countries

This topic will review recent CDM sustainability criteria used by non-Annex I countries. We have selected Asia-Pacific countries as a case study. Consequently, this study covers a total of nineteen non-Annex I countries[1]. Clearly, we can divide these countries into two groups: (i) countries with CDM sustainability criteria; and (ii) countries with no specific sustainability criteria.

5.3.1 Countries with No Specific Sustainability Criteria

We found that 7 out of 19 non-Annex I countries in the region do not have specific CDM sustainability criteria These countries are China, Bhutan, Fiji, Mongolia, Nepal, Papua New Guinea, and South Korea. Mostly these countries use their existing national SD agenda to assess CDM projects. However, these national SD agenda are generally too vague to provide effective guidelines for assessment. Although China has the largest number of registered CDM projects in the world, it still does not have specific CDM sustainability criteria for assessing projects. However, China has identified priority areas for CDM project implementation. Article 4 of 'Measures for Operation and Management of Clean Development Mechanism Projects in China', states that "*The priority areas for CDM projects in China are energy efficiency improvement, development and utilization of new and renewable energy, and methane recovery and utilization.*" Importantly, China is the only nation to impose different tax levels on CDM projects with different perceived sustainability benefits (Muller [75]). China applies three tax levels on CER transfers: (i) 65% for HFCs and PFCs projects; (ii) 30% for N_2O projects; (iii) 2% for CDM projects in priority areas defined in Article 4 and forestation projects. Consequently, China prefers using the priority areas and several tax levels for assessing CDM projects rather than specific sustainability criteria. South Korea also does not have specific sustainability criteria for assessing CDM projects despite hosting the 8th largest number of registered CDM projects in the world.

[1] Non-Annex I countries in Asia-Pacific region are Bangladesh, Bhutan, Cambodia, China, Fiji, India, Indonesia, Lao PDR, Malaysia, Mongolia, Nepal, Pakistan, Papua New Guinea, Philippines, Singapore, South Korea, Sri Lanka,Thailand, Vietnam.

5.3.2 Countries with CDM Sustainability Criteria

We found that only 12 countries have their own specific SD criteria for assessing CDM projects (see Table 5.4). The criteria used by these countries clearly show what benefits these countries expect to gain from CDM projects. Therefore, it is very easy for investors and project developers to understand national preferences. In this group, Cambodia has the largest number of sustainability criteria (25 criteria), followed by Thailand (24 criteria). These criteria focus on environmental aspects. Cambodia, Indonesia, Lao PDR, Malaysia, and Thailand have developed criteria applicable for specific types of CDM project. For example, expanding rural electricity coverage is one of Malaysia's special criteria applicable for assessing energy projects (CDM Malaysia [14]). Malaysia and Thailand allow projects to have a negative rating for any single sustainability criterion, provided the overall score of the project is positive. This implies a cost/benefit decision criteria (i.e. negative outcomes allowed provide thet are outweighed by benefits and consequently a *weak* interpretation of SD. On the other hand, Cambodia and Indonesia do not allow negative ratings for any criteria. The Cambodian DNA Assessment Procedures state that "*The absence of negative impacts for each criterion is considered to be the minimum threshold with which project proponents must comply*" [12]. This implies a much *stronger* interpretation of SD and implies Praeto efficiency as the driver of decision making (i.e. no negative outcomes).

Country	Assessment method	Number of goals	Number of criteria	Number of indicators	Scaling	Permission on at least one negative impact	Specific criteria for approval
Bangladesh	Multi-Criteria	4	10	10	+2 to -2	Not yet addressed	No
Cambodia	Checklists	4	25	25	No	No	Special Criteria for energy projects
Indonesia	Checklists	4	6	17	No	No	Special Criteria for many sectors
Malaysia	Checklists	3	8	13	No	Yes	Special Criteria for energy and forestry projects
Thailand	Multi-Criteria	4	24	26	+3 to -1	Yes	Special Criteria for monitorin g projects
Vietnam	Checklists	3	9	17	No	Not yet addressed	No
India	Checklists	4	9	No	No	Not yet addressed	No
Lao PDR	Checklists	4	19	No	No	Not yet addressed	Special Criteria for energy projects
Pakistan	Checklists	4	13	No	No	Not yet addressed	No
Philippines	Checklists	3	10	Depend on project developer	No	Not yet addressed	No
Singapore	Checklists	3	5	No	No	Not yet addressed	No
Sri Lanka	Checklists	3	10	No	No	Not yet addressed	No

Table 5.4: Countries with CDM sustainability criteria; (source: Data from each host country DNA website, status March, 2009)

SD criteria for assessing CDM projects are categorized into four groups: environmental, economic, social, and technological sustainability. However 5 of the 12 countries listed in Table 5.5 combine technological and economic criteria.

Country	Environmental Criteria		Social Criteria		Economic Criteria		Technological Criteria		Total
	Number	%	Number	%	Number	%	Number	%	
Bangladesh	2	20	3	30	3	30	2	20	10
Cambodia	11	44	8	32	4	16	2	8	25
India	4	45	3	33	1	11	1	11	9
Indonesia	7	41	3	18	4	23	3	18	17
Lao PDR	7	37	7	37	3	16	2	10	19
Malaysia	8	62	2	15	3	23	0	0	13
Pakistan	2	15	6	47	3	23	2	15	13
Philippines	3	30	3	30	4	40	0	0	10
Singapore	2	40	1	20	2	40	0	0	5
Sri Lanka	4	40	3	30	3	30	0	0	10
Thailand	15	57	3	12	5	19	3	12	26
Vietnam	7	41	6	35	4	24	0	0	17

Table 5.5: The structure of sustainability criteria; (source: Data from each host country DNA website, status March, 2009)

When we consider the structure of SD criteria used by Asia-Pacific countries, we find strong focus on environmental aspect (see Table 5.5). This would suggest a *strong* interpretation of SD, according to Dobson's typology (Dobson [21]), with the environment being prioritized over human needs. For example, environmental criteria account for 41% of India's SD criteria. Most Asia-Pacific countries tend approach this issue from similar perspectives and have similar sets of criteria for assessing CDM projects. The four groups of SD criteria can be described as follows:

(i) Environmental criteria:

Thailand has the largest number of environmental criteria (15), followed by Cambodia (11), and Malaysia (8). These three countries have the well defined environmental criteria ensuring the environmental sustainability of CDM projects. Bangladesh, Pakistan, and Singapore have the smallest number of environmental criteria (2 each). The environmental criteria created by these three countries are so broad that they are difficult to apply these criteria at project level. Table 5.6 illustrates, the top seven most widely used environmental criteria for assessing CDM project in the Asia-Pacific region.

Environmental Criterion	Countries
Reduction of GHGs	Bangladesh, Cambodia, Malaysia, Pakistan, Singapore, Thailand, and Vietnam
Biodiversity conservation	Cambodia, India, Indonesia, Lao PDR, Malaysia, Thailand, and Vietnam
Reduction in air pollution	Cambodia, Lao PDR, Malaysia, Thailand, and Vietnam
Reduction in water pollution	Cambodia, Lao PDR, Malaysia, Thailand, and Vietnam
Sustainable use of natural resources	Cambodia, India, Indonesia, Lao PDR, and Philippines
Reduction in soil pollution	Cambodia, Lao PDR, Malaysia, and Thailand
Reduction of pollutants	Bangladesh, India, Indonesia, and Philippines

Table 5.6: The top seven most widely used environmental criteria in Asia-Pacific region; (source: Data from each host country DNA website, status March, 2009)

Other important environmental criteria used by Asia-Pacific countries include protection of archaeological, cultural, historical and spiritual heritage and sites; reduction in noise pollution; impact on human health; and waste management. Reduction of GHGs and biodiversity conservation are the most widely used environmental criteria in the region used by 7 Asia-Pacific countries. The second most widely used environmental criteria are reduction in air pollution, reduction in water pollution, and sustainable use of natural resources each used by 5 Asia-Pacific countries. We can see that most Asia-Pacific countries tend to have similar environmental criteria for assessing the environmental sustainability of CDM projects.

(ii) Social criteria

Cambodia has the largest number of social criteria (8), followed by Lao PDR (7 criteria), Pakistan (6), and Vietnam (6). The five most widely used social criteria for assessing CDM projects are: creation of employment; poverty alleviation; improvement in quality of life; stakeholder consultation; and gender equity (see Table 5.7). Used by 7 countries, the creation of employment and poverty alleviation are the most widely used social criteria. 'Improvement in quality of life' is the second most widely used social criterion, which is used by 6 countries. Other important social criteria include: impact on public health; social equity; provision of community infrastructures; and equity in accessing the community benefits. Like environmental criteria, most Asia-Pacific countries tend to have similar social criteria for assessing the social sustainability of CDM projects

Social Criterion	Countries
Creation of employment	Bangladesh, Cambodia, India, Lao PDR, Pakistan, Singapore, and Vietnam
Poverty alleviation	Cambodia, India, , Lao PDR, Malaysia, Pakistan, Sri Lanka, and Vietnam
Improvement in quality of life	Bangladesh, India, Malaysia, Singapore, Sri Lanka, and Vietnam
Stakeholder consultation	Cambodia, Indonesia, Lao PDR, Philippines, and Thailand
Gender equity	Bangladesh, Cambodia, Lao PDR, and Pakistan

Table 5.7: The top five most widely used social criteria in Asia-Pacific region; (source: Data from each host country DNA website, status March, 2009)

(iii)Economic criteria

Unlike environmental, social, and technological criteria, most Asia-Pacific countries create their own economic criteria in the different perspective. Therefore, it may be difficult to standardize economic criteria applied to all non-Annex I countries. Thailand is responsible for the largest number of economic criteria with 5. The five most widely used economic criteria are: impact on balance of payments; reduced dependence on fossil fuels; cost effectiveness; reduced dependence on imported energy; and share of project budget spent in country (see Table 5.8). Impact on balance of payments is the most widely used economic criteria in the region. However, this criterion is used by only 4 countries for assessing economic sustainability.

Economic Criterion	Countries
Impact on balance of payments	Bangladesh, Pakistan, Sri Lanka, and Vietnam
Reduced dependence on fossil fuels or increased use of renewable energy	Cambodia, Lao PDR, and Thailand
Cost effectiveness	Bangladesh, and Pakistan
Reduced dependence on imported energy	Cambodia, and Lao PDR
Share of project budget spent in country	Cambodia, and Lao PDR

Table 5.8: The top five most widely used economic criteria in Asia-Pacific region; (source: Data from each host country DNA website, status March, 2009)

(iv) Technological criteria

Technological criteria are created to assess technological sustainability of CDM projects. In this context a CDM project can be deemed beneficial it results in:

- technology transfers that are environmentally safe, efficient, and the best available; and
- capacity building through education and training.

Malaysia, Philippines, Singapore, Sri Lanka, and Vietnam combine technological and economic criteria. In each country, the technological criteria account for the smallest proportion of SD criteria (See Table 5.5). For example, technological criteria account for only 8% of Cambodia’s total number of SD criteria. Used by 7 countries, the transfer of appropriate and best available technology is the most widely used technological criterion (See Table 5.9). According to 3 options for defining technical additionality discussed in Chapter 4, most Asia-Pacific countries use Option 1 for defining technical additionality. Like environmental and social criteria, most Asia-Pacific countries tend to have similar technological criteria for assessing the sustainability of CDM projects.

Technological Criterion	Countries
Transfer of appropriate and best available technology	Cambodia, Indonesia, Lao PDR, Pakistan, Sri Lanka, Thailand, and Vietnam
Transfer of skills or capacity building	Cambodia, Indonesia, Lao PDR, Pakistan, Singapore, and Thailand
Transfer of environmentally safe, sound, and efficient technology	India, Malaysia, Philippines, Singapore, and Thailand

Table 5.9: The top three most widely used technological criteria in Asia-Pacific region; (Source: Data from each host country DNA website, status March, 2009)

5.3.3 Summary of SD Criteria

Currently, most Asia-Pacific countries tend to have similar environmental, social, and technological criteria for assessing CDM projects. The most widely used SD criteria are reduction of GHGs; biodiversity conservation; creation of employment; poverty alleviation; quality of life; transfer of appropriate and best available technology; and capacity building. However, none of these seven fall into economic category (see Figure 5.2).

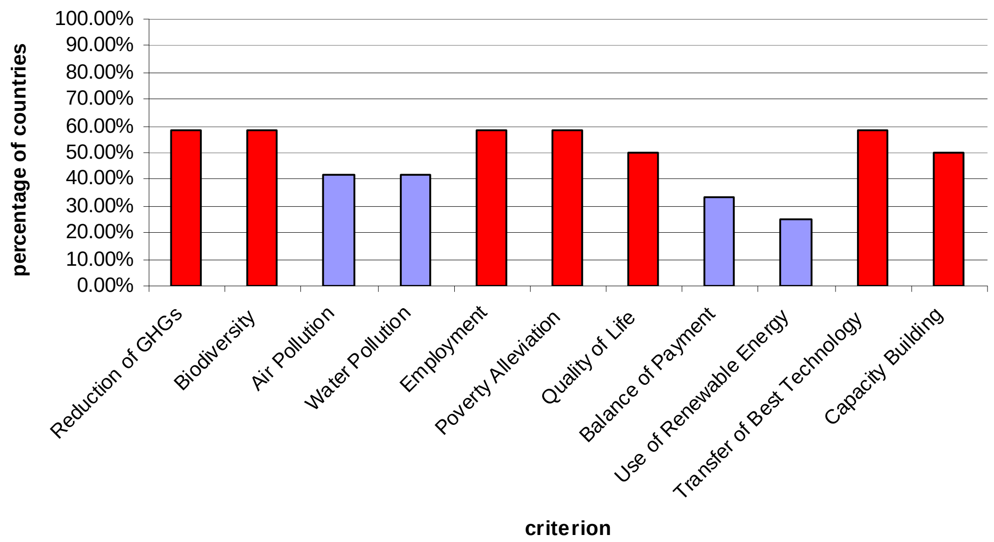

Figure 5.2: The SD Criteria used by countries with their own SD criteria; (source: Data from each host country DNA website, status March, 2009, and author's calculations)

Indonesia is the only one country which creates SD criteria focusing on local impacts of CDM project. Indonesia design environmental, economic, and social criteria for measuring local benefits of CDM project [48]. Only technological criteria are designed to measure national benefits.

Singapore has the smallest number of SD criteria (5 criteria). This is insufficient to measure a CDM project's overall impacts on SD. Most importantly, Singapore's economic criteria concern only technological issues (technology transfer, capacity building, and efficient technology) [102]. Technological issues on their own are not sufficient to measure the overall economic benefits. Singapore's economic criteria lack the main economic issues such as impact on balance of payment, national income generation, and share of project budget spent in country.

Although these 12 Asia-Pacific countries have their own specific SD criteria, they are still not finalized and are under constant revision. For example, Thailand's SD indicators are both quantitative and qualitative. However Thailand is planning to eliminate qualitative indicators and use only quantitative indicators to assess future CDM projects.[2] Using CDM projects to 'increasing the green area' is one example of Thailand's qualitative indicators [113]. The objective of this criterion is to grow more

2 Personal Communication with Dr. Chaiwat Muncharoen, Deputy Executive Director of Thailand Greenhouse Gas Management

trees in the area of CDM projects. However, Thai DNA does not decide what kinds of trees should be planted. It is very difficult for Thailand to interpret how the CDM project can increase green area. Consequently Thailand is planning eliminate this indicator from its environmental criteria.

5.4 Methodologies for assessing the sustainability of CDM projects

Although there are many methods for assessing CDM project's contribution to SD, only two methods are the most commonly used (Olsen and Fenhann [85]). These methods are:

5.4.1 Checklists

Checklists are the most commonly used for assessing CDM projects. 10 Asia-Pacific countries use checklists (see Table 5.4). This method is a descriptive approach. The committee appointed by the DNA creates the national sustainability criteria which must be met in order to certify its contribution to SD. The sustainability assessment is done by the DNA or both the DNA and the project developer. The evaluator must provide a detailed description of the impact of CDM projects on each sustainability criterion. Moreover, an explanation must be given of the additionallity created by the project comparing conditions after the implementation of the project with a no-project baseline condition. Supporting data for justification can be quantitative and qualitative. This method has two strengths: (i) this approach is simple and quick, and (ii) it allows the inclusion of both qualitative and quantitative data. The main difficulty is assessing sustainability criteria which require qualitative data, and then achieve consistency in decision making. Checklists created by Singapore can be shown in Table 5.10.

Criterion	Description
Environmental sustainability	• Project meets Singapore's Environmental Protection requirements, standards and regulations • Project produces real and measurable reductions in greenhouse gas
Economic sustainability	• Project utilizes more efficient (energy efficient, resource efficient) technology than common industrial practice • Project results in technology transfer and/or capacity building in GHG emission reduction technologies
Social Sustainability	• Project helps to improve quality of life by creating opportunities for jobs, job enhancement, etc

Table 5.10: Singapore's sustainable development criteria; (source: [102])

5.4.2 Multi-criteria Analysis (MCA)

Olsen and Fenhann [85] state that "*few host countries and few investors actually make use of the multi-criteria assessment methodologies*". In Asia-Pacific region only Bangladesh and Thailand use Multi-criteria Analysis (MCA) (see Table 5.4). MCA is used to measure the performance of various criteria. These criteria are translated into SD indicators (quantitative or qualitative) which are measured relative to a baseline. Each of these indicators is given a negative or positive score representing the negative impact or positive impacts of the CDM project. Bangladesh's SD indicators are scored between -2 to +2, whereas Thailand's SD indicators are scored between -1 to +3. The CDM project will be approved if the aggregate value of all scores is positive. However, some countries do not allow the project to have a negative rating for any SD indicator. MCA methodologies include various specific approaches such as Multi-Attributive Utility Theory (MAUT), The Gold Standard, South South North (SSN) SD tool, etc. Generally, this methodology has six steps:

i) Identifying the SD criteria.

ii) Translating the SD criteria into SD indicators.

iii) Weighting the criteria to reflect relative importance to the decision (Some countries do not weight the criteria, so these countries will skip this step).

iv) Assessing and scoring each SD indicator.

v) Combining weights and scores to get the overall value of sustainability.

vi) Examine results.

Multicriteria analysis appeared in the 1960s as a decision-making tool. The method is designed to help decision-makers to integrate the different options, reflecting the opinions of the actors concerned, into a prospective or retrospective framework Strager and Rosenberger [107]. Participation of the decision-makers in the process is a central part of the approach. Multi-Attributive Utility Theory (MAUT) is a well-known example of MCA methodology. MAUT is frequently used in economics as a tool for decision making. Both quantitative and qualitative can be used in this methodology for measuring different dimensions of a project. Christoph Sutter applies MAUT to assess the sustainability of the CDM project (Sutter [108]). According to this approach, the SD indicators are measured in the unit of utility. This methodology measures the utility of each SD indicator, and then combines the utility of each SD indicator into an overall utility of the CDM project. Generally, MAUT has five steps:

I. Identification of sustainability criteria: The overall goal of SD will be divided into criteria. Sutter [108] divided SD goals of the South African and Indian into 12 criteria within 3 sub-goals of SD. These 3 sub-goals of SD are environmental development, social development, and economic development. The 12 criteria used in the South African and Indian cases can be shown in Figure 5.3.

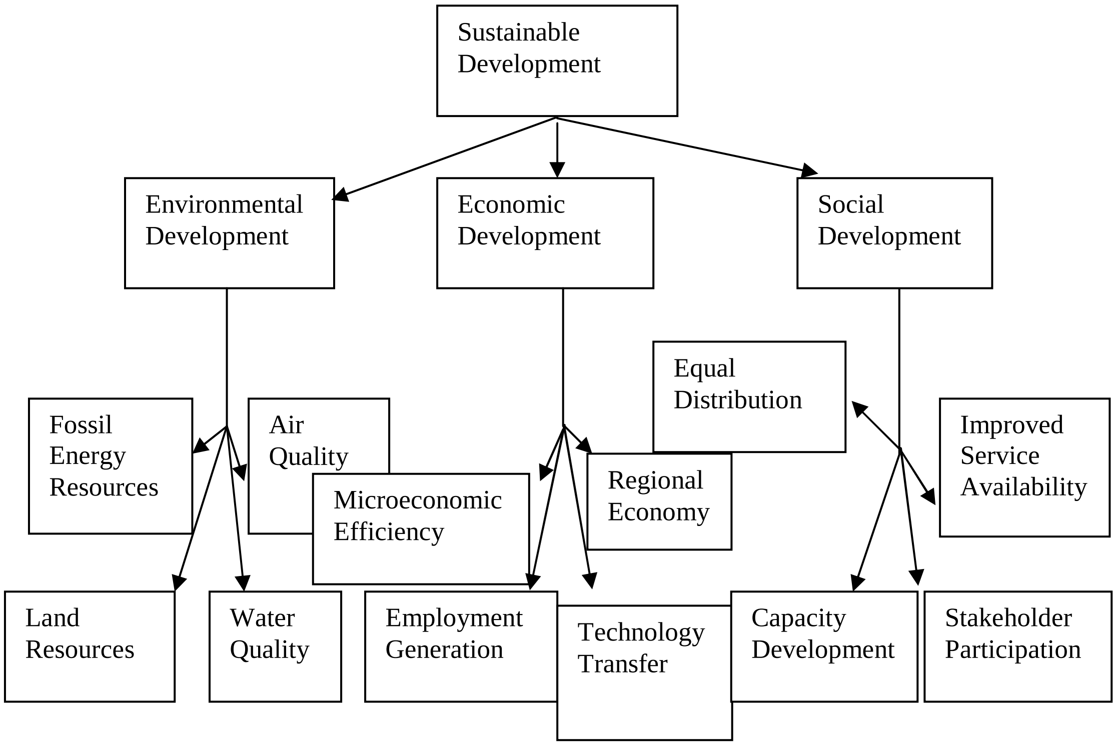

Figure 5.3: The 3 sub-goals of sustainable development and the 12 SD criteria are used in the South African and Indian cases; (source: Sutter [108])

II. Defining SD indicators: Each sustainability criteria must be translated into a set of SD indicators. These indicators are either qualitative or quantitative, and will be applied at the project level. These indicators are measured in the unit of utility. Thus, the evaluator must develop utility function for each SD indicator in order to measure the single utility of each indicator. A single utility value of each indicator ranges from -1 (minimum) to +1 (maximum). The sustainability criteria and SD indicators designed for assessing the CDM projects in the South African and Indian are shown in the Table 5.11 below.

Sub-goal	SD Criteria	Classification	Indicator
Environmental Development	Fossil Energy Resources	Quantitative	MWh coal saved/ GHG reduction
	Land Resources	Semi-quantitative	Change relative to baseline
	Air Quality	Semi-quantitative	Change relative to baseline
	Water Quality	Semi-quantitative	Change relative to baseline
Economic Development	Microeconomic Efficiency	Quantitative	Internal Rate of Return (IRR)
	Regional Economy	Semi-quantitative	Economic performance of project location
	Technology Transfer	Qualitative	Qualitative indicator with descriptive five-step scale
	Employment Generation	Quantitative	Additional man-month per GHG reduction
Social Development	Stakeholder Participation	Qualitative	Qualitative indicator with descriptive five-step scale
	Improved Service Availability	Semi-quantitative	Change in availability of services compared to baseline
	Capacity Development	Qualitative	Qualitative indicator with descriptive five-step scale
	Equal Distribution of Project Return	Quantitative	Share of turnover benefiting people below poverty line

Table 5.11: The sustainability criteria and SD indicators designed for assessing the CDM projects in the South African and Indian; (source: Sutter [108])

III. Weighting the SD indicators: The SD indicators must be weighted for reflecting their relative importance. The weighted SD indicators represent the sustainability preferences of an individual or a group. The SD indicators are weighted by the stakeholders. Table 5.12 show results of the criteria weighting done by participants in India

SD Criteria	Result of the criteria weighting
Fossil Energy Resources	5.7%
Land Resources	7.6%
Air Quality	7.7%
Water Quality	9.6%
Microeconomic Efficiency	6.7%
Regional Economy	7.6%
Technology Transfer	8.5%
Employment Generation	11.3%
Stakeholder Participation	7.4%
Improved Service Availability	10.8%
Capacity Development	10.0%
Equal Distribution of Project Return	7.1%
Total	100.00%

Table 5.12: Results of the criteria weighting done by participants in India; (source: Sutter [108])

IV. Assessing each SD indicator: Each SD indicator must be assessed. Then, MAUT will use utility function to convert the assessment result to a single utility value of each indicator.

V. Calculating an overall utility of the CDM project: The weights (from step 3) are used to combine the single utilities of indicators into an overall utility of the CDM project. An overall utility of the CDM project is calculated by using the following equation:

$$U = \sum_{i=1}^{n} Ui * Wi$$

where

U = overall utility

Ui = single utility of criterion i

Wi = weighting of criterion i

Finally, an overall utility of the CDM project represent how much the CDM project contribute to the local SD. An overall utility of the CDM project ranges from -1 (minimum) to +1 (maximum). A positive overall utility means the CDM project has positive impact on the local SD. On the other hand, a negative overall utility means the CDM project has negative impact on the local SD.

MCA has three strengths. Firstly, the stakeholders can decide and/or weight the SD criteria used for the sustainability assessment, so MCA can really reflect the preferences of the stakeholders. Secondly, MCA use a designated scoring value as a unit of measurement for the SD assessment, which improves transparency. The last strength is that it can provide measurement capabilities for both qualitative and quantitative data. The weakness of multi-criteria analysis is its reliance on arbitrary judgments about the criteria (Wattage and Mardle [138]). Both the choice of criteria to be included and the relative weight given to each criterion can bias the final result. Furthermore, the technique may help to reach a compromise or define a coalition of views, but it does not dictate the individual or collective judgement of the partners (Sato [99]). Moreover, there is a tendency for stakeholders to include a large number of highly complex criteria which are difficult to determine (Sutter [108]). Finally, there is no consistent procedure for the weighting of criteria a process which itself can be qualitative and is ultimately open to institutional capture.

5.5 The Problem of CDM's Contribution to Sustainable Development

Although the number of CDM projects is increasing (see section 6.2.1), the CDM's contribution to SD is being questioned. There are many researchers trying to examine the CDM's contribution to SD. The balance of opinion is that that CDM does not significantly contribute to SD (see Burian [10], Kolshus et al. [59], Michaelowa [74], Nussbaumer [80], Olsen [84], Olsen and Fenhann [85], Schneider [101], Sutter and Parreno [109]). CDM projects may fail to achieve SD objective because of the two fundamental problems: (1) a conflict between the twin objectives of CDM projects (sustainability and carbon reduction); and (2) the lack of consistency in the fulfillment of host countries' duties to assess CDM projects for sustainability. These problems are discussed below.:

5.5.1 A Conflict between the Twin Objectives of CDM Projects

Each ton of GHG emission reduction is given a monetary value through the CERs, but the CDM's contribution to SD is not given a similar monetary value. The missing value of SD benefit has resulted in a trade-off between the CDM target of supplying cheap emission credits and the promotion of SD making projects with high SD obligations unattractive to investors. On the other hand, the monetary value placed upon carbon reductions encourages investment in CDM projects which deliver large volumes of CERs. There is a widespread perception that projects that deliver large volumes of CERs cannot deliver other SD benefits. In particular, industrial gas projects (HFCs, N_2O, PFCs) can generate high CER volumes, but cannot create many jobs or contribute directly to community development. Erion [26] described these industrial gas projects as *" low hanging fruit"*

Kolshus et al. [59] conducted a research to investigate whether the two objectives of CDM project can be achieved simultaneously by analyzing two case studies from Brazil and China. They developed a set of indicators to evaluate non-carbon benefits of CDM project candidates on the environment, development, and equity. Finally, they found that a high cost per ton of carbon dioxide abated was linked to a high score on sustainability indicators, whereas a low abatement cost per ton of carbon dioxide was linked to a low score on sustainability indicators. These findings indicated that there was a conflict between fulfilling cost-effective criteria and achieving sustainability criteria.

Schneider [101] has divided CDM project into three different types (categories A, B, and C) according to the impact of CER revenues on the IRR. Category A projects does not generate revenue beyond the CER revenue, so this category largely depends on the CER revenue. These projects include HFC, N2O, flaring of landfill gas projects, etc. Category B projects generate revenues other than the CER's, but the CER revenue has considerable impact on the IRR. These projects include coal bed/mine methane, power generation from landfill gas, etc. Schneider found that mostly projects in categories A and B are likely to be additional, but these projects have few SD benefits. On the other hand, Project category C creates other revenues that by far outweigh the CER revenue. The impact of CER revenue on the IRR is very low (ranging from 0.5% to 2%). This project includes renewable energy generation (except biomass), the construction of new natural gas power plants, energy efficiency in industry, etc. Schneider found that mostly projects in categories C are unlikely to be additional, but these projects have high SD benefits. Finally, these findings lead to the conclusion that there is a clear trade-off between additionality and SD benefits. For example, projects without any benefits other than CERs often have few SD benefits, but they are likely to be additional.

More recently, Olsen and Fenhann [85] conducted the sustainability assessment based on text analysis of the PDDs. They set 13 SD criteria for analyzing the expected SD benefits described in the 744 PDDs (744 CDM projects). They tried to count the number of SD benefits each CDM project has by matching each SD benefits described in its PDD with one of the 13 SD criteria. They found that HFC and N2O projects have the least SD benefits, compared to other types of CDM project. N2O projects have on average only one benefit per project and HFC projects have 1.8 benefits per project, whereas renewable energy projects have 3.2 benefits per project. Moreover, small-scale projects were found to have a higher average number of SD benefits than large-scale projects. Finally, Olsen and Fenhann arrived at the conclusion that a significant conflict exist between the twin objectives of CDM projects.

Consequently, the results of these three studies clearly showed that the twin objectives of the CDM are not being achieved simultaneously. If this is the case it ultimately means that CDM projects may fail to achieve SD objective under the existing implementation and audit regime.

5.5.2 A Lack of Consistency in the Application of the Host Countries' Duties to Ensure the Sustainability of CDM Projects

According to Sutter [108], an assessment of the sustainability of the CDM project represents an ill-defined problem. This is because the concept of SD defined in the Kyoto Protocol is vague. Different countries have different views on the concept of SD. Host countries develop their own SD criteria for assessing CDM projects. However, there are no common international standards for the host country approval processes and the development of SD criteria. In contrast to GHG emissions, whose assessment and monitoring are standardized, the SD criteria for approval of projects are not clearly defined. Several studies have now concluded that the SD objectives of CDM project are not clearly interpreted by many host countries (Brown *et al*. [8], Schneider [101], Sterk *et al*. [105]). Consequently, the host countries' duties to assess the SD benefits of CDM projects are inconsistently applied and SD criteria vary widely.

There were two main reasons to assign this duty to host country. Firstly, it can be argued that the SD principles and criteria should be country specific, the justification being that each country has its own specific national circumstances and development priorities (UNDP [122]). Secondly, many countries have their own well developed principles of SD which could in theory be simply applied to CDM assessment. There are advantages and disadvantages to host country assessment of CDM sustainability. One advantage is that it gives an opportunity for host countries to build linkages between national SD policies and CDM projects. On the other hand, assigning host countries the responsibility of assessing CDM projects creates an incentive to set low sustainability standards in order to attract CDM investments (Sutter [108]). If countries have relatively strict SD criteria, this will lower their CDM market share, as the developers will choose to run projects with low SD benefits in other countries (Schneider [101]). Ultimately, the low sustainability standards can lead to "*a race to the bottom*" in terms of SD standards (Sutter [108]). The second disadvantage is that some the poorest host countries, who stand to gain most from the CDM, have inadequate capacity and resources to assess the sustainability of projects.

An assessment of rejected projects by host country might provide an indication of how rigorously SD criteria are being applied. However, it is very difficult to find information on rejected projects by host country (UNDP [122]). Normally, information on rejected projects is not made public. Consequently, it cannot be observed that host countries prioritize projects with high SD benefits by rejecting projects with low SD benefits (Schneider [101]). According to Burian [10], the results of a survey at Carbon Expo 2005 showed that the reasons to reject projects by host countries include projects' negative impacts on environment, major stakeholder conflicts, and badly elaborated PDDs. This limited analysis of rejected projects suggests that SD benefits are given a low weighting in the decision-making process (UNDP [122]).

The question of whether host country can ensure the sustainability of CDM projects is open to debate. Erion [26] goes as far as to suggest that even if host countries have their own SD criteria for assessing CDM projects, host countries may ignore some SD criteria for assessing CDM projects. This is because they try to attract CDM investments. Burian [10] found that several projects with negative ecological or social impacts have been approved by host country DNAs. These results implied that host countries cannot guarantee the SD benefits of CDM projects. Finally, this make the CDM fail to achieve SD objective.

5.6 CDM Sustainability Labels: Paving the Way to Sustainability Path

As previously discussed, the CDM is facing the two fundamental problems. In order to solve this problem, the two prominent concepts: the use of preferential tax rates levied on projects with significant expected sustainability benefits or a CDM sustainability label. China is the first nation which imposes several tax levels on CDM projects with different expected sustainability benefits. According to different sustainability performances of CDM projects, China set three tax levels applied for CDM projects. For the first level, the Government of China takes 65% CER transfer benefit from HFC and PFC projects. For the second level, the Government of China takes 30% CER transfer benefit from N2O project. For the last level, Government of China takes 2% CER transfer benefit from renewable energy and forestation projects. However, revenues of this tax are earmarked for further climate policy projects, not general development activities (Michaelowa [74]; Curtius and Vorlaufer [18]). Consequently, the current tax levied on expected sustainability benefits is not sufficient to guarantee the project's contribution to sustainable development. Moreover, tax proposals usually face considerable opposition and an implementation in the CDM might not be politically visible on a global level (Muller [75]).

CDM sustainability labeling is another option for solving the problem of the CDM's inability to achieve SD. CDM sustainability labeling was first addressed in the literature by Muller [75]. Sustainability labels provide their own independent standards to assess the sustainability of CDM projects. Projects with CDM sustainability labels must pass both the sustainability test set by the host country and the test set by CDM sustainability labels, while non-labelled project need only pass sustainability test set by the host country. One may view the test set by CDM sustainability labels as an additional guarantee of SD benefits. The intention of CDM sustainability labels is to provide simple, clear, and reliable information on sustainability aspect of CDM projects to CER buyers who cannot themselves verify the project's contribution to SD (Muller, [75]). There are now several CDM sustainability labels including the Gold Standard, the Climate, Community, and Biodiversity Alliance Standard (CCB Standards), the Community Development Carbon Fund (CDCF), and the MDG Carbon Facility (Nussbaumer [80]). We will investigate the sustainability test set by CDM sustainability labels through a case study of the Gold Standard (GS) label in the next topic.

Since projects with sustainability labels are likely to be more costly than non-labelled projects, there is a question whether labelled projects can really outperform non-labelled projects in terms of SD profile. Ultimately, this question is answered by Nussbaumer [80]. Nussbaumer apply a multi-criteria methodology to evaluate how labelled projects perform with respect to sustainability criteria in comparison to similar non-labelled projects. Nussbaumer comes to the conclusion that the SD profile of labelled projects tends to be better than similar non-labelled projects.

Consequently, CERs generated by the project with CDM sustainability label are accepted as the high quality CERs in terms of their SD benefits. The carbon market is segmented, the quality of CERs and buyers' consciousness of the SD (Grandpre [38]). According to Sutter, if CDM sustainability labels can attract a price premium, it will induce the project developers to develop projects with high SD. Consequently, a price premium for CERs is the key motivation for project developer to invest in CDM project with sustainability label. This will help the CDM to achieve its SD objective. However, the willingness to pay a price premium for CERs with CDM sustainability label is unclear.

5.7 An Example of CDM Sustainability Labels: The Gold Standard Label

The Gold Standard (GS) label is the first best practice benchmark for the CDM and JI projects. The GS label was developed as a tool for promoting emission reduction projects that simultaneously reduce greenhouse gases emission, promote sustainable development, and benefit local communities. This reflects the twin objectives of the CDM as defined in the Kyoto Protocol (Grandpre [38]). The GS is endorsed by 42 non-governmental organizations, including the World Wide Fund for Nature (WWF), SouthSouthNorth, and Greenpeace. According to Gold Standard [37], the GS itself is a project methodology, completely consistent with the CDM Executive Board's Project Design Document, providing assurance that CDM projects will achieve both twin objectives. The Gold Standard has three objectives:

I. To promote investments in energy technologies and management techniques reducing climate change effects.
II. To contribute to sustainable development.
III. To contribute towards a transition to non-fossil energy systems.

Not all CDM project types are eligible for the GS. The CDM project types eligible to the GS can be shown in Table 5.13.

Renewable energy:

- Photovoltaic
- Solar thermal (Electricity, Heat)
- Ecologically sound biomass, biogas and liquid biofuels (Electricity, Heat, Cogeneration, Transport)
- Wind
- Geothermal
- Small low-impact hydro, with a size limit of 15MW, complying with World Commission on Dams guidelines

End use energy efficiency improvement:

- Industrial energy efficiency
- Domestic energy efficiency
- Energy efficiency in the transport sector
- Energy efficiency in the public sector
- Energy efficiency in the agricultural sector
- Energy efficiency in the commercial sector

Table 5.13: The CDM project types eligible to the Gold Standard; (source: The Gold Standard Foundation [36])

To assess CDM projects the GS use the following methods: (1) the SD assessment matrix; (2) a stakeholder consultation; and (3) an Environmental Impact Assessment (EIA).

The SD assessment matrix includes three categories of SD indicators, namely local/regional/global environment, social sustainability and development, and economic and technological development, and has 12 items in total. The SD assessment matrix can be shown in Table 5.14.

Indicators	Score (-2 to 2)
Local/regional/global environment • Water quality and quantity	
• Air quality (emissions other than GHGs)	
• Other pollutants (including, where relevant, toxicity, radioactivity, POPs, stratospheric ozone layer depleting gases)	
• Soil condition (quality and quantity)	
• Biodiversity (species and habitat conservation)	
Sub total	
Social sustainability and development • Employment (including job quality, fulfillment of labor standards)	
• Livelihood of the poor (including poverty alleviation, distributional equity, and access to essential services)	
• Access to energy services	
• Human and institutional capacity (including empowerment, education, involvement, gender)	
Sub total	
Economic and technological development • Employment (numbers)	
• Balance of payments (sustainability)	
• Technological self reliance (including project replicability, hard currency liability, skills development, institutional capacity, technology transfer)	
Sub total	
Total	

Table 5.14: The sustainable development assessment matrix; (source: The Gold Standard Foundation [36])

For evaluating each indicator, the evaluator will use a five-value scale. A five-value scale range from +2 (maximum) to -2 (minimum), with a middle value at zero and two intermediate values (+1 and -1). The definition of a scoring system is shown in Table 5.15.

Score	Definition
+2	Major positive impacts
+1	Minor positive impacts
0	No, or negligible impacts, i.e. there is no impact or the impact is considered insignificant by stakeholders.
-1	Minor negative impacts, i.e. where there is a measurable impact but not one that is considered by stakeholders to mitigate against the implementation of the project activity or cause significant damage to ecological, social, and/or economic systems.
-2	Major negative, i.e. where there is significant damage to ecological, social, and/or economic systems that cannot be mitigated through preventive (not remedial) measures.

Table 5.15: The definition of a scoring system; (source: The Gold Standard Foundation [36])

The SD indicators must be measured relative to the baseline situation as described in the project documents. The SD assessment must be based on existing sources of information such as existing reports, results from stakeholder consultations, past experiences with similar project type, etc. For eligibility to the GS, the project must meet all the following requirements (The Gold Standard Foundation [36]):

- Each of the components must get a non-negative sub-total score.
- The project must get a positive total score.
- If one of the indicators has a score of -2, the project is not eligible for the Gold Standard.

The objective of stakeholder consultation is to ensure local acceptance of the project. Project developers must invite local stakeholders to two consultation meetings, one in the initial stages of project, and another one before validation (Gold Standard [37]). Finally, the GS requires an EIA if the stakeholders indicate significant environmental impacts.

Finally, the GS cannot be widely implemented because this methodology was designed for only renewable energy projects and end use energy efficiency improvement projects. Therefore, the GS is not suitable for other project types to implement.

5.8 Conclusions

This chapter investigates the concept of SD and the methods for assessing the sustainability of the CDM project. The first and the most widely quoted definition of SD was coined by the Brundtland Report. Later, the UNCED created the three dimensions of SD for defining the concept of SD. The three dimensions of SD include environmental sustainability, economic sustainability, and social sustainability. These three dimensions are also used to define the sustainability of CDM projects. Under each dimension of SD, SD criteria are created for assessing sustainability of CDM projects. The United Nations designed the potential SD indicators for assessing CDM projects (see Table 5.1, 5.2, and 5.3). These SD indicators are equally important, so each SD indicator is not given a weight based on its importance. However, not all SD indicators of CDM project are equally important in the specific context of a country or a region (Sutter [108]). Consequently, the potential SD indicators suggested by the United Nations may not reflect stakeholder preferences towards the sustainability of CDM projects.

Our review clearly finds that the SD objectives of CDM project are not clearly interpreted by many host countries. This finding is consistent with Brown *et al*. [8], Schneider [101], and Sterk *et al*. [105]. Moreover, we found that most host countries use checklists as a method for assessing the sustainability of CDM projects. However, this method has two weaknesses: (i) It is very difficult to implement this methodology because this methodology gives the wide and vague assessment requirements and therefore it provides much room for interpretation; and (2) The validity of assessment based on this methodology is low because there is no clear procedure for implementation.

Finally, we found the two problems of CDM’s contribution to SD: (1) a conflict between the twin objectives of CDM projects (sustainability and carbon reduction); and (2) the lack of consistency in the fulfillment of host countries’ duties to assess CDM projects for sustainability. These problems are shown in Figure 5.4.

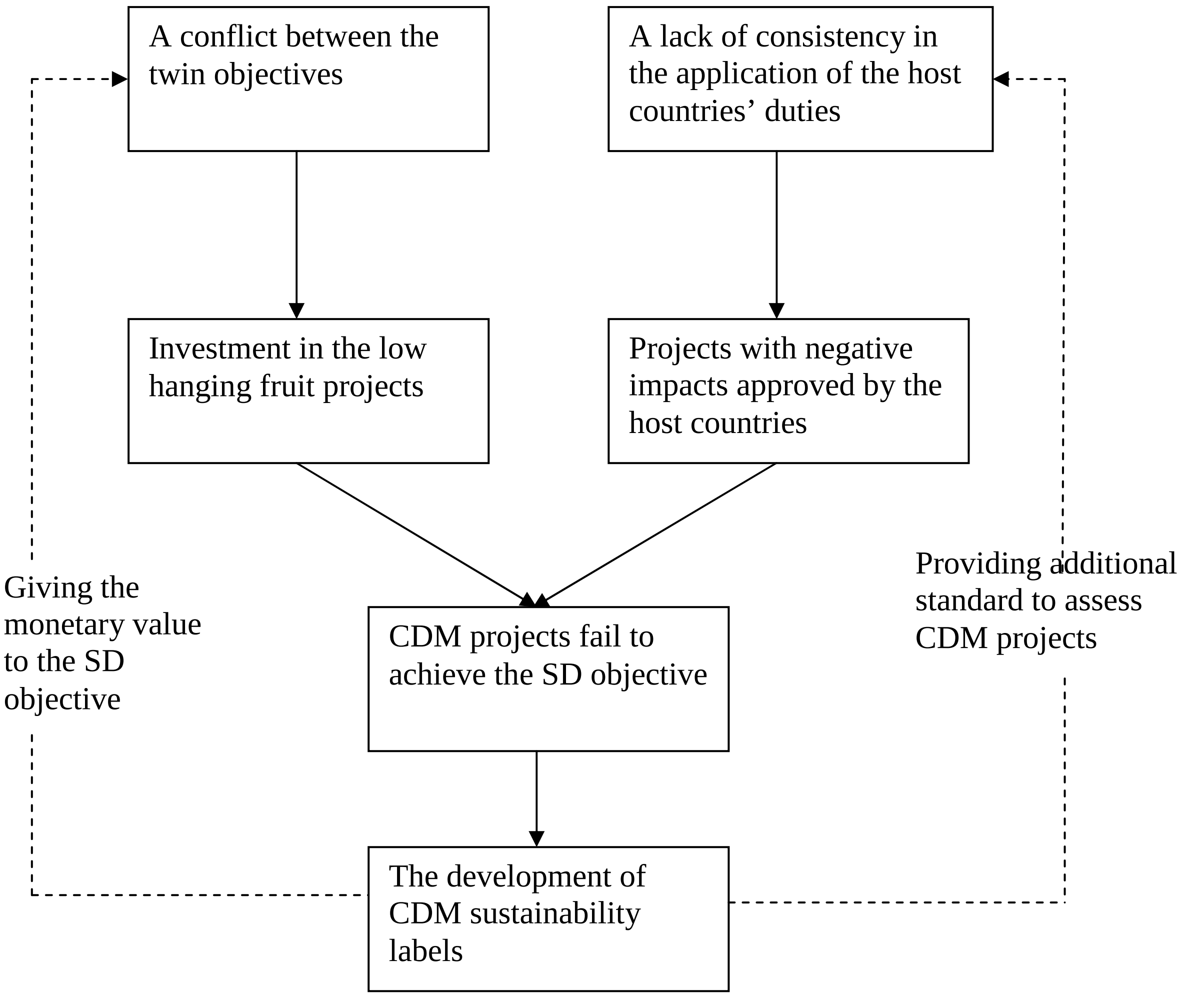

Figure 5.4: The two fundamental problems of CDM's contribution to SD

The vague concept of sustainability gives the host countries a chance to set their own SD assessment for CDM projects, so their SD assessments are inconsistent. This means some host countries cannot guarantee the sustainability of CDM projects. Consequently, we found that some projects with negative impacts were approved by some host countries. Considering another problem, there is a conflict between the twin objectives of CDM projects. This is because the SD objective of CDM projects is not given a monetary value. Finally, this encourages investors to invest in the low hanging fruit projects which can deliver huge volumes of CERs, but cannot deliver other SD benefits. These two problems make CDM projects fail to achieve the SD objective. Finally, this has resulted in the development of CDM sustainability labels.

In theory CDM sustainability labels will give a monetary value to the SD objective. This can result in a synergy between the twin objectives of "ensuring cost-effectiveness of GHG emission reductions" and "promoting sustainable development". Moreover, CDM sustainability labels will provide additional standard to assess the sustainability of CDM projects which is very clear and consistent. This has potential to help host countries to guarantee the sustainability of CDM projects. In principle, CDM sustainability labels can completely solve these two problems. However, the willingness to pay a price premium for CERs with CDM sustainability labels is unclear. Therefore, we will investigate whether CDM sustainability labels can give monetary value to SD in Chapter 7 and 8.

Chapter 6

An Analysis of Current CDM Portfolio

As previously noted, CDM projects are facing the problem of their contribution to SD. According to Kolshus *et al*. [59], CERs generated by industrial gas projects (including HFCs, PFCs, and N2O projects) produce fewest SD benefits compared to other types of project. This implies that all types of CDM project are not the same in terms of SD benefits. Although the CDM could be considered successful in terms of the number of registered projects, serious questions remain about whether the current CDM portfolio generates high quality of carbon credits in terms of SD benefits. Consequently, this chapter aims to: (1) investigate the demand and supply of CDM projects; and (2) investigate whether the current CDM portfolio is generating the high quality of carbon credits in terms of SD benefits.

As CDM projects generate CERs directly, CERs represent the demand and supply of the CDM projects. Consequently, we will use the demand and supply of CERs as representative of CDM portfolio.

6.1 Demand Side

The value of CERs is, like any traded good, influenced by both demand and supply. An increase in the number of the CDM projects will directly raise the supply of CERs to the market. However there are many drivers of CER demand. The key drivers are the Kyoto commitments, the multinational and national commitments, and the voluntary commitments. Buyers largely engage in CER transactions because of emission commitments at international, national, and local levels. The Kyoto Protocol is the largest demand for CERs (World Bank [142]). Besides large scale buyers, there is also a growing number of retail buyer who purchase emission permits to meet their own individual emission reduction targets. The major demand for CERs can be divided into the following groups.

6.1.1 *The Kyoto Obligation*

The Kyoto obligation generates the largest demand for CERs. Under the Kyoto Protocol, Annex I countries have their own emission reduction targets. Thus, Annex I countries must buy CERs generated by the CDM projects to meet their own emission reduction targets. Figure 6.1 show the gap between average 2008–2010 total GHG emissions and Kyoto targets (without the use of carbon sinks and flexible mechanisms) for the European countries (European Environment Agency [27]). Each bar represents the gap between domestic emissions and the Kyoto target. A positive value indicates that national total emissions were lower than the Kyoto target. According to European Environment Agency [27], Austria, Luxembourg, and Spain were furthest away from their individual targets (see Figure 6.1). Therefore, these countries are the majority of European countries' demand for CERs.

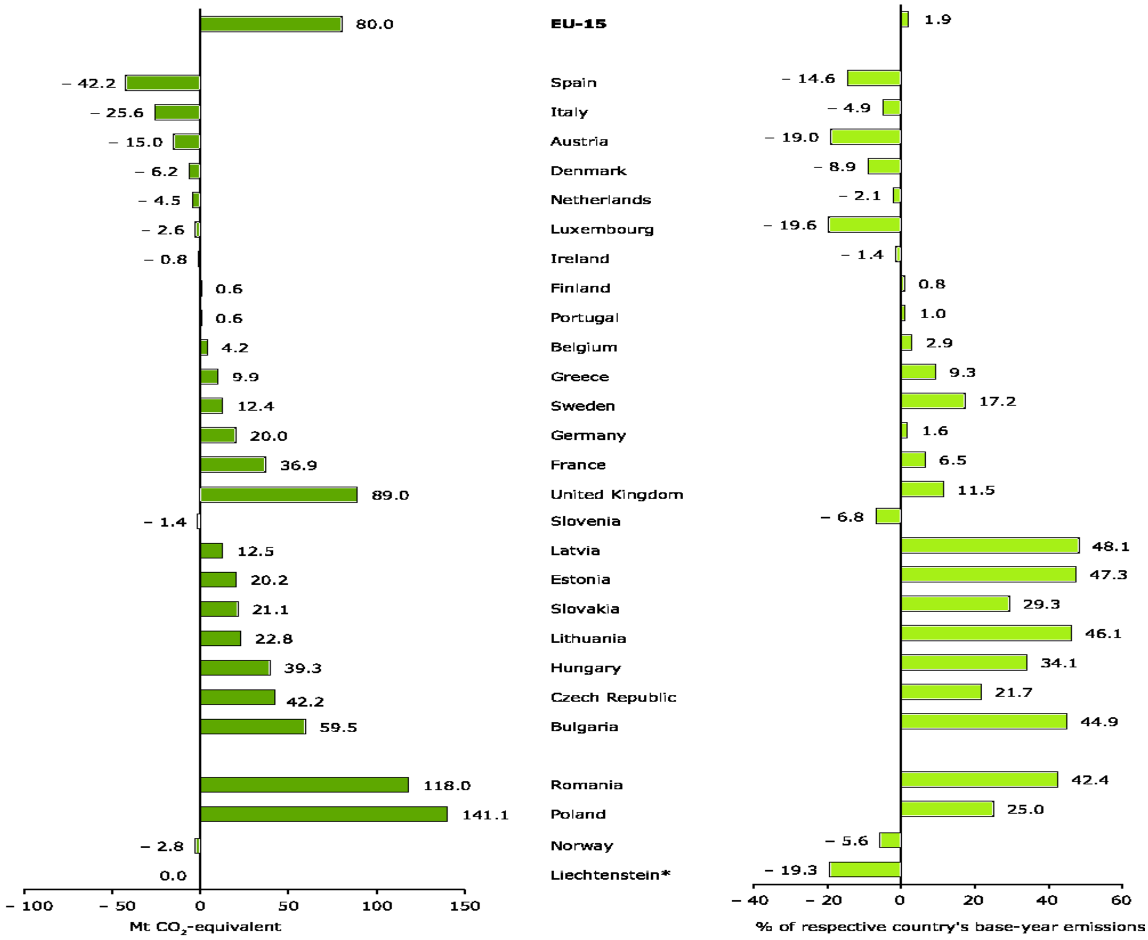

Figure 6.1: The gap between average 2008–2010 total GHG emissions and Kyoto targets (without the use of carbon sinks and flexible mechanisms) for the European countries (source: European Environment Agency [27])

6.1.2 The European Union Emissions Trading Scheme (EU ETS)

The EU ETS is currently the largest multinational emissions trading scheme in the world. Under the EU ETS, the EU member states will agree their national emission caps and then allocate allowances to their main industrial sectors. Currently, each member state allocate allowances to five main industrial sectors, namely power and heat generation, iron and steel, mineral oil refineries, mineral industry, and the pulp and paper. The EU ETS allow the companies to trade surplus allowances between themselves. The company that reduces its GHG emissions beyond its target will has a surplus of allowances and then can sell these surplus allowances to the company that can not meet its own target. Moreover, the EU ETS allow the companies to purchase CERs and ERUs generated by the CDM and JI respectively for meeting their own targets. Consequently, the EU ETS generate the high demand for CERs. In year 2008 and 2009, 86.9 million CERs and 83.5 million CERs respectively, were surrendered for compliance in the EU ETS (Trotignon [120]).

6.1.3 The U.S. Cap-and-Trade Program

Despite the US rejection of the Kyoto Protocol, individual states have their own climate change policies aiming to reduce GHG emissions. Indeed, the state and local climate change policies far outpace the federal climate change policies. Although the local government has less power than the federal government, the local government has more responsibility for climate change problem than the federal government. These climate change policies developed by local government represent a sharp contrast to the federal government's official stance on climate change. Many states have enacted climate change legislation. State climate change policies were initiated by state Climate Action Plans (CAPs) and their policies focus on the use of renewable energy, energy efficiency, public transportation, climate-neutral land use, waste management, alternative fuel fleets, and recycling (Byrne *et al*. [11]). The objective of the state and local climate change policies is to reduce their GHG emissions. State and local governments are now setting climate change action plans. Most state and local governments set two key policies which include individual emission reduction targets and a multi-state cap-and-trade program in their climate change action plans.

In their climate change action plans, state governments set their own emission reduction targets which are similar to those of the Kyoto Protocol. Different states have different emission reduction targets as shown in Table 6.1.

States	Climate Change Policies
Arizona	Targets to reduce GHG emissions to 50% below 2000 levels by 2040
California	Targets to reduce GHG emissions to 80% below 1990 levels by 2050
Delaware	Targets to reduce GHG emissions to 7% below 1990 levels by 2010
New Jersey	Targets to reduce GHG emissions to 3.5% below 1990 levels by 2005
New Mexico	Targets to reduce GHG emissions to 75% below 2000 levels by 2050
New York	Targets to reduce GHG emissions by 5% below 1990 levels in 2010, and 10% below 1990 levels by 2020

Table 6.1: An example of state emission reduction targets; (source: [134])

Moreover, state and local governments set a multi-state cap-and-trade program which represents the cooperative action by multiple states to reduce GHG emissions. A multi-state cap-and-trade program is developed by the multi-government alliances to help US states to reduce their GHG emissions in a cost-effective manner. A multi-state cap-and-trade program is also known as the U.S. cap-and-trade program. The multi-state cap-and-trade programs are being developed under the three multi-state programs for climate change which include the Regional Greenhouse Gas Initiative (RGGI), the Western Climate Initiative (WCI), and the Midwestern Greenhouse Gas Reduction Accord. A multi-state cap-and-trade program is firstly developed under the Regional Greenhouse Gas Initiative (RGGI).

The Regional Greenhouse Gas Initiative (RGGI) is a cooperative initiative of the Northeastern and Mid-Atlantic United States region to reduce CO_2 emissions and develop a multi-state cap-and-trade program. A multi-state cap-and-trade program is aimed to reduce CO_2 emissions from power plants in participating states. The RGGI is currently participated by 10 states: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont. Moreover, the District of Columbia, New Brunswick, Pennsylvania, and the Eastern Canadian Provinces are observers in the process. The RGGI is initiated by New York Governor George E. Pataki who invited the Northeastern and Mid-Atlantic States to work together to develop climate change action plan. According to a Memorandum of Understanding (MOU), the signatory states would stabilize their CO_2 emissions from power plants at 2005 levels by 2015. Then the CO_2 emissions will be reduced by 2.5% per year for the four years 2015 through 2018. This approach will result in a total of a 10% reduction by the end of 2018. The RGGI will go into effect on 1 January 2009. Then, a multi-state cap-and-trade program is developed under the Western Climate Initiative (WCI) on February 2007. The WCI is participated by Arizona, California, New Mexico, Oregon, Utah, Washington, and the Canadian provinces of British Columbia and Manitoba. The purpose of the WCI is to collaborative in identifying, evaluating, and implementing ways to reduce GHG emissions and to achieve related co-benefits. On August 2007, The WCI set a regional target to reduce GHG emissions by 15% below 2005 levels by 2020. The WCI is now developing a multi-state cap-and-trade program to help its members meet their emission reduction targets at least cost. The WCI members will release design recommendations for a multi-state cap-and-trade program by August 2008.

Finally, the most recent multi-state cap-and-trade program is developed under the Midwestern Greenhouse Gas Reduction Accord (The Midwest Accord). The Midwest Accord (MA) is developed on November 2007 to reduce GHG emissions and create a multi-state cap-and-trade program. The Midwest Accord is participated by the US states of Illinois, Iowa, Kansas, Michigan, Minnesota, Wisconsin, and the Canadian province of Manitoba. Moreover, Indiana, Ohio, and South Dakota are observers in the process. The Midwestern cap-and-trade program is expected to be active in Mid-2010.

(Million Metric Tons of Carbon Dioxide)

State	Cap-and-Trade Program	State Carbon Dioxide Emissions (Year 2004)	Percent of total state CO_2 emissions
Connecticut	RGGI	45.5	0.77%
Delaware	RGGI	16.9	0.28%
Maine	RGGI	23.3	0.39%
Maryland	RGGI	80.6	1.36%
Massachusetts	RGGI	83.6	1.41%
New Hampshire	RGGI	22.0	0.37%
New Jersey	RGGI	128.6	2.16%
New York	RGGI	216.7	3.65%
Rhode Island	RGGI	11.0	0.19%
Vermont	RGGI	7.0	0.12%
Total		635.2	10.69%
Arizona	WCI	96.9	1.63%
California	WCI	398.9	6.71%
New Mexico	WCI	59.0	0.99%
Oregon	WCI	42.5	0.72%
Utah	WCI	65.7	1.11%
Washington	WCI	82.9	1.40%
Total		745.9	12.55%
Illinois	MA	244.5	4.11%
Iowa	MA	81.8	1.38%
Kansas	MA	77.8	1.31%
Michigan	MA	189.9	3.20%
Minnesota	MA	102.8	1.73%
Wisconsin	MA	108.8	1.83%
Total		805.6	13.56%
Total Programs		2,186.7	36.80%

Table 6.2: State CO_2 emissions (Year 2004) under the three cap-and-trade programs; (source: [104])

Table 6.2 show how much CO_2 emissions all multi-state cap-and-trade programs cover. Clearly, all multi-state cap-and-trade programs cover 36.8% of the total US CO_2 emissions. The Midwest Accord covers the largest proportion (13.56%) of the total state CO_2 emissions, closely followed by the WCI (12.55%), and the RGGI (10.69%). All multi-state cap-and-trade programs account for 2,186 million metric tons in 2004, whereas Russia which is the world's third largest emitter in 2004 account for 1,669 million metric tons. Thus, CO_2 emissions from these cap-and-trade programs can be ranked the third largest CO_2 emissions in the world. Unfortunately, Texas, Pennsylvania, Ohio, and Florida which are the major CO_2 emitters do not participate in these multi-state cap-and-trade programs. In the year 2004, these four major CO_2 emitters account for 24.5% of the total US CO_2 emissions.

Clearly, all multi-state cap-and-trade programs represent the large demand for emission permits in the carbon market because CO_2 emissions from these cap-and-trade programs are ranked the third largest CO_2 emissions in the world. Consequently, U.S. states will soon become one of the large buyers of emission permits. Although the U.S. has not ratified the Kyoto Protocol, the U.S. companies can buy CERs from the members of the Kyoto Protocol for meeting their own targets (Engel [25]). This is because there are no Kyoto regulations which prohibit members of the Kyoto Protocol from selling emission permits to nonparty countries. Consequently, these three multi-state cap-and-trade programs will become the large sources of demand for CERs in the future.

6.1.4 The other trading schemes

There are many other trading schemes such as the Keidanren voluntary action plan, Canadian Large Final Emitters system (LFE), etc. These schemes are the major sources of demand for CERs. The Keidanren voluntary action plan is created by the Nippon Keidanren which is a Japan Business Federation. The Keidanren plan is aimed to stabilize CO_2 emissions from fuel combustion and industrial processes at 1990 level by 2010, but this plan make no commitment to the Japanese government (Kiko Network [57]). Currently, there are 35 industries including energy, mining, manufacturing, and construction participating in the Keidanren plan. These industries select their own target indices such as CO_2 emission per unit, gross CO_2 emission, energy efficiency, etc. The Keidanren plan bundle these industrial targets together as one. Industries under the Keidanren plan can purchase CERs for meeting their own targets.

Another example of trading scheme is Canadian Large Final Emitters system (LFE). The LFE aimed to reduce emissions by approximately 270 Mt annually in the period 2008-2012. The LFE consist mainly of companies active in three industries including thermal electricity, oil and gas, and mining and manufacturing. Reducing emissions in these industries will help Canada to meet its emission reduction targets during the first period of the Kyoto Protocol. Like other trading schemes mentioned above, the LFE allow the companies to use CERs for compliance purposes.

6.2 Supply Side

6.2.1 Overview of the CDM Projects

As of July 2010, 2,262 projects are registered as CDM projects and a further 171 projects are in the registration process (UNEP-Risoe [126]). 49 projects are withdrawn and rejected. The amount of CERs issued is 421 million CERs. CER price is about €12.00 per tonne of CO_2e, so the value of CERs issued is 5,052 million Euros. These 2,262 projects are expected to generate 370 million CERs per year. The total amount of expected 2012 CERs is 2,879 million CERs. The growth of total expected accumulated 2012 CERs can be shown in Figure 6.2.

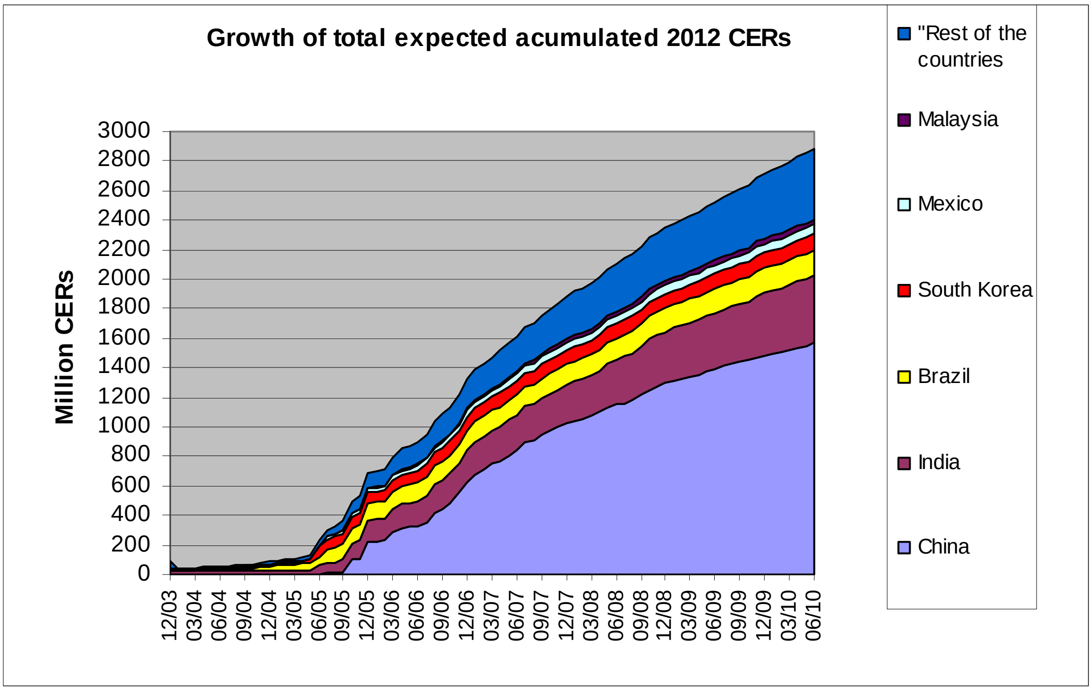

Figure 6.2: The growth of total expected accumulated 2012 CERs; (source: UNEP-Risoe [126])

6.2.2 *Distribution of Registered Projects by Host Region and Host Country*

As of July 2010, the CDM projects are concentrated in Asia-Pacific and Latin America, with a 75.07% and 20.73% share of total number of registered projects, respectively (UNEP-Risoe [126]). Asia-Pacific creates the largest amount of CERs (300,666,000 CERs), followed by Latin America (49,901,000 CERs), and Africa (11,181,000 CERs). The distribution of registered projects by host region is shown in Table 6.3 and Figure 6.3.

Host Country	Number of registered project	% share of the registered project	kCERs	% share of CERs
Latin America	469	20.73%	49,901	13.50%
Asia-Pacific	1698	75.07%	300,666	81.34%
Europe and Central Asia	26	1.15%	2,151	0.58%
Africa	43	1.90%	11,181	3.02%
Middle-East	26	1.15%	5,727	1.55%
Total	2,262	100.00%	369,626	100.00%

Table 6.3: The distribution of registered projects by host region; (source: UNEP-Risoe [126] and author's calculations)

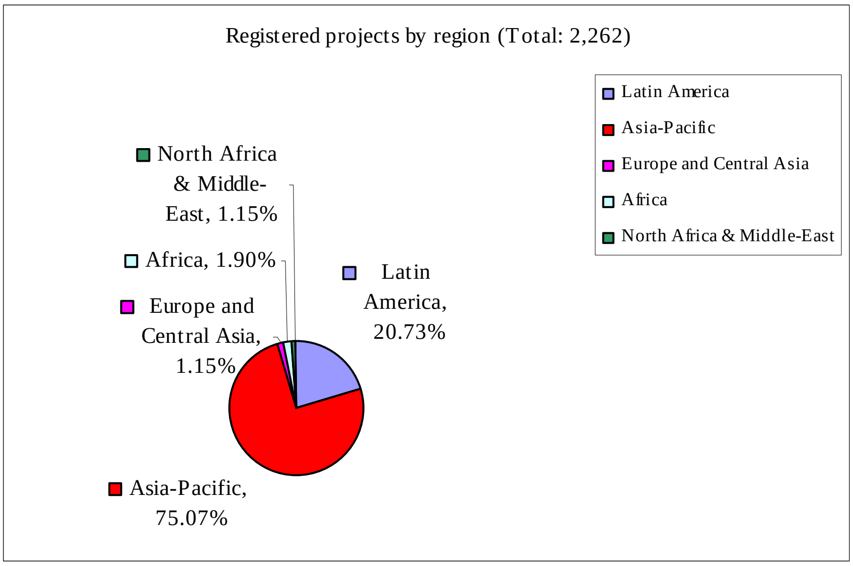

Figure 6.3: The distribution of registered projects by host region

Considering the distribution of registered projects by host country, China has the largest number of registered projects (883 projects), followed by India (513 projects), Brazil (173 projects), Mexico (121 projects), and Malaysia (81 projects). In these developing countries which are actively hosting the CDM projects, it is seen as a means to attract new, foreign capital, and possibly to stimulate technology transfer (Ellis and Kamel [23]). The distribution of registered projects by host country can be shown in Table 6.4 and Figure 6.4.

Host Country	Number of registered project	% share of the registered project
China	883	39.04%
India	513	22.68%
Brazil	173	7.65%
Mexico	121	5.35%
Malaysia	81	3.58%
Indonesia	48	2.12%
Philippines	41	1.81%
South Korea	40	1.77%
Others	362	16.00%
Total	2262	100.00%

Table 6.4: The distribution of registered projects by host country; (source: UNEP-Risoe [126] and author's calculations)

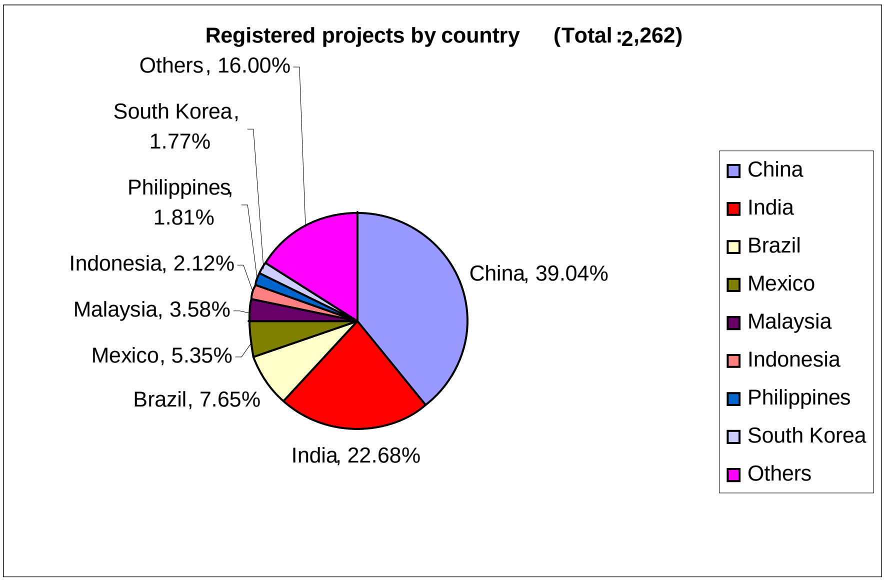

Figure 6.4: The distribution of registered projects by host country

Host Country	kCERs	% share of CERs
China	225,019	60.88%
India	42,816	11.58%
Brazil	20,385	5.52%
South Korea	14,933	4.04%
Mexico	9,474	2.56%
Malaysia	5,230	1.42%
Chile	4,705	1.27%
Indonesia	4,327	1.17%
Others	42,738	11.56%
Total	369,627	100.00%

Table 6.5: The distribution of CERs by host country; (source: UNEP-Risoe [126] and author's calculations)

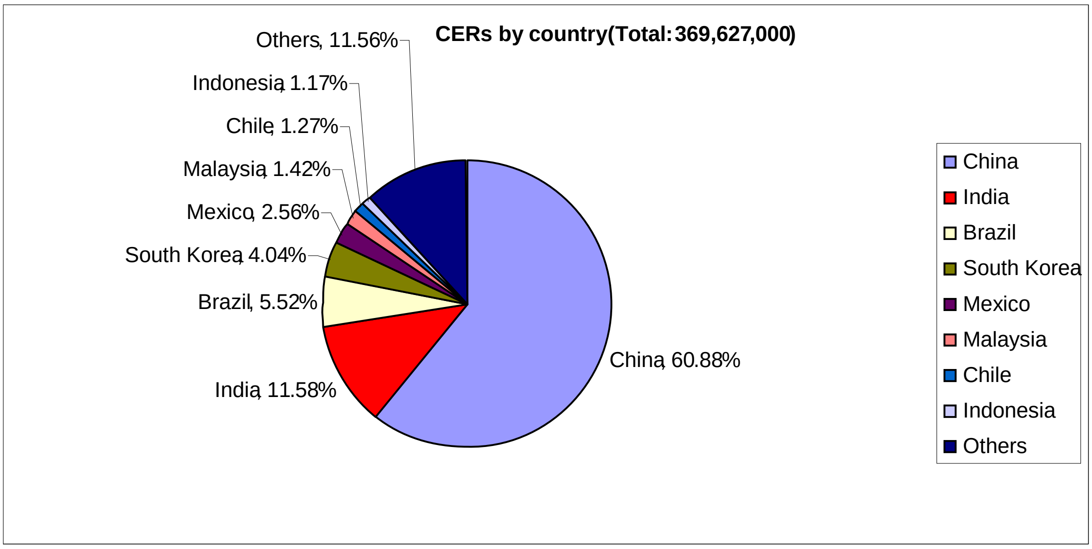

Figure 6.5: The distribution of CERs by host country

The amount of CERs generated by the CDM projects does not correlate strongly with the number of registered projects in a given country. Although India accounts for 22.68% of total number of registered projects, these projects provide only 11.58% of CERs. South Korea is ranked fourth in the amount of CERs generated by the registered projects despite hosting the eighth largest number of registered projects. South Korea has the number of registered projects close to Philippines (see Table 6.4), but South Korea (14,933,000 CERs) far surpasses Philippines (1,474,000 CERs) in the amount of CERs. This is because the amount of CERs is strongly related to CDM project types. Industrial gas projects (including HFCs, PFCs, and N2O projects) generate more CER volumes than other CDM project types. South Korea has 12 industrial gas projects, whereas Philippines has only one industrial gas project. Consequently, South Korea can generate higher CER volumes than Philippines. China far surpasses India in the amount of CERs generated by the registered projects. China is responsible for the largest amount of CERs (60.88%), distantly followed by India (11.58%), Brazil (5.52%), South Korea (4.04%), and Mexico (2.56%). The distribution of CERs by host country can be shown in Table 6.5 and Figure 6.5.

6.2.3 Distribution of CDM Project Types

So far, renewable energy projects account for the largest number of registered projects. Renewable energy projects are responsible for 58.75% share of total number of registered projects, distantly followed by CH_4 reduction & Cement & Coal mine/bed (24.14%), Supply-side EE (7.21%), and HFC & N2O reduction (3.98%). The distribution of CDM project types can be shown in Table 6.6 and Figure 6.6. The amount of CERs generated by the CDM projects does not correlate strongly with the number of registered projects in a given project type. Although renewable energy projects account for more than 50% share of total number of registered projects, these projects can provide only 31.58% of CERs. On the other hand, HFC and N2O reduction projects surpass renewable energy projects in the amount of CERs generated by the registered projects. HFC and N2O reduction projects ranked fourth in the number of registered projects are responsible for only 90 projects (3.98%), but these projects can provide the largest amount of CERs. HFC and N2O reduction projects account for 35.37% share of CERs, followed by Renewables (31.58%), CH_4 reduction & Cement & Coal mine/bed (17.97%), Supply-side EE (7.33%), and Fuel switch (6.98%). The distribution of CERs by project type can be shown in Table 6.7 and Figure 6.7.

CDM project type	Number of registered project	% share of the registered project
Renewables	1,329	58.75%
CH_4 reduction&Cement&Coal mine/bed	546	24.14%
Supply-side EE	163	7.21%
HFC&N2O reduction	90	3.98%
Demand-side EE	71	3.14%
Fuel switch	45	1.99%
Afforestation & Reforestation	15	0.66%
Transport	3	0.13%
Total	2,262	100.00%

Table 6.6: The distribution of CDM project types; (source: UNEP-Risoe [126] and author's calculations)

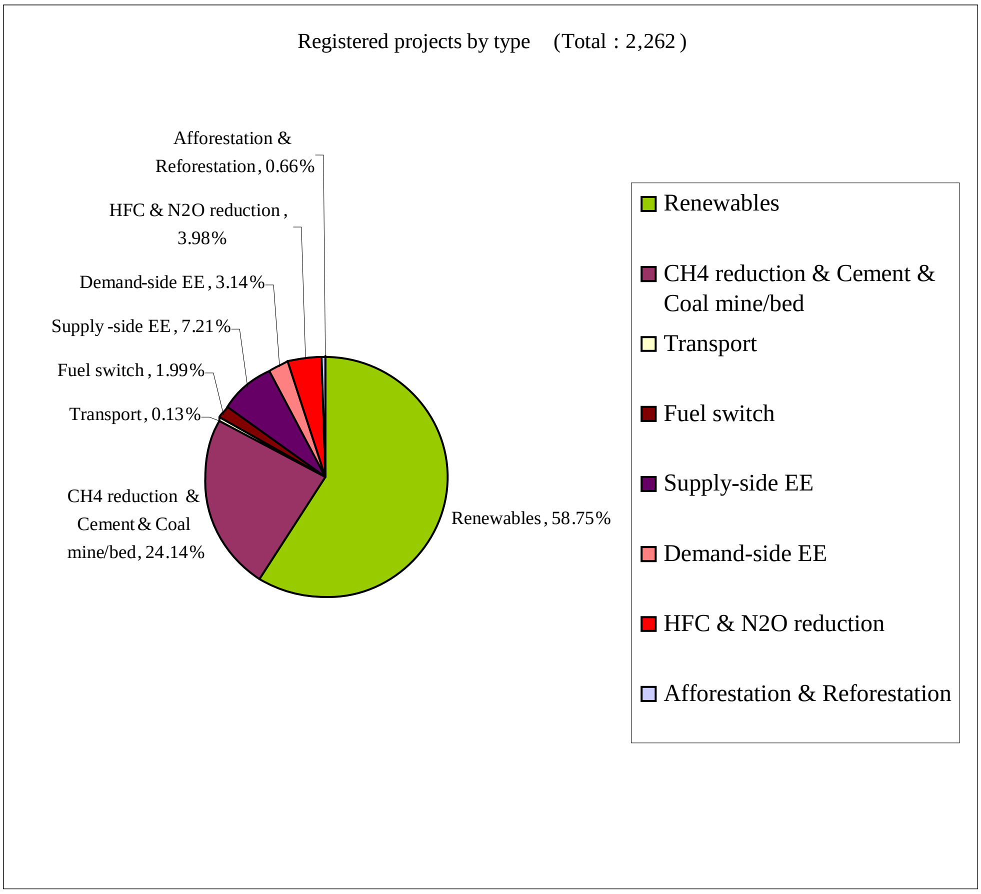

Figure 6.6: The distribution of CDM project types

CDM project type	kCERs	% share of CERs
HFC & N2O reduction	130,749	35.37%
Renewables	116,713	31.58%
CH_4 reduction & Cement & Coal mine/bed	66,414	17.97%
Supply-side EE	27,106	7.33%
Fuel switch	25,817	6.98%
Demand-side EE	2,060	0.56%
Afforestation & Reforestation	463	0.13%
Transport	305	0.08%
Total	369,627	100.00%

Table 6.7: The distribution of CERs by project type; (source: UNEP-Risoe [126] and author's calculations)

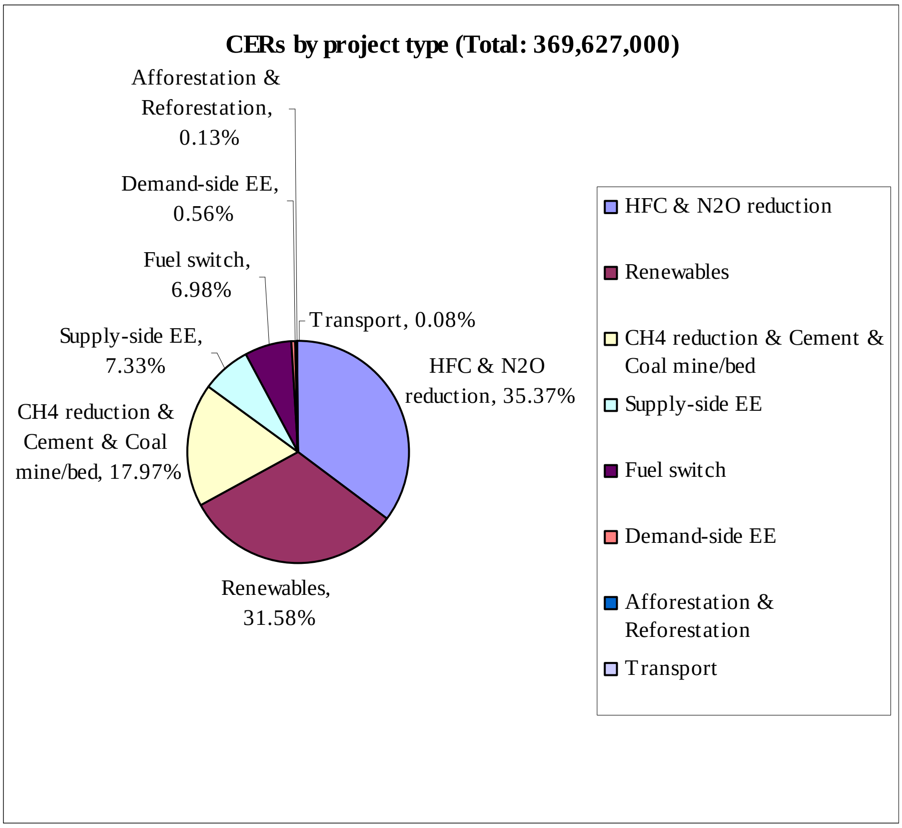

Figure 6.7: The distribution of CERs by project type

6.2.4 Distribution of Renewable Energy CDM Projects

So far, hydro projects account for the largest number of registered projects. The hydro projects are responsible for 48.23% share of total number of registered projects, distantly followed by Wind (27.69%), Biomass (21.67%), and Solar (1.66%). There is only one tidal CDM project, namely Shinwa Tidal Power Plant Project, which is located in South Korea. The distribution of renewable energy CDM projects can be shown in Table 6.8 and Figure 6.8. The hydro projects provide the largest amount of CERs (52.69%), distantly followed by Wind (30.81%), Biomass (14.25%), and Geothermal (1.57%). Surprisingly, the only one tidal CDM project provides 0.27% of CERs, whereas the 22 solar CDM projects can provide only 0.40%. The only 9 geothermal projects can generate more CERs than 22 solar CDM projects. The distribution of CERs by type of renewable energy can be shown in Table 6.9 and Figure 6.9.

Type of renewable energy	Number of registered project	% share of the registered project
Hydro	641	48.23%
Wind	368	27.69%
Biomass energy	288	21.67%
Solar	22	1.66%
Geothermal	9	0.68%
Tidal	1	0.07%
Total	1,329	100%

Table 6.8: The distribution of renewable energy CDM projects; (source: UNEP-Risoe [126] and author's calculations)

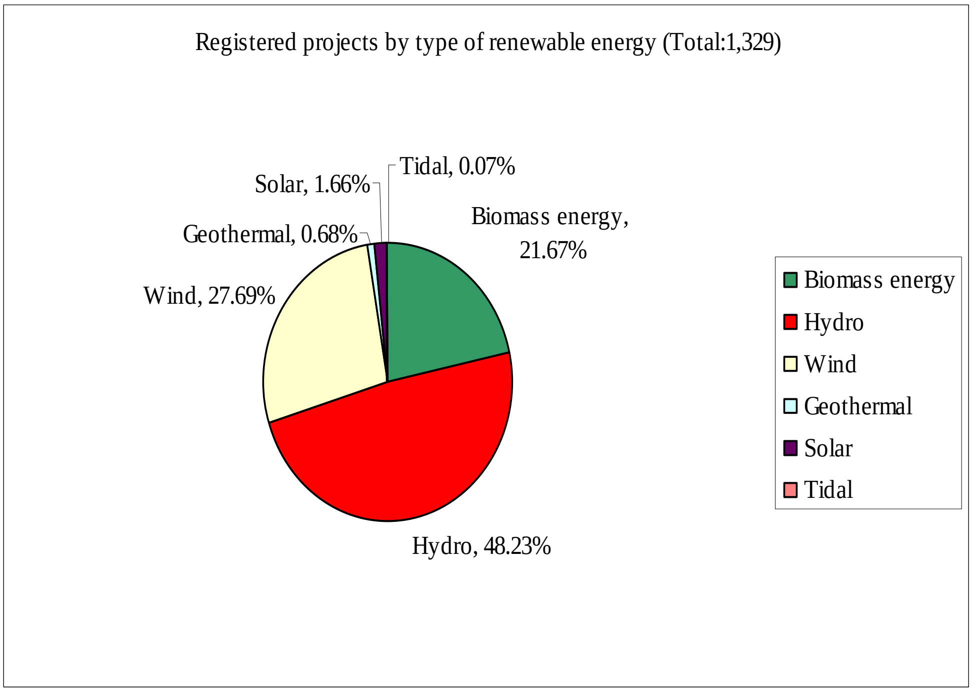

Figure 6.8: The distribution of renewable energy CDM projects

Type of renewable energy	kCERs	% share of CERs
Hydro	61,496	52.69%
Wind	35,963	30.81%
Biomass energy	16,637	14.25%
Geothermal	1,835	1.57%
Solar	467	0.40%
Tidal	315	0.27%
Total	116,713	100.00%

Table 6.9: The distribution of CERs by type of renewable energy; (source: UNEP-Risoe [126] and author's calculations)

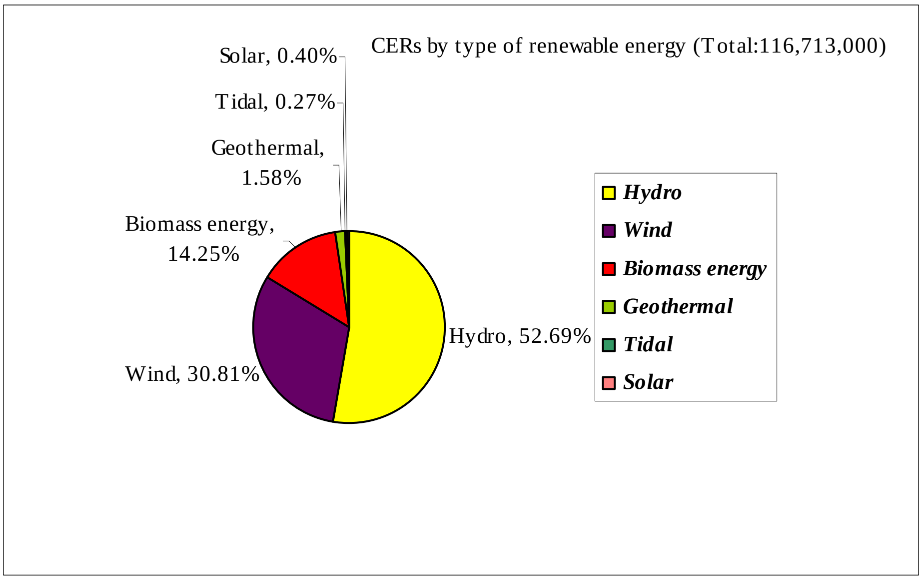

Figure 6.9: The distribution of CERs by type of renewable energy

6.3 Conclusions

Currently, the CDM projects are concentrated in Asia-Pacific region with a 75.07% share of total number of registered projects. So far, China has the largest number of registered projects and provides more than 50% of CERs. Considering the distribution of CDM project types, HFC and N2O reduction projects account for the largest share of CERs (35.37%). According to Kolshus et al. [59], industrial gas projects (including HFCs, PFCs, and N2O projects) produce fewest SD benefits compared to other types of project. Therefore, this result showed that carbon credits with low quality in terms of

SD benefits are occupying the carbon market. Moreover, CER buyers may not be concerned with the SD benefits generated by project types. Although renewable energy projects account for the largest number of registered projects, they account for the second largest share of CERs (31.38%). This imply that the amount of CERs does not correlate strongly with the number of registered projects in a given project type. Renewable energy projects are concentrated in three sectors: (1) hydro, (2) wind, and (3) biomass projects.

Chapter 7

A Conceptual Framework and Research Methodology for Classifying CER Buyers and Valuing the Sustainable Development Benefits of CDM Projects

7.1 Introduction

The Kyoto Protocol intended CERs to conform to a common standard (for carbon reduction and sustainability) providing a homogenous good that could be bought and sold. In reality they are not all the same, some CERs are worth more (or less) than others in terms of the SD benefits (Meyrick [73]). As previously noted, CERs generated by industrial gas projects produce fewest SD benefits compared to other types of project (Kolshus *et al*., [59]). The quality of carbon credits has now entered into the market's consciousness. Consequently, credits are not perceived as a homogenous product with traders differentiating between CERs. A lack of consistency in the application of the host countries' duties to ensure the sustainability of CDM projects and a conflict between the twin objectives of sustainability and carbon reduction make credits different from each other. This has resulted in the development of international CDM sustainability labels. CERs with CDM sustainability label are accepted as the high quality CERs in terms of their SD benefits. According to Sutter [108], there is a need for developing CDM sustainability label to guarantee a high quality of CDM projects in addition to the low requirements by the host country. Moreover, Sutter suggested that CDM sustainability labeling has the potential to drive the CDM down the sustainability path provided the buyers are willing to pay a price premium. This is because a price premium will encourage project developers to develop more projects with CDM sustainability labels. The promotion of these labels is therefore a critical issue. In order to increase the market share of CDM sustainability label, the marketing is important (Muller, [75]). However, not all buyers are concerned with the SD quality CERs. Some buyers still target cheap credits from projects which deliver large volumes of CERs, but cannot deliver other SD benefits. There is no information about the characteristics of buyers favoring CDM sustainability labels and those who do not. Moreover, the market does not know why some buyers participate in CDM sustainability labels (Meyrick, [73]). Therefore, it is now necessary to validate the concept of non-homogeneous carbon credits and investigate buyers' willingness to pay a price premium for CERs with CDM sustainability label. This research will use cluster analysis to classify CER buyers according to their attitudes towards and involvement in CDM sustainability labels and apply the contingent valuation method (CVM) to assess the value of SD benefits of CDM projects. Finally, this study has chosen the Gold Standard (GS) label as the representative of CDM sustainability labels traded in the premium market.

7.2 Research Objectives, Research Questions, and Research Hypotheses

1) *To classify CER buyers according to their attitudes towards and involvement in CDM sustainability labels.*

   This objective can be achieved by pursuing these two research questions:

   - Whether the carbon market is comprises multiple groups based on their attitudes towards and involvement in CDM sustainability labels.

     We can evaluate this research question by formulating Hypothesis 1:

     Hypothesis 1: CER buyers can be classified into distinct groups based on their attitudes towards and involvement in CDM sustainability labels.
   - What are the key characteristics of each buyer cluster?

     We can evaluate this research question by formulating the following hypothesis:

     Hypothesis 2: The buyer clusters are significantly different in: organization type; level of paid up capital; perception of SD benefits; perception of return on investment; perception of image of the sustainability labeling; participation in the voluntary market; the project priority; knowledge in the sustainability label; the attitude towards the host country's duty; and their willingness to pay.

2) *Investigate the value of SD benefits generated by CDM projects through the willingness of buyers to pay a price premium for CERs with CDM sustainability label.*

This objective can be achieved by pursuing these two research questions:

- Whether the buyers are willing to pay a price premium for CERs with CDM sustainability label in recognition of the contribution to SD.
  We can evaluate this research question by formulating Hypothesis 3:
  Hypothesis 3: Buyers are willing to pay a price premium for CERs with CDM sustainability label.
- How much are the buyers willing to pay a price premium for CERs with CDM sustainability Label in recognition of the contribution to SD?

3) *Identify the factors influencing buyers' willingness to pay a price premium for CERs with CDM sustainability label.*
   This objective can be achieved by pursuing this research question:

- What are the factors influencing the willingness of CER buyers to pay a price premium for CERs with CDM sustainability label?
  We can evaluate this research question by formulating the following hypothesis:
  Hypothesis 4: Expected SD benefits, expected return on investment, involvement in the GS label, importance of the GS label, and the attitude towards the host country's duty are significantly related to the probability of the willingness to pay a price premium for CERs with CDM sustainability label.

7.3 An Application of Cluster Analysis to Classify CER Buyers

This study will use cluster analysis to classify the carbon market according to buyers' attitudes towards and involvement in CDM sustainability labels. Cluster analysis is a multivariate technique, which is sometimes described as more of an art than a science (Ulengin *et al*. [121]). The objective of cluster analysis is to partition a set of objects into two or more groups based on the similarity of the objects for a set of specific characteristics (Hair *et al*. [41]). The clustering methods are broadly classified into two; namely hierarchical and non-hierarchical methods. Hierarchical clustering creates a hierarchy of a treelike structure called a dendrogram to see the relationship among observations. The root of a dendrogram consists of a single cluster containing all observations. Hierarchical method join observations or clusters until instructed to stop. This method is often criticized because observations joined early in the process cannot be separated (Gloy and Akridge [35]). In contrast to the hierarchical method, a non-hierarchical method does not create a hierarchy of a treelike structure. The non-hierarchical method is frequently referred to as the K-means method. This method assigns observations into cluster once the number of clusters to be formed is specified. The objective of the K-means method is to partition *n* cases into *k* clusters where each case belongs to the cluster with the nearest mean. By the K-means method, there will be a maximum intergroup and minimum intragroup variance. Analysts must decide how many clusters they wish to obtain before starting the calculation process of the K-means clustering (Hair *et al*. [41]).

In the past the hierarchical method was more popular than the non- hierarchical method, but now the non-hierarchical method gain increased acceptability and is applied increasingly (Hair *et al*. [41]). Moreover, Hair et al. conclude that the non-hierarchical method has several advantages over the hierarchical method. The results generated by the non-hierarchical method are less susceptible to the outliers in the data, the distance measure used, and the inclusion of irrelevant or inappropriate variables.

In this study the K-means method is selected to classify the CER buyers in the market. According to the literature discussed previously, the carbon market appears to offer two products: (1) CERs with CDM sustainability labels; and (2) Non-labelled CERs. CDM projects generating non-labelled CERs pass only the sustainability test set by the host country, while projects generating labelled CERs must pass both the sustainability test set by the host country and another set by CDM sustainability labels. This suggests the adoption of a two-cluster solution. Furthermore, the K-means method can identify a clear cluster structure if the number of clusters is known in advance (Hair *et al*. [41], Jung [54], Perez and Nadal [90]). The clustering variables and additional variables used in cluster analysis are identified as follows:

7.3.1 Clustering Variables

Clustering variables will be used to characterize CER buyers. Selecting the clustering variables is based on an explicit theory, past research, and practical considerations (Hair *et al.*, [41]). The clustering variables can be both demographic variables and behavioral variables. According to Herath *et al.* [45], sub-groups or segments of customers can be differentiated on the basis of shared needs, wants, lifestyle, values, and behavioral responses to information cues. Vlosky *et al.* [136] use two variables to differentiate buyers in the wood product industry, namely (i) involvement in environmentally certified products and (ii) attitudes towards the importance of environmentally certified products. Following Vlosky *et al.* [136] we use these two behavioral variables as the clustering variables. As discussed previously, this study will use the GS label as the representative of CDM sustainability labels. Therefore, we will measure buyers' involvement in the GS label and attitudes towards an importance of the GS label. This was achieved by asking whether they agreed with these five statements:

- My organization has purchased CERs with the Gold Standard label in the past year;
- If available, I would seek out CERs with the Gold Standard label;
- My organization believes there is a need for the Gold Standard label in the carbon market;
- My organization believes the Gold Standard label can guarantee the sustainable development benefits of CDM projects; and
- My organization believes the Gold Standard label can help improve the CDM's contribution to sustainable development.

The participants gave answers on a five-point Likert scale where, 1 = totally disagree and 5 = totally agree. This study used these five statements as clustering variables. Following Vlosky *et al.* [136], key indicators of consumers' involvement in environmentally certified products are: (i) behavior to seek out product, and (ii) past purchase of products. Therefore, we will use the first and second statements to measure consumer involvement.

According to Vlosky *et al.* [136], positive attitudes towards product certification are translated into demand for certified products. In this study the attitudes towards an importance of the GS label will represent buyer's consciousness in the SD objective of CDM project. We will use the third, fourth, and fifth statements to measure buyers' attitudes towards an importance of the GS label.

Finally, we get the five clustering variables from these statements. The answers to these questions are presented in a five-point Likert scale. Therefore, we must check if these five statements measure the same dimension. The Cronbach alpha was used to measure the reliability of these five statements. The results of reliability testing will be presented with the research results.

7.3.2 Additional Variables

A set of additional variables will be used to develop more detailed profiles of each buyer cluster. To determine if differences exist based on this set of additional variables, a cross-tabulation will be employed to identify the profiles of the two buyer clusters. The chi-square statistic is used to determine if there are any statistically significant differences between the two buyer clusters. Such variables, if significant, would offer efficient ways for developing a policy to promote the products that can contribute to SD (Getzner and Grabner-Krauter [32]). Additional variables are concluded in Table 7.1 and 7.2 below.

Variable Name	Description
Organization type	Nominal; “1” for “Private company”; “2” for “Government”; “3” for “Charity”
Paid up capital	Ordinal; “1” for “less than 1 million Euros”; “2” for “1 – 10 million Euros”; “3” for “11 – 99 million Euros”; “4” for “100 – 499 million Euros”; “5” for “500 – 1,000 million Euros”; “6” for “More than 1 billion Euros”
Buyers’ perception of SD benefits generated by the GS project	Ordinal; “1” for respondents stating “The expected SD benefits generated by Gold Standard are lower than non-labelled project”; “2” for “The expected SD benefits generated by Gold Standard are the same as non-labelled project”; “3” for “The expected SD benefits generated by Gold Standard are higher than non-labelled project”
Buyers’ perception of return on investment (ROI) of CERs from the GS project	Ordinal; “1” for respondents stating “ROI of CERs from Gold Standard is lower than non-labelled project”; “2” for “ROI of CERs from Gold Standard is the same as non-labelled project”; “3” for “ROI of CERs from Gold Standard is higher than non-labelled project”
Overall image of the GS label	Ordinal; “1” for “Very negative”; “2” for “Fairly negative”; “3” for “Neither positive nor negative”; “4” for “Fairly positive”; “5” for “Very positive”

Table 7.1: Additional variables for cluster profiling

Variable Name	Description
Buyers' participation in the voluntary carbon offset market	Nominal-Binary; "0" for "No"; "1" for "Yes"
Priority for purchasing carbon credits	Nominal; "1" for "Private company"; "2" for "Government"
Buyers' knowledge in the GS label	Ordinal; "1" for "No knowledge"; "2" for "Poor"; "3" for "Fair"; "4" for "Good"; "5" for "Excellent"
Attitude towards the host country's duty to assess the sustainability of CDM projects	Ordinal; The participants asked whether they agreed with the statement; "I cannot rely on a host country's criteria to assess the sustainable development benefits of CDM projects"; "1" for "Totally disagree"; "2" for "Disagree"; "3" for "Not sure"; "4" for "Agree"; "5" for "Totally agree"
Buyers' willingness to pay	Nominal-Binary; "0" for "No"; "1" for "Yes"

Table 7.2 Additional variables for cluster profiling (Cont.)

7.4 An Application of Contingent Valuation to Investigate the Value of SD benefits

Contingent valuation (CV) is a survey-based hypothetical and direct method to estimate the monetary value of non-market resources. CV is referred to as a stated preference method because it asks respondents to directly state their value. This approach asks respondents to directly report their willingness to pay (WTP) or less often willingness to accept (WTA) compensation. Therefore, it is called "contingent" valuation because the respondents are asked to report their WTP or WTA, contingent on a specific hypothetical scenario and description of non-market resources. CV has been successfully used for resources that are not exchanged in the regular market. It creates a hypothetical marketplace where no actual transactions are made. CV was first presented in theory in 1947 by S.V. Ciriacy-Wantrup who stated that people's preferences can be obtained by appropriated interviews. However, S.V. Ciriacy-Wantrup never followed up his idea. According to Kristrom [63], the first practical application of CV was undertaken by a consulting company in 1958. This company asked people visiting the Delaware Basin to report their WTP for entering national parks. Moreover, Kristrom stated that the first significant academic application of CV was undertaken by Robert K. Davis in his Harvard dissertation in 1963. Currently, CV is being extensively employed in many research areas.

According to Damigos *et al*. [19], CV is the most frequently and widely applied stated preference valuation technique because it is the only method available for capturing non-use values and it produce estimates as good as estimates obtained by other direct or indirect valuation methods. One objective of this study is to estimate the monetary value of SD benefits generated by CDM projects. As Yoo and Kwak [145] point out, the National Oceanic and Atmospheric Administration's Panel (NOAA) concluded that CV can produce estimates that are reliable enough to be the starting point for administrative and judicial determinations and presented several recommendations.

As previously noted, CV is based on asking people WTP questions. Freeman [29] defined that WTP is direct and indirect benefits of developing environmental quality in the form of money which is reported by people in the society. According to Tejam and Ross [112], WTP is the personal value over and above the actual cost or price of a good or service that is assigned by a person according to his/her own judgment. Considering the definition of WTP value, Hanley and Spash [43] defined that it is the sum of the product price and an individual's consumer surplus. WTP values are represented by points along a demand curve for a product or service. Moreover, WTP values represent the marginal benefits of individuals at each point along the demand curve. Figure 7.1 show WTP values. At point A, the quantity demanded is Q1 and the price is PC. The total WTP value is the whole area under the demand curve to the left of Q1. In other words, the total WTP value is represented by the area Q1AB0. This value is the sum of consumer surplus and producer revenue. The consumer surplus is represented by the triangle ABC and the producer revenue is represented by the area Q1AC0.

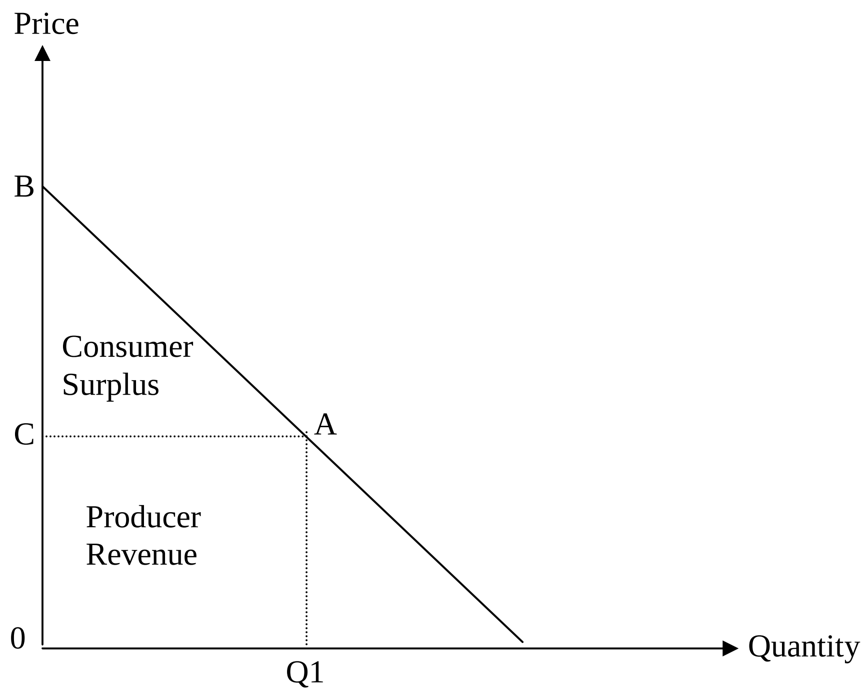

Figure 7.1: WTP value

In economic theory, the WTP value should be approximately the same as the WTA value. However, Kahneman *et al*. [55] found that WTA value significantly exceed WTP value. Tohmo [123] gave the five reasons for the WTP/WTA disparity: (1) people act more cautiously in questions of WTP; (2) people reject the proprietorship connected with WTA; (3) people's behavior is strategic; (4) people do not want to take any risks; and (5) income flexibility in the demand for goods in question is large.

The advantage of the CV approach is that it can be used to estimate the monetary value of non-market goods and services that cannot be measured through other techniques (Tejam and Ross [112]). However, this method has some noteworthy limitations. Firstly, Evenson and Santaniello [28] find that the CV approach is susceptible to two types of bias – hypothetical bias; and strategic bias. Hypothetical bias typically occurs when the respondents are unable to accurately assess their WTP. This is because they have limited prior experience with the non-market good or service. Considering strategic bias, it occurs when the respondents deliberately understate or overstate the true value they place on the non-market good or service. An underbid may be indicative of the fact that someone isn't willing to state his actual value for a resource because he believes it should be available at no cost. An overbid might represent a respondent's strategy to give a higher than reality price to something in hopes that the inflated response will influence the final results of the survey (Basili *et al*. [5]). Secondly, the CV approach can be very expensive and time-consuming because of the extensive survey work.

Since the SD objective of the CDM is not given a monetary value, CV is chosen as a valuation method in this research. An application of CV to find the monetary value of SD benefits of the CDM is so far very limited. There have been only two studies that have employed CV to investigate willingness to pay a price premium for CERs in recognition of SD benefits. These studies were conducted by Asuka and Okimura [4] and Sterk *et al*. [105]. Asuka and Okimura conducted a survey in the carbon market with 82 usable questionnaires from CER buyers. Asuka and Okimura found that quality of CERs is determined by three aspects: (1) risks; (2) technologies; and (3) project's contribution to SD. This study revealed that the willingness to pay a price premium for CERs in recognition of SD benefits and country risk was low. However, WTP value for SD benefits stand for only an improvement of the local environment in the host countries, the study failed to consider all SD aspects. This study showed that willingness to pay a price premium for an improvement of the local environment was € 0.254 per tonne of CO_2e. Moreover, the WTP value reported by this study may not be consistent because they did not give a clear definition of CERs used in the WTP question. In this study CERs may come from labelled CDM projects or non-labelled CDM projects. Consequently, some buyers may report their WTP in recognition of labelled CERs, whereas some buyers may report their WTP in recognition of non-labelled CERs. In reality labelled CERs can attract a price premium more easily than non-labelled CERs. Therefore, the WTP question used in this study was inappropriate.

More recently, Sterk *et al*. [105] conducted a survey of the demand for GS CERs and buyer's willingness to pay a price premium for GS CERs. Sterk *et al*. sent questionnaires to 55 carbon credit buyers in the compliance market and got 17 usable questionnaires. When given the first question – "Has the buyer purchased GS-labelled CERs or would be interested in doing so?", only 6 buyers (35%) answered "Yes" and the remaining 11 buyers answered "No". These 6 buyers were then asked to report their WTP – "What level of premium on the normal CER price has been paid or would the buyer be willing to pay in relative and absolute terms?". These buyers reported their WTP value ranging from € 1 to € 7 per tonne of CO_2e. Finally, Sterk *et al*. concluded that a premium of 5% – 25% for GS CERs is possible and the tendency to pay a price premium for GS CERs exists. However, a price premium for GS CERs varies widely. A price premium for GS CERs reported by Sterk *et al*. may not reflect the monetary value of SD benefits. This is because there are many reasons to pay a price premium for GS CERs such as high SD benefits, low Post-Kyoto risk, low methodology risk, etc. The Post-Kyoto risk is the risk that some CDM project types such as HFC, PFC, etc. may not be illegible to qualify as CDM project activity in the Post-Kyoto, whereas the methodology risk is the risk that some methodologies may not be used to demonstrate additionality and assess the sustainability of CDM projects in the Post-Kyoto. Consequently, some buyers may pay a price premium for GS CERs because of the low Post-Kyoto risk, not SD benefits. The WTP question used in this research was therefore incorrect.

It is clear that the CV questions used in these two studies were inappropriate. This affected the WTP value. Moreover, these studies did not investigate the factors influencing the probability of the willingness to pay a price premium. The Sterk *et al* study also relied on a very small number of respondents. Therefore, there is clearly a need for more research to employ CV to investigate willingness to pay a price premium for CERs in recognition of SD benefits.

7.4.1 An Econometric Model of Willingness to Pay

CV is applied to measure the WTP value by employing survey questions to elicit buyers' stated preferences for CDM sustainability labels. Therefore, the willingness to pay question plays a significant role in the accuracy of WTP value. In an exploring WTP for carbon offset certification and co-benefits among high-flying young adults in the UK, MacKerron [69] found that the WTP value measured in this research is overestimated and cannot be implemented because the maximum bid level designed in this research was set too low. The result show that the mean WTP is around £24 per person per flight which is higher than the highest price presented to respondents (£20). This implies that the maximum bid level was set too low, which unfortunately was not detected during piloting; that the WTP distribution therefore has a 'fat tail'; and that the WTP measure could thus be overestimated. This research result implies that we should carefully design the WTP question to elicit the buyers' WTP. Kotchen and Reiling [62] suggested that the valid CV questions of the WTP must include three components: (1) a detailed description of the resource to be valued, including the initial and alternative conditions of the hypothetical scenario; (2) the form and frequency of payment; and (3) how respondent are asked their WTP (the formats of the WTP question). This research tries to design the WTP question which is based on Kotchen and Reiling. The chosen format for the WTP question is a payment card which provides CER buyers with an array of potential WTP amounts ranging from zero to some large amount. Buyers will be presented with the following values in the payment card: €0.10, €0.20, €0.30, €0.40, €0.50, €0.75, €1.00, €1.50, €2.00, and other. It is supposed that the adjacent WTP values on a payment card represent the ranges of WTP values containing the true underlying WTP of the buyer. A binary logistic regression will be used to evaluate factors influencing the probability of WTP. A binary logistic regression is appropriate when the dependent variable to be evaluated is a binary variable [1,0]. The WTP model is set up in a binary logistic regression where the dependent variable is the natural logarithm of an odds ratio in favour of willingness to pay a price premium:

$$\ln \left(\frac{Pi}{1 - Pi} \right) = Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots\ldots + \beta_n X_n$$

Where

Pi = the probability of being willing to pay

1- Pi = the probability of not being willing to pay

βn = the estimated coefficient

Xn = an independent variable

$\left(\frac{Pi}{1 - Pi} \right)$ = Odds ratio

Therefore, a binary regression creates the equation to explore the statistical relationship between the probability of the willingness to pay a price premium and the independent variables. The regression analysis aims to see which factors might contribute positively and negatively to the probability of the willingness to pay a price premium for the GS label. The dependent variable, willingness to pay a price premium, is dichotomous, coded 0 (unwillingness to pay) or 1 (willingness to pay).

7.4.2 The Independent Variables

There have been no studies identifying the factors influencing the probability of the willingness to pay a price premium for CERs with CDM sustainability labels. The research presented in this thesis attempts to identify those factors. In this research, the WTP for CDM sustainability labels is modeled and elicited through a survey. The conceptual model of buyers' WTP for CDM sustainability labels incorporates five independent variables: expected sustainable development benefits (ExpectedSD), expected return on investment (ExpectedROI), involvement in the Gold Standard label (Involvement), importance of the Gold Standard label (Importance), and the attitude towards the host country's duty (Attitude).

7.4.2.1 Expected sustainable development benefits:

According to Nussbaumer [80], CDM projects with sustainability labels can generate more SD benefits than non-label projects. Higher expectations for sustainable development benefits generated by CDM sustainability labels will lead to a higher probability of the willingness to pay a price premium. There was still not enough information about the possible relationship between expected SD benefits and the probability of the WTP. Thus, this variable is included to determine whether expected sustainable development benefit has an influence on the probability of the WTP.

7.4.2.2 Expected return on investment:

In the carbon market, CER buyers can use CERs to meet their own Kyoto targets alternatively they can sell CERs in the emission trading market for speculative purposes. The objective of buying CERs is not only to meet the Kyoto obligation, but also to make profit through the emission trading market. Therefore, some CER buyers may expect to gain profit through the carbon market. In exploring the willingness of consumers to invest in "green shares", Getzner and Grabner-Krauter [32] found that higher expectations for the return on investment lead to a higher probability of investment in "green shares". Therefore, it is reasonable to assume that buyer's perception of ROI has an influence on the probability of the WTP.

7.4.2.3 Involvement in the Gold Standard label:

As previously noted in the clustering variables, the key indicators of consumers' involvement in environmentally certified products are: (i) behavior to seek out product, and (ii) past purchase of products. Therefore, this variable is measured as the sum score on a multi-item scale consisting of questions 10 and 11 in the questionnaire. According to Vlosky [136], a time and effort expended in finding and buying environmentally certified products are translated into a desire or at least a willingness to pay a price premium for environmentally certified products. Moreover, Vlosky found that there is a positive relationship between consumer involvement in environmentally certified products and willingness to pay a price premium for environmentally certified products. Thus, this variable is included to determine whether an involvement in the GS label has an influence on the probability of the WTP.

7.4.2.4 Importance of the Gold Standard label:

As previously noted in the clustering variables, we create three questions (question 12, 13, 14) to measure buyers' attitudes towards the importance of the GS label. Therefore, this variable is measured as the sum score on a multi-item scale consisting of questions 12, 13 and 14. In exploring the willingness of consumers to pay a premium for environmentally certified products, Vlosky [136] found that there was a positive relationship between consumer perception of environmental importance and their willingness to pay a premium for environmentally certified products. Therefore, it is reasonable to assume that an importance of the GS label has an influence on the probability of the WTP.

7.4.2.5 The attitude towards the host country's duty:

As previously discussed in Chapter 5, Erion [26] and Burian [10] found that host countries cannot guarantee the SD benefits of CDM projects. However, the buyer's perception of the host country's duty may not be the same as Erion and Burain's conclusion. Buyers who do not trust in the host country's duty to assess the CDM projects will try to find additional standards to guarantee the sustainability of CDM projects. Buyers with negative attitude towards the host country's duty may pay a price premium for the GS label which can guarantee a high quality of CDM projects in addition to the low requirements given by the host country. Therefore, this variable is included to determine whether the attitude towards the host country's duty has an influence on the probability of the WTP. This variable is measured as the sum score on a multi-item scale consisting of questions 15 and 16.

Based on these five variables, we therefore hypothesize:

Hypothesis 4: Expected sustainable development benefits, expected return on investment, involvement in the Gold Standard label, importance of the Gold Standard label, and the attitude towards the host country's duty are significantly related to the probability of the willingness to pay a price premium for CERs with CDM sustainability label.

7.5 Survey design and data Collection

A survey is designed to collect information from CER buyers in the carbon market. The lists of CER buyers are taken from the UNEP Risoe CDM/JI Pipeline Analysis and Database. However, this database provides only the name of companies, not the name of responsible persons and their E-mail address. The names of responsible individuals are taken from the PDDs of CDM projects. Eliminating many incorrect E-mail and postal address in the PDDs, resulted in a usable list of 295 buyers, as of May 2009. The unit of measurement in this research is the organization, not the individual, so one respondent represents one organization in the carbon market. We asked that participants answer the questions from the perspective of their organization.

A draft questionnaire was developed after a thorough literature review. This draft questionnaire was refined after a review by 3 carbon credit traders at EU companies. The final questionnaire comprises two parts (see Appendix A). The first part is designed to investigate the respondents' demographic information and the respondents' perceptions of the sustainability of CDM projects:

- Demographic information: organization type, nationality of organization, experience in the carbon market, the paid up capital, knowledge in the GS label, and participation in the voluntary carbon market.
- Perceptions of the sustainability: overall image of the GS label, project priority for purchasing carbon credits, ROI of the GS label, involvement in the GS label,

attitude towards an importance of the GS label, and attitude towards the host countries' duties to assess CDM projects.

The second part is designed to investigate the monetary value of SD benefits of CDM projects through WTP. In the second part the WTP questionnaire uses a two-step approach. Respondents are first asked whether they are willing to pay a price premium as follows:

"*There are many reasons to buy Gold Standard CERs such as high sustainable development benefits, low Post-Kyoto risk, low methodology risk, etc. However, this question will consider only the sustainable development benefits. Would your organization be willing to pay a price premium per tonne of CO_2e for CERs from <u>the Gold Standard label</u> in recognition of its contribution to sustainable development? (This price premium given will stand for only the sustainable development benefits, not including other benefits such as low Post-Kyoto risk, low methodology risk, etc.)*"

Those who refuse to pay a price premium are asked to give the reason for that choice. Those who agree to pay a price premium are then asked as follows:

"*If you answered **YES** to question 1, what is the maximum amount you would be willing to pay as a price premium per tonne of CO_2e for CERs with <u>the Gold Standard Label</u> in recognition of the contribution to sustainable development? Assume the current CER price, without any premium, is €10.00 per tonne of CO_2e.*

☐ *1. € 0.10/tCO_2e* ☐ *2. € 0.20/tCO_2e* ☐ *3. € 0.30/tCO_2e* ☐ *4. € 0.40/tCO_2e*

☐ *5. € 0.50/tCO_2e* ☐ *6. € 0.75/tCO_2e* ☐ *7. € 1.00/tCO_2e* ☐ *8. € 1.50/tCO_2e*

☐ *9. € 2.00/tCO_2e* ☐ *10. Other*_______________"

Moreover, they are asked to give the reason for willingness to pay. Finally, we provide the space for participants to give the qualitative comments for this survey. Respondents required approximately 15 minutes to complete this questionnaire.

An online survey method was chosen to collect the data. Online questionnaires (http://www.kwiksurveys.com/online-survey.php?surveyID=OKJHK_f437b2ba) were sent to these buyers between September and November 2009. Online survey has several advantages: it is inexpensive, it does not suffer from interviewer bias, and respondents are likely to feel more comfortable answering sensitive questions (MacKerron *et al*. [69]). In order to increase the response rate, we offered anonymised research results and entry in a free prize draw to the participants.

7.6 Data Analysis

SPSS (Statistical Package for the Social Sciences) was used for data analysis. The statistic methods applied in the analysis are as follows:

i) Analysis of organizational characteristics by using percentage, means, and standard deviation to explain general characteristics of sample group.

ii) Classifying CER buyers according to their attitudes towards and involvement in CDM sustainability labels by using K-means method.

iii) The analysis to find the validity of the two cluster solution by using hierarchical method and discriminant analysis.

iv) Analysis of the differences between the two buyer clusters based on a set of additional variables by using a cross-tabulation and the chi-square statistic.

v) The analysis to find the willingness to pay a price premium for CDM sustainability label by using CVM to find mean of the willingness to pay which was retrieved from the questionnaire.

vi) Analysis of the relationship between independent variable and dependent variables by using binary regression to examine which factors might contribute positively and negatively to the probability of the willingness to pay a price premium for the Gold Standard label.

Chapter 8

Research Results: Classifying CER Buyers and Willingness to Pay a Price Premium for CDM Sustainability Label

8.1 Introduction

This Chapter presents the research results from the survey conducted between September and November 2009. Online questionnaires were sent to the list of 295 buyers which can be found in UNEP-Risoe website. The unit of measurement in this research is the organization, not the individual, so one respondent represent one organization in the carbon market. We suggested that the participants answered the questions from the perspective of their organization. In order to increase the response rate, we offered anonymised research results and entry in a free prize draw to the participants. With a response rate of 40% the survey generated 117 valid questionnaires. The numbers of the usable questionnaires is higher than those found in previous research. Exploring the price premium for CDM credits, Asuka and Okimura [4] conducted a survey in the carbon market with 82 usable questionnaires from CER buyers. Lappalainen [64] conducted a survey investigating carbon offset practices of EU companies receiving 47 usable questionnaires. More recently, Sterk et al. [105] conducted a survey of the demand for GS CERs and buyer's willingness to pay a price premium for GS CERs. Sterk et al. sent questionnaires to 55 carbon credit buyers in the compliance market and received only 19 usable questionnaires. The characteristics of our 117 respondents will be presented in the next section.

This chapter first describes the organizational characteristics of respondents. Secondly, we present the results of cluster analysis. Next, we discuss the outcomes related to the answers to the questions on WTP for the Gold Standard carbon credits. Finally, we present the results of econometric estimations.

8.2 The Reliability of Questionnaires

As discussed in the research methods, we must check if the five statements used as variables in cluster analysis and regression analysis measure the same dimension. The

Cronbach alpha was used to measure the reliability of these statements. These five statements are shown in Table 8.1.

Does your organization agree or disagree with the following statements: (question 10-14)

10. My organization has purchased CERs from Gold Standard label in the past year.
11. If available, I would seek out CERs from Gold Standard label.
12. My organization believes there is a need for Gold Standard label in the carbon market.
13. My organization believes Gold Standard label can guarantee the sustainable development benefits of CDM projects.
14. My organization believes Gold Standard label can help improve the CDM's contribution to sustainable development.

Table 8.1: The statements are evaluated by the Cronbach method

Cronbach alpha is a coefficient of reliability. It is commonly used as a measure of the internal consistency or reliability of a psychometric test score for a sample of examinees. It measures how well a set of variables or items measures a single, one-dimensional latent aspect of individuals. Nunnally [80] suggested that a Cronbach alpha greater than 0.70 demonstrates a high reliability. Churchill [16] and Robinson [97] suggested that a cut off point of 0.6 is used as the minimum. The Cronbach alpha for these five statements was 0.862, representing a high reliability. Therefore, all these five statements were used for cluster analysis.

8.3 Demographic and Organizational Characteristics of Respondents

8.3.1 Nationality and Type of Organization

Table 8.2 show the information on the nationality and organization type of respondents. In this study the majority of participants were European organizations (55.56%), distantly followed by Japanese organizations (11.97%), US and Canadian organization (11.11%), Multinational organizations (11.11%), and Australian and New Zealand organizations (7.69%). Although the US has not ratified the Kyoto Protocol, we include the US organization in this survey. This is because the U.S. can buy emission permits from the members of the Kyoto Protocol for meeting its emission reduction targets under the US cap-and-trade programs (see 6.1.3). Certainly, there are no regulations which prohibit members of the Kyoto Protocol from selling emission permits to nonparty countries. Thus, the United States can act as a buyer of emission permits. Regarding organization type, the majority of participants were private organizations (86.33%), distantly followed by governments (7.69%), and charities (5.98%).

	Number	%
Nationality		
Europe	65	55.56
Australia&New Zealand	9	7.69
USA&Canada	13	11.11
Japan	14	11.97
Multinationality	13	11.11
Other Coutries	3	2.56
Total	117	100
Organization Type		
Private Organization	101	86.33
Government	9	7.69
Charity	7	5.98
Total	117	100

Table 8.2: Nationality and organization type

8.3.2 Organization's Experience in the Carbon Market

Table 8.3 provides information on organization's experience in the carbon market. The table shows that most participants have 3 years of experience in the carbon market (19.66%), followed by companies with more than 8 years of experience (17.95%). Few of them have 7 years and 8 years experience in the carbon market at only 4.27% and 1.71% respectively.

Experience	Number	%
1 year	6	5.13
2 years	15	12.82
3 years	23	19.66
4 years	17	14.53
5 years	16	13.67
6 years	12	10.26
7 years	5	4.27
8 years	2	1.71
More than 8 years	21	17.95
Total	117	100

Table 8.3: Organization's experience in the carbon market

8.3.3 The Paid Up Capital

A question concerning the paid up capital is applied to only the participants in the group of private organizations. The paid up capital is the amount of money that has been received by shareholders who have completely paid for their purchased shares. A classification of the participants by paid up capital (Table 8.4) indicated that most participants were companies with paid up capital less than 1 million Euros (38.62%) and between 1 – 10 million Euros (20.79%). The companies with paid up capital of more than 1 billion Euros accounted for 18.81% of all participating companies. Few of them were companies with paid up capital between 500 – 1,000 million Euros (3.96%).

The Paid Up Capital	Number	%
less than 1 million Euros	39	38.62
1 - 10 million Euros	21	20.79
11 - 99 million Euros	12	11.88
100 - 499 million Euros	6	5.94
500 - 1,000 million Euros	4	3.96
More than 1 billion Euros	19	18.81
Total	101	100

Table 8.4: The paid up capital

8.4 Participation in the Voluntary Carbon Market

According to World Bank [143], participation in the voluntary carbon offset market reflects a positive attitude towards the environment. Consequently, this study use firm's participation in the voluntary carbon offset market to assess if participants were aware of climate change. The participants were asked about their participation in the voluntary carbon market, "*Has your company purchased carbon credits for offsetting its own emissions in the voluntary carbon offset market*". 33.33% of the participants have purchased carbon credits from the voluntary carbon offset market (Table 8.5). In other words, they have purchased carbon credits from both the compliance market and voluntary market. However, the majority of the participants have participated in only the compliance market. With respect to the nationality of organization Australian and New Zealand organizations were becoming more aware of climate change. More than a half of participants of these three countries (78%) have purchased carbon credits for offsetting their own emissions in both the compliance market and voluntary market. Regarding organization type, charities were more aware of climate change than other organization types. 43% of charities had purchased carbon credits from both the compliance market and voluntary market.

Participation in the Voluntary Market	Number	%
No Participation	78	66.67
Participation	39	33.33
Total	117	100

Table 8.5: Participation in the voluntary carbon market

8.5 Ethical Purchasing Policy for Carbon Credits

There is a widespread perception that industrial gas projects (HFC, N2O, PFC projects) can deliver huge volumes of CERs, so they can attract CER buyers to invest in them. However, these prejects cannot create many jobs and also cannot contribute directly to community development (Erion [26], Kolshus [59], Michaelowa [74]). So carbon credits generated by the industrial gas projects represent low quality carbon credits in term of the SD benefits. Currently, the carbon market is worried about these buyers' behavior. Erion [26] recommend CER buyers to apply "an ethical purchasing policy" for purchasing carbon credits in the compliance market. According to Erion, an ethical purchasing policy will give the first priority to carbon credits generated by the renewable energy projects and give the last priority to carbon credits generated by the industrial gas projects (HFC, N_2O, PFC projects). This policy will make organizations purchase carbon credits from project with high SD benefits.

In this study we use the project priority for purchasing carbon credits to represent the organization's ethical purchasing policy. This study will assess whether the organizations purchase CERs in accordance with an ethical purchasing policy. Therefore, the participants were asked, "*What is your first project priority between the renewable energy projects and the industrial gas projects (HFCs, PFCs, N2O project) in purchasing carbon credits?"* Finally, the result showed that nearly all organizations gave the first priority to carbon credits generated by the renewable energy projects (Table 8.6). We received 116 usable valid questionnaires for this question because one respondent report that his company has no priority for purchasing carbon credits. 91.38% gave the first project priority to the renewable energy projects, whereas the remaining 8.62% gave the first project priority to the industrial gas projects. One participant states that "*I would choose to buy carbon credits from my own list of positive* *projects excluding the industrial gas projects.*[3]" These comments from respondent also clearly represent that this buyer is concerned with the SD benefits generated by projects. This result implied that CER buyers were becoming more concerned with ethical behavior in purchasing carbon credits. So the results may make the carbon market to be less worried about the ethical behavior of CER buyers.

Project priority	Number	%
the renewable energy projects	106	91.38
the industrial gas projects	10	8.62
Total	116	100

Table 8.6: Project priority

Although the industrial gas projects (HFC, N_2O, PFC projects) dominated the carbon market as discussed in Chapter 6, this research result imply that the proportion of the industrial gas projects in CDM market is decreasing. This is because many organizations increasingly prefer to purchase carbon credits generated by the renewable energy projects than those generated by the industrial gas projects. Therefore, this result shows an optimistic trend in the distribution of CDM project type in the future.

8.6 An Overall Image of Gold Standard Label

In this study, "overall image" refer to CER buyers' overall perceptions of CDM sustainability labels, formed by processing information and by prior knowledge about CDM sustainability labels. To investigate the carbon market's general view of the Gold Standard label, the participants were asked to assess its image and the possible answers to select from very negative, fairly negative, neither positive nor negative, fairly positive, and very positive. The results show that an overall image of GS label was fairly positive with a mean score of 4.04 (Table 8.7 and 8.8). 53.85% of participants viewed that an overall image was fairly positive and 26.5% of participants viewed that an overall image was very positive. Few of them (2.56%) viewed that an overall image was fairly negative. More clearly, no participant viewed that an overall image was very

[3] Author's survey.

negative. The GS label has the strength in its image with an optimistic view reported by more than 75% of buyers.

	Number	%
Very negative	-	-
Fairly negative	3	2.56
Neither positive nor negative	20	17.09
Fairly positive	63	53.85
Very positive	31	26.50
Total	117	100

Table 8.7: An overall image of Gold Standard label

Statistical Result	Score
Mean	4.04
Std. Deviation	0.736
Minimum	2
Maximum	5

Table 8.8: Statistical results of an overall image of Gold Standard label

8.7 Buyers' Knowledge in CDM Sustainability Labels

Increased product knowledge also plays a positive role on whether consumers believed the net benefits of product (Wheeler [139]). Therefore, one would expect that people with excellent knowledge of CDM sustainability labels will be confident with the benefits of buying carbon credits from accredited projects. This study will explore buyers' knowledge of CDM sustainability labels by using the Gold Standard (GS) and the Climate, Community, and Biodiversity Alliance Standard (CCB Standards) as case studies. Moreover, we will investigate whether buyers' knowledge in each label are substantially different. In other words, we will investigate whether buyers' knowledge in the GS differs from those in the CCB Standards. This study followed Wheeler [139] to use buyers' self-perception of their own knowledge as a proxy for knowledge. The respondents were asked to conduct the self-assessment of their knowledge in the Gold Standard and the CCB Standards. The possible answers to select are from no knowledge; poor; fair, good; and excellent. This may not reflect their true knowledge. However Wheeler concluded that we can trust the knowledge given by self-assessment because there was a high correlation between the knowledge derived from a test question and the knowledge derived from an individual's self-perception. Moreover, a test question may make CER buyers feel uncomfortable with the score they get from the test and CER buyers cannot spend too much time on a lot of test questions, so it is impossible to design a test question with right or wrong answer[4]. When asked about their knowledge in the GS, 43.59% have good knowledge in label, while 4.27% have no knowledge in this label (Figure 8.1). The majority of buyers have a high level of knowledge in this label with a mean score of 3.55 (Table 8.9).

On the other hand the majority of buyers have a low level of knowledge in the CCB Standards with a mean score of 2.53 (Table 8.9). When asked about their knowledge in the CCB Standards, 25.64% have no knowledge in label and 24.79% have poor knowledge. Only 4.27% have excellent knowledge in the CCB Standards (Figure 8.1). The results clearly showed that buyers have better knowledge in the Gold Standard than knowledge in the CCB Standards.

To investigate statistically the differences of the buyers' knowledge in these two labels, we applied the Paired Samples T-test, the parametric test for testing the differences between the means of two variables. This hypothesis can be written as:

H_0: On average there is no difference between the knowledge in the two labels.

H_1: On average there is a difference between the knowledge in the two labels.

The analyzed results clearly show that the differences between buyers' knowledge in the GS and those in the CCB Standards are statistically significant at the 99% confidence level (Table 8.10). Moreover, there is also a slight positive correlation between the knowledge in the two labels. The correlation is statistically significant at the 99% confidence level (Table 8.11). This means that buyers who have a high level of knowledge in the GS also have a high level of knowledge in the CCB Standards.

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[4] Interviewed with Mr.Boonrod Yaowapruek, Carbon Trader at Eneco Energy Trade.

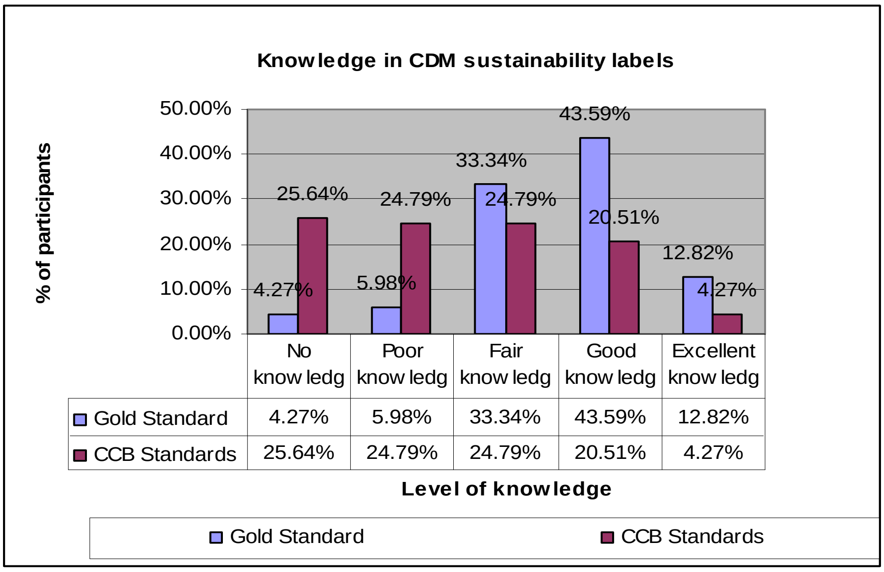

Figure 8.1: Knowledge in CDM sustainability labels

	Mean	N	Std. Deviation
Knowledge in the Gold Standard	3.55	117	.942
Knowledge in the CCB Standards	2.53	117	1.200

Table 8.9: Statistical results of knowledge in Gold Standard label

	Mean	Std. Deviation	Std. Error Mean	99% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
				Lower	Upper			
Knowledge in Gold Standard - Knowledge in CCB	1.02	1.320	.122	.70	1.34	8.338	116	.000

Table 8.10: Paired samples test

	N	Correlation	Sig.
Knowledge in Gold Standard & Knowledge in CCB	117	.260	.005

Table 8.11: Paired samples correlations

8.8 Involvement in the Gold Standard Label

To investigate buyers' involvement in the GS label, the participants were given the two statements to consider. The participants must give the answer on a five-point Likert scale. When given the first statement - "*My organization has purchased CERs from Gold Standard label in the past year*", 47.01% of respondents totally disagreed with the statement, 25.64% disagreed, 12.82% totally agreed, 8.55% agreed, and 5.98% not sure (Table 8.12). The mean score was 2.15 for this statement. Considering the second statement – "*If available, I would seek out CERs from Gold Standard label*", 30.77% of respondents agreed with this statement, 21.37% not sure, 18.8% disagreed, 17.09% totally agreed, and 11.97% totally disagreed (Table 8.12). The mean score was 3.22 for this statement. The results showed that most participants have not purchased CERs from GS label. However, most participants have a strong intention to buy CERs from GS label in the future.

Survey statement	Totally Disagree	Disagree	Not Sure	Agree	Totally Agree	Mean on the Likert scale	S.D.
My organization has purchased CERs from Gold Standard label in the past year.	47.01% (55)	25.64% (30)	5.98% (7)	8.55% (10)	12.82% (15)	2.15	1.42
If available, I would seek out CERs from Gold Standard label.	11.97% (14)	18.80% (22)	21.37% (25)	30.77% (36)	17.09% (20)	3.22	1.27

Table 8.12: Involvement in the Gold Standard label

8.9 The Attitude towards an Importance of the Gold Standard Label

To investigate buyers' attitude towards the importance of the GS label, the participants were asked whether they agreed with the three statements. When the participants were asked, "*Does your organization agree or disagree with this statement – "My organization believes there is a need for Gold Standard label in the carbon market"*", 39.32% of participants agreed with this statement, 24.79% totally agreed, 17.09% not sure, 11.11% disagreed, and 7.69% totally disagreed (Table 8.13). The mean score was 3.62 for this statement. The results clearly indicated that most buyers believed that there is a need for the GS label in the carbon market. Considering the second statement – "*My organization believes Gold Standard label can guarantee the sustainable development benefits of CDM projects*", 37.61% of respondents agreed with this statement, 24.79% not sure, 17.09% totally agreed, 12.82% disagreed, and 7.69% totally disagreed (Table 8.13). The mean score was 3.44 for this statement. Regarding the last statement – "*My organization believes Gold Standard label can help improve the CDM's contribution to sustainable development*", 47.01% of respondents agreed with this statement, 22.22% not sure, 17.95% totally agreed, 6.84% disagreed, and 5.98% totally disagreed (Table 8.13). The mean score was 3.64 for this statement.

All these results clearly showed that most buyers have an optimistic view on the GS label. In the viewpoint of buyers the GS label is very important in terms of its contribution to SD. Most buyers have a positive attitude towards the GS label.

Survey statement	Totally Disagree	Disagree	Not Sure	Agree	Totally Agree	Mean on the Likert scale	S.D.
My organization believes there is a need for Gold Standard label in the carbon market.	7.69% (9)	11.11% (13)	17.09% (20)	39.32% (46)	24.79% (29)	3.62	1.19
My organization believes Gold Standard label can guarantee the sustainable development benefits of CDM projects.	7.69% (9)	12.82% (15)	24.79% (29)	37.61% (44)	17.09% (20)	3.44	1.15
My organization believes Gold Standard label can help improve the CDM's contribution to sustainable development.	5.98% (7)	6.84% (8)	22.22% (26)	47.01% (55)	17.95% (21)	3.64	1.05

Table 8.13: Buyers' attitude towards an importance of the Gold Standard label

8.10 Classification of CER Buyers by Cluster Analysis

The results of a literature review indicated that the carbon market is separated into the two segments. Consequently, we used the two-cluster solution for K-means clustering. However, we firstly applied the hierarchical method to find the appropriateness of the two-cluster solution and after classifying the buyers by the K-means method we applied a discriminant analysis to recheck the appropriateness of this solution.

The hierarchical method was first performed to create a hierarchy in the form of a treelike structure called a dendrogram to see the relationship among observations. By the hierarchical procedure, the dendrogram clearly suggested that the two clusters would be appropriate for this study (see Figure 8.2). Therefore, the two-cluster solution was used as the starting process for K-means clustering.

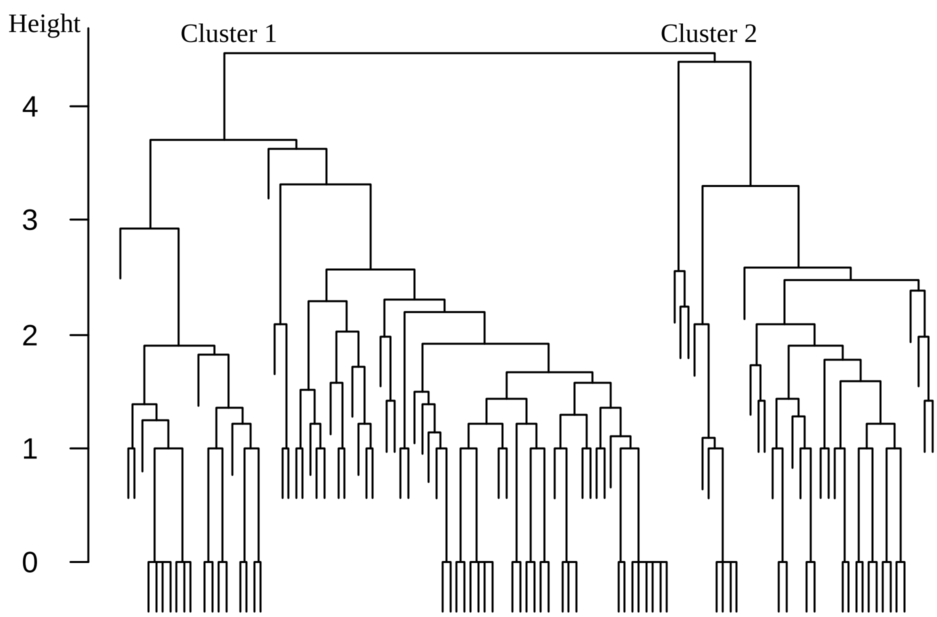

Figure 8.2: Jointing-tree cluster analysis output: Dendrogram

The K-means clustering was performed using the five clustering variables measuring buyers' involvement with SD labels and buyers' attitudes towards labels as independent variables. Finally, two clusters of the CER buyers were identified. These clusters varied with respect to buyers' attitude towards and involvement in the GS label.

After clustering the buyers into two groups, we performed a discriminant analysis to investigate whether the two-cluster solution was appropriate and whether these two clusters were really homogenous within clusters and different between clusters. Discriminant analysis was used with cluster membership as the grouping variable and the five clustering variables as the independent variables. The results showed that 95.7% of the original clustered cases were correctly classified (See Table 8.14) confirming that the two-cluster solution is valid.

Actual group	Total	Predicted group membership		Percentage correct
		Cluster 1	Cluster 2	
Cluster 1	55	51	4	92.7%
Cluster 2	62	1	61	98.4%
Overall percentage				95.7%

Table 8.14: Classification table

Table 8.15 shows means of final cluster centers and the significance testing of differences between cluster centers. For each cluster, the mean values of the five clustering variables were provided along with the univariate *F* ratios and levels of significance comparing the differences between the cluster means. Means of all five clustering variables were significantly different between the two clusters at the 0.01 level using the univariate *F* test (see Table 8.15). These results ensure that the two groups are truly distinctive. Therefore, the means of all five clustering variables were used to interpret and name the segment.

Summary of means of final cluster centers				
Clustering variables	Cluster		*F*	Significance
	1 (n=55)	2 (n=62)		
(1) My organization has purchased CERs from Gold Standard label in the past year.	0.652	-0.579	70.677	0.000
(2) If available, I would seek out CERs from Gold Standard label.	0.725	-0.643	101.986	0.000
(3) My organization believes there is a need for Gold Standard label in the carbon market.	0.696	-0.617	87.748	0.000
(4) My organization believes Gold Standard label can guarantee the sustainable development benefits of CDM projects.	0.634	-0.563	64.634	0.000
(5) My organization believes Gold Standard label can help improve the CDM's contribution to sustainable development.	0.639	-0.567	66.093	0.000

Table 8.15: Results of cluster analysis for CER buyers

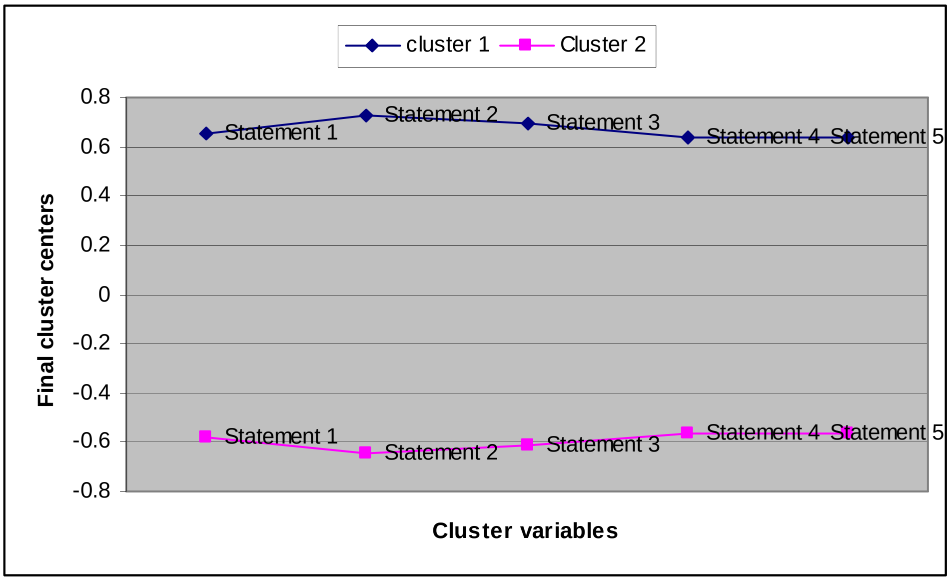

Figure 8.3: Mean values of clustering variables

8.10.1 Cluster 1: Buyers Favouring CERs with Sustainability Labels

Members of Cluster 1 have higher mean scores across all clustering variables than those of Cluster 2 (see Figure 8.3), showing that this group has strong preference for the GS label. Consequently, this cluster containing 55 buyers (47% of respondents) was described as *buyers favouring CERs with sustainability labels*. These buyers require the additional standard to ensure the sustainability of CDM projects. Considering buyers' involvement in the GS label: most buyers who have purchased CERs from the GS label in the past were in Cluster 1 and 84% of buyers in this group have strong intentions to purchase GS labelled CERS in the future. There was only one buyer in Cluster 2 who had purchased CERs from the GS label. Regarding buyers' attitudes towards the importance of the GS label; 95% of buyers in this group believed that there is a need for the GS label in the carbon market. Moreover, 84% of buyers in this group believed that the GS label can guarantee the SD benefits of CDM projects. Finally, a high level of buyers in this group (93%) believed that the GS label can help improve the CDM's contribution to SD. These results strongly confirmed that buyers in this group have a positive attitude towards an importance of the GS label. Of this group, they had an average of 4.9 years of experience in the carbon market, 60% were European, followed by US and Canadian (12.73%), and Multinational organizations (9.09%).

8.10.2 *Cluster 2: Buyers Favouring Non-Labelled CERs*

Members of Cluster 2 gave low scores to all clustering variables, showing that this group had a low preference for the GS label. Therefore, this group was described as *buyers favouring non-labelled CERs*. This cluster contained 62 buyers (53% of respondents). Some 97% of buyers in this group have not purchased CERs from the GS label in the past. No buyers in this group totally agreed with the second statement asking about future buying intentions towards the GS label. More clearly, 55% of buyers in this group have no intention of purchasing CERs from the GS label. These results clearly showed that these buyers were the least involved in the GS label. Most buyers in this group did not believe that there is a need for the GS label in the carbon market. In contrast with the previous cluster, most buyers did not believe that the GS label could guarantee the SD benefits of CDM projects and improve the CDM's contribution to SD. These results strongly confirmed that buyers in this group have a negative attitude towards an importance of the GS label. Members of this group, had an average of 5.2 years of experience in the carbon market, 51.61% were European, followed by Japanese (16.13%), and Multinational organizations (12.90%). Most nationalities excluding Japanese seem to be equally distributed between the two clusters. Japanese organizations were more likely to be in Cluster 2 (16.13%) than in Cluster 1 (7.27%), but these differences were not statistically significant.

8.11 Profiling the Cluster Members on Additional Variables

In order to understand the characteristics of each cluster better a set of additional variables were used to develop more detailed profiles (see Table 8.16).

1) organization type
2) paid up capital,
3) buyers' perception of SD benefits generated by the GS project,
4) buyers' perception of return on investment of CERs from the GS project,
5) overall image of the GS label,
6) buyers' participation in the voluntary carbon offset market,
7) priority for purchasing carbon credits,
8) buyers' knowledge in the GS label,
9) attitude towards the host country's duty to assess the sustainability of CDM projects,
10) buyers' willingness to pay.

Table 8.16: Additional variables for cluster profiling

To determine if differences exist based on this set of additional variables, a cross-tabulation was employed to identify the profiles of the two buyer clusters. The chi-square statistic was used to determine if there were any statistically significant differences between the two buyer clusters (see Table 8.17 and 8.18).

Characteristics	Cluster 1: Buyers favoring labelled CERs	Cluster 2: Buyers favoring non-labelled CERs	Chi-square	Significance
Organization type	Profit organization (80%); non-profit (20%)	Profit organization (92%); non-profit (8%)	3.517	0.061*
The paid up capital	< 100 million Euros (82%); >= 100 million Euros (18%)	< 100 million Euros (63%); >= 100 million Euros (37%)	4.224	0.040**
An overall image of label	Very positive (49%); fairly positive (45.5%); neither positive nor negative (5.5%); fairly negative (0%)	Very positive (6.4%); fairly positive (61.3%); neither positive nor negative (27.4%); fairly negative (4.9%)	32.244	0.000***
Perception of SD benefits (Comparing SD benefits generated by labelled project with non-labelled project)	Labelled project higher than non-labelled project (87%); the same as non-labelled project (13%); lower than non-labelled project (0%)	Labelled project higher than non-labelled project (42%); the same as non-labelled project (55%); lower than non-labelled project (3%)	25.995	0.000***
Perception of ROI (Comparing ROI of CERs from labelled project with non-labelled project)	Labelled project higher than non-labelled project (64%); the same as non-labelled project (22%); lower than non-labelled project (14%)	Labelled project higher than non-labelled project (40%); the same as non-labelled project (45%); lower than non-labelled project (15%)	7.734	0.021**

*** Significant at $P < 0.01$ level; ** Significant at $P < 0.05$ level; * Significant at $P < 0.10$ level

Table 8.17: Profile of the two buyer clusters on a set of additional variables

Characteristics	Cluster 1: Buyers favoring labelled CERs	Cluster 2: Buyers favoring non-labelled CERs	Chi-square	Significance
Participation in voluntary market	Yes (42%); No (58%)	Yes (26%); No (74%)	3.362	0.067*
The project priority for purchasing carbon credits	Renewable energy (98%); Industrial gas (2%)	Renewable energy (85%); Industrial gas (15%)	6.144	0.013**
Knowledge in the label	Excellent (18%); good (53%); fair (27%); poor (2%); no knowledge (0%)	Excellent (8%); good (35%); fair (39%); poor (10%); no knowledge (8%)	12.903	0.012**
Attitude towards the host country's duty (I cannot rely on a host country's criteria to assess the sustainable development benefits of CDM projects)	Totally agree (13%); agree (34%); not sure (42%); disagree (9%); totally disagree (2%)	Totally agree (0%); agree (39%); not sure (26%); disagree (29%); totally disagree (6%)	17.630	0.001***
Willingness to pay a price premium for the label	Yes (82%); No (18%)	Yes (34%); No (66%)	27.249	0.000***

*** Significant at $P < 0.01$ level; ** Significant at $P < 0.05$ level; * Significant at $P < 0.10$ level

Table 8.18: Profile of the two buyer clusters on a set of additional variables (Cont.)

Table 8.17 and 8.18 shows the results of the chi-square analysis and a cross-tabulation between the two buyer clusters and a set of additional variables. As we can see, the two buyer clusters have distinctive profiles on this set of additional variables. However, these differences were statistically significant at levels ranging from the 0.01 to the 0.10. The details of these results were the following.

8.11.1 Organization Type

Non-profit organizations, including governments, and the charities were more likely to be in Cluster 1 (20%) than in Cluster 2 (8%). While, Cluster 2 had a higher percentage of private organizations (92%). These differences were statistically significant at the

0.10 level. This may be because non-profit organizations are potentially inclined to contribute to environment (Basili *et al*. [5]).

8.11.2 The Paid up Capital

An analysis concerning the paid up capital is only applied to private organization. Private companies with the paid up capital <100 million Euros were more likely to be in Cluster 1 (82%) than in Cluster 2 (63%). On the other hand, companies with large paid up capital (≥100 million Euros) were more likely to be in Cluster 2. These differences were statistically significant at the 95% confidence level.

8.11.3 An Overall Image of the GS Label

A firm’s image plays a critical role in consumer’s decision-making process. Based on this variable, the two clusters were significantly different at the 99% confidence level. The proportion of buyers who viewed that an overall image of the GS label was fairly positive and very positive is significantly higher in Cluster 1 (94.5%) than in Cluster 2 (67.7%). In other words, buyers with a positive view of the GS label were more likely to be in Cluster 1 than in Cluster 2. These results were consistent with Han *et al*. [42] who reported that an overall image of a green hotel has a positive influence on demand for a green hotel.

8.11.4 Buyers’ Perception of SD Benefits Generated by the GS Project

As previously noted, Nussbaumer [80] found that CERs generated by the GS projects generate higher SD benefits. However, the buyer’s perception of SD profile of GS projects may not be the same as Nussbaumer’s conclusion. In this study the SD benefits generated by the GS label represent the social benefits of CDM projects. Based on this variable, there were statistically significant differences between the two buyer clusters at the 99% confidence level. Cluster 1 (87%) had a higher proportion of buyers who perceived that the expected SD benefits generated by project with GS label are higher than similar non-labelled project than Cluster 2 (42%). Most buyers in Cluster 2 (55%) believed that the expected SD benefits generated by project with GS label are the same as similar non-labelled project. There were no buyers in Cluster 1 who believed that the expected SD benefits generated by projects with GS label are lower than similar non-labelled project. Therefore, buyers with positive perception of the SD benefits generated by the GS projects were more likely to be in Cluster 1. These results were consistent with Getzner and Grabner-Krauter [32] who found that the higher social benefits of product lead to higher demand for that product.

8.11.5 Buyers' Perception of Return on Investment (ROI) of CERs from the GS Project

The objective of buying CERs is not only to meet the Kyoto obligation, but also to make profit on the emission trading market. Providing shareholders and investors with returns on investment (ROI) in carbon credits is one of the purposes of carbon funds. ROI of the GS label also reflects the product value. According to Getzner and Grabner-Krauter [32], purchase and investment decisions can be assumed to be correlated with expectations of profit. Consumers expecting higher profitability (higher benefits) might be willing to demand more of the product or investment. Based on this variable, the two clusters were significantly different at the 95% confidence level. A greater proportion of Cluster 1 members (64%) believed that ROI of CERs from the GS label is higher than non-labelled project compared to members of Cluster 2 (40%). Most buyers in Cluster 2 (45%) believed that ROI of CERs from the GS label is the same as non-labelled project. Clearly buyers with positive perception of ROI of CERs from the GS label were more likely to be in Cluster 1.

8.11.6 Buyers' Participation in the Voluntary Carbon Offset Market

According to Laroche *et al*. [65], environmental consciousness leads an increasing number of individuals to engage in environmentally friendly activity in their everyday lives. Attitudes towards environment will represent environmental consciousness which is positively correlated to environmentally friendly buying behaviours. Based on this variable, the two clusters were significantly different at the 0.10 level. Organizations that participated in the voluntary carbon market were more likely to be in Cluster 1 (42%) than in Cluster 2 (26%). These results were consistent with Kotchen and Reiling [62] who reported that attitudes towards environment are good predictors of environmentally based actions and participation decisions.

8.11.7 *The Project Priority for Purchasing Carbon Credits*

As previously noted, an ethical purchasing policy would prioritize carbon credits generated by renewable energy projects and give lowest priority to carbon credits generated by industrial gas projects. The results clearly showed that the proportion of buyers who gave the first project priority to the industrial gas projects was significantly higher in Cluster 2 (15%) than in Cluster 1 (2%). These differences were statistically significant at the 95% confidence level. Only one buyer in cluster 1 gave the first project priority to the industrial gas projects.

8.11.8 *Buyers' Knowledge in the GS Label*

Buyers who have good or excellent knowledge of the GS label were more likely to be in Cluster 1 (71%) than in Cluster 2 (43%). Cluster 2 had a higher percentage of buyers who have a low level of knowledge of the GS label. These differences were statistically significant at the 0.05 level. More clearly, there were no buyers in Cluster 1 who have no knowledge of the label. According to Wheeler [139], increased product knowledge also plays a positive role on whether consumers believe the claimed benefits of a product. Therefore, buyers with a high level of knowledge in CDM sustainability label will be confident with the benefits of buying CERs from projects with CDM sustainability label.

8.11.9 *Buyers' Attitude Towards the Host Country's Duty to Assess the Sustainability of CDM Projects*

As previously discussed, there are no international standards for the host country approval processes or the host country SD criteria for assessing CDM projects. Erion [26] and Burian [10] found that host countries cannot guarantee the SD benefits of CDM projects. However, the buyer's perception of the host country's duty may not be the same as Erion and Burain's conclusion. Therefore, this study sought to test buyers' attitudes towards the host country's duty guarantee SD benefits from CDM projects. The participants asked whether they agreed with the statement; "*I cannot rely on a host country's criteria to assess the sustainable development benefits of CDM projects*". The participants gave answers on a five-point Likert scale where, 1 = totally disagree and 5

= totally agree. The results showed that buyers who agreed and totally agreed with this statement were more likely to be in Cluster 1 (47%) than in Cluster 2 (39%). These differences were statistically significant at the 99% confidence level. More clearly, there were no buyers in Cluster 2 who totally agreed with this statement. This means that buyers with a negative attitude towards the host country's duty were more likely to be in Cluster 1. This may be because buyers who do not trust in the host country's duty to assess the CDM projects will try to find other standards to guarantee the sustainability of CDM projects.

8.11.10 Buyers' Willingness to Pay a Price Premium for the Label

When asked about their willingness to pay (WTP) a price premium for the GS label in recognition of its contribution to SD, Cluster 1 (82%) had a higher proportion of buyers who were willing to pay a price premium than Cluster 2 (34%). These differences were statistically significant at the 99% confidence level. These results suggest that CDM sustainability labels can attract a price premium for the SD benefits from buyers favoring them. However, not all buyers who seek environmentally certified products are necessarily willing to pay a price premium (Aguilar and Vlosky [2]). This is observable in Cluster 1 where 18% were not willing to pay a price premium for the SD label.

8.12 WTP Responses

This study investigates whether buyers are willing pay a price premium for GS CERs, so the participants were asked, "*Would you be willing to pay a price premium per tonne of CO_2e for CERs from the Gold Standard label in recognition of its contribution to sustainable development?*" The results of buyers' WTP are presented in Figure 4. 56.4% of the buyers were willing to pay a price premium, whereas the remaining 43.6% were not willing to pay (see Figure 8.4).

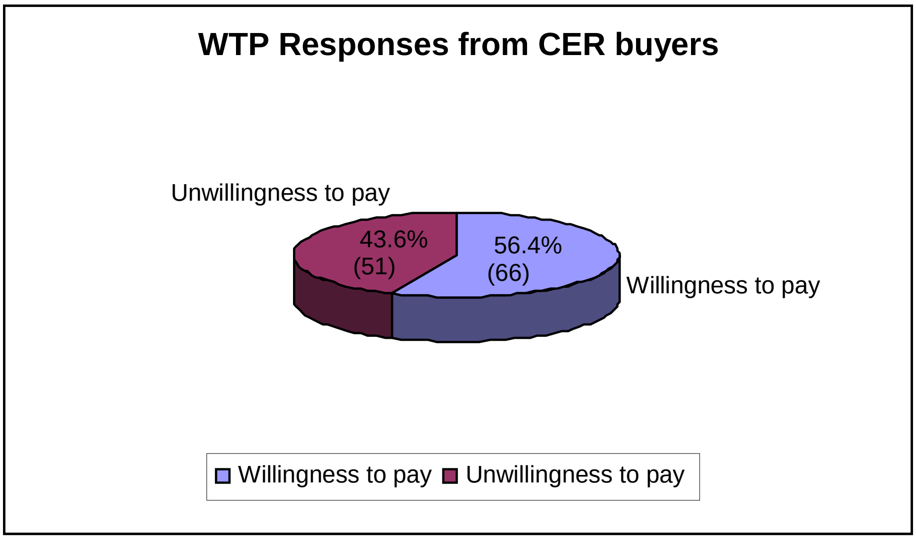

Figure 8.4: WTP responses from CER buyers

8.12.1 WTP Responses in Relation to Organization Type

Considering the aspect of organization type against responses to the WTP question, it is clearly seen that the highest number of buyers that are willing to pay was found in the charity group (85.71%), followed by the government group (77.78%). As expected, the charity group and the government group have a greater percentage of the "yes" WTP responses than the private group (Table 8.19). In other words the charity and the government are more willing to pay than the private group.

Organization Type	WTP Responses			
	Yes		No	
	Number	%	Number	%
Private Organization	53	52.48	48	47.52
Government	7	77.78	2	22.22
Charity	6	85.71	1	14.29
Total	66	56.40	51	43.60

Table 8.19: WTP responses by organization type

Figure 8.5 showed the "yes" WTP response in relation to type of organization. As expected, the data showed that there was an obvious trend in the "yes" WTP response in relation to type of organization. Non-profit organizations tend to be more willing to pay than profit organizations.

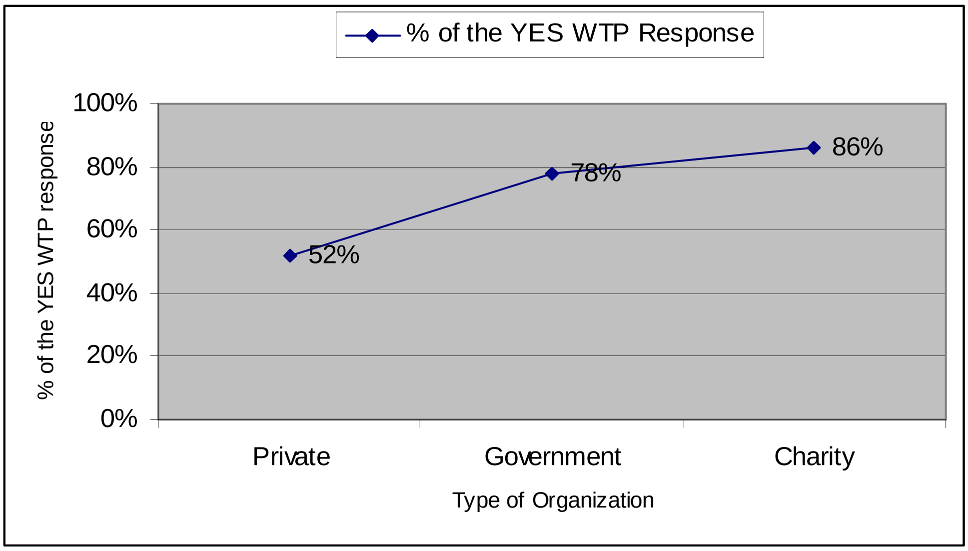

Figure 8.5: WTP responses in relation to type of organization

8.12.2 WTP Responses in Relation to Overall Image of Gold Standard Label

WTP responses were different among the groups of buyers' perception of image of Gold Standard label (Table 8.20). The group with a "*very positive image*" showed a highest occurrence of the "yes" WTP responses. As can be seen, 87.10% of buyers in the group with a "*very positive image*" were willing to pay a price premium. On the other hand the group with a "*fairly negative image*" showed a lowest occurrence of the "yes" WTP responses. As can be seen, 100% of buyers in the group with a "*fairly negative image*" were not willing to pay. The groups with a "*very positive image*" and "*fairly positive image*" have a greater percentage of the "yes" WTP responses than the group of "*neither positive nor negative image*" and "*fairly negative image*".

Buyer's perception of image	WTP Responses			
	Yes		No	
	Number	%	Number	%
Fairly negative	0	0	3	100
Neither positive nor negative	4	20	16	80
Fairly positive	35	55.55	28	44.45
Very positive	27	87.10	4	12.90
Total	66	56.40	51	43.60

Table 8.20: WTP responses by overall image of Gold Standard label

Figure 8.6 showed the "yes" WTP response in relation to overall image of Gold Standard label. The data clearly showed that there was an obvious trend in the "yes" WTP response in relation to image of label. A more optimistic view of image of Gold Standard label will lead to a higher probability of the "yes" WTP responses.

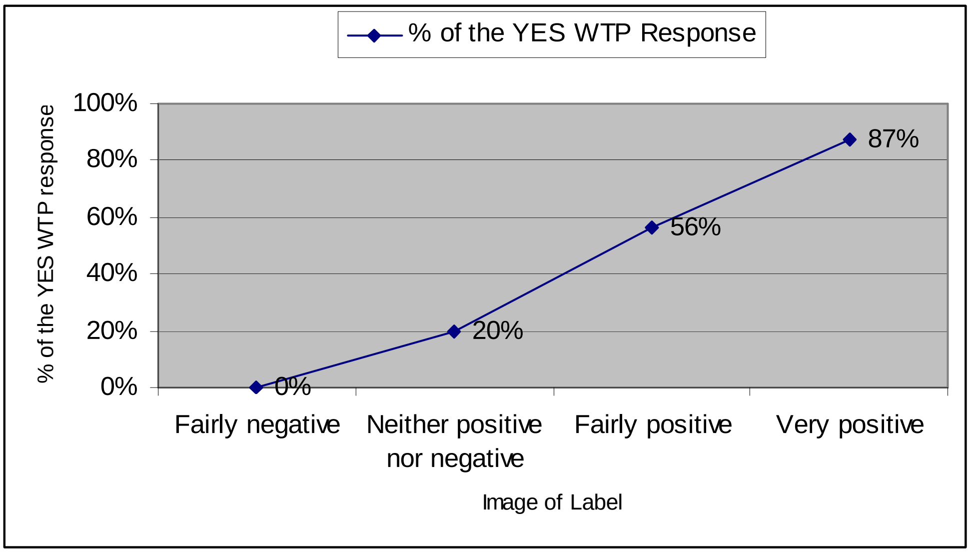

Figure 8.6: WTP responses in relation to overall image of Gold Standard label

8.12.3 WTP Responses in Relation to Knowledge in the Gold Standard Label

Table 8.21 present the different WTP responses among the group of buyers' knowledge. Buyers who have an excellent knowledge showed a highest occurrence of the "yes" WTP responses (73.33%), followed by those who have a good knowledge (64.71%). On the other hand only 28.57% of buyers in the group of poor knowledge were willing to pay a price premium.

Level of knowledge	WTP Responses			
	Yes		No	
	Number	%	Number	%
No knowledge	2	0.40	3	0.60
Poor knowledge	2	28.57	5	71.43
Fair knowledge	18	46.15	21	53.85
Good knowledge	33	64.71	18	35.29
Excellent knowledge	11	73.33	4	26.67
Total	66	56.40	51	43.60

Table 8.21: WTP responses by level of knowledge in label

Figure 8.7 showed the "yes" WTP response in relation to knowledge in label. As expected, the data showed that there was an obvious trend in the "yes" WTP response in relation to knowledge in label. Buyers with high level of knowledge in label are more willing to pay than those with low level of knowledge.

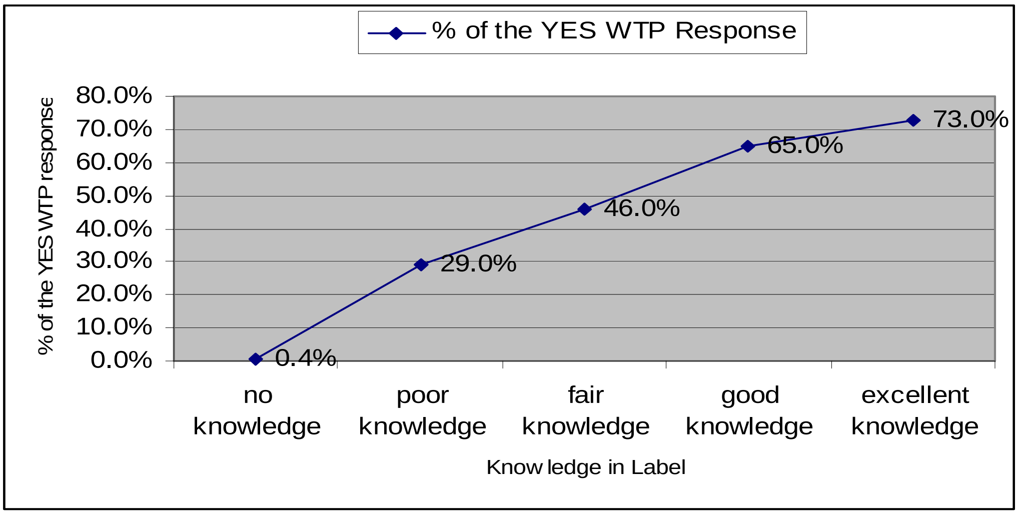

Figure 8.7: WTP responses in relation to knowledge in Gold Standard label

8.13 Reasons for the Willingness to Pay

Considering the reasons for the willingness to pay, 36.4% of participants view the payment of a premium as a reward given to the CDM sustainability labels and the project developers. Some 25.8% of participants believed that paying a price premium was worthwhile as the GS label is a tool for public relations and branding their organizations. This concurs with Meyrick [73] and Sutter [108] hypothesized that buyers may pay a price premium because they may use it for public relations activities. Therefore, our findings proved that their assumption of reason for willingness to pay is correct. Another motive for paying a price premium for the GS projects is the belief that it will help CDMs projects achieve their SD objectives (25.8%). Few of them (7.6%) stated that they were worried about the CDM's inability to generate SD benefits, so they would like to pay a price premium for project with high SD benefits.

There were three participants (4.4%) who stated other reasons for WTP. The first participant stated that the Gold Standard project can generate more SD benefits than the non-labelled project, so this participant would like to pay a price premium. The second participant stated that the Gold Standard CER is very liquid in the market and the company can easily resell it for speculative purpose, so this participant would like to pay. The last participant stated that the Gold Standard project give a chance for the local community to participate in it and can generate many benefits for the local people, so this participant were willing to pay.

8.14 Reasons for the Unwillingness to Pay

The participants identified many reasons for unwillingness to pay. For the first reason 29.4% of participants did not believed that paying a price premium for the Gold Standard project can help CDM project in achieving its sustainable development objectives. One respondent stated that this payment cannot help CDM projects, so it is a waste of money. For the second reason 23.5% stated that they are not interested in sustainable development benefits, but they would like to pay a price premium for Gold Standard CERs in recognition of its other benefits such as low methodology risk, low Post-Kyoto risk, etc. More clearly, in qualitative comments one respondent said "*We are not concerned with type of CER which is being acquired. However, we would be concerned about the risks associated with some project types (post-Kyoto etc.). Also, we* *could acquire only a reduced amount of CERs (thus achieving a diminished effect only) if we paid a premium per CER*". For the third reason 13.8% of participants stated that paying a price premium will result in higher costs of acquiring carbon credits, so there is no benefit for the compliance buyer. More clearly, in qualitative comments one respondent said "*CER purchases are purchases to ensure compliance with the relevant regulation. I am required to meet compliance at least cost and I have no reason to incur additional costs to achieve SD objectives*".

For the fourth reason 11.8% of participants stated that their budget is not enough to pay. For the fifth reason 11.8% of participants stated that the SD benefits generated by GS project are the same as similar non-labelled project. In qualitative comments one respondent said "*We buy CERs for compliance buyers, and the SD value of a CER is the same regardless of the standard*". Another respondent said "*I am for SD benefits but those should be included in the CDM itself, so there is no need for paying a price premium*". For the sixth reason 5.9% of participant stated that paying a price premium will destroy the market mechanism in the carbon market.

There were two participants (3.8%) who stated other reasons for WTP. The first participant said "*I have very little confidence in the GS methodology for assessing the SD benefits of a project*". Another participant said "*This is about CO_2, not social issues, the carbon money and in particular private money should not go to fixing social problems in countries where the governments are ignoring their social duties, it is bribe money*". So the second participant has a pessimistic view on paying a price premium.

Finally, one respondent suggested that strict regulation for proving sustainability of CDM projects may make the company change its decision to pay a price premium. This respondent said "*During a current market situation, it is difficult for credit buyer to pay premium for GS but situation may change especially when there is a strict regulation for proving sustainability of CDM projects*". This implied that the WTP responses may change in the future.

8.15 WTP Values

Buyers who agreed to pay a price premium were asked to state the maximum amount they would be willing to pay as a price premium per tonne of CO_2e for CERs with the GS Label in recognition of the contribution to SD. Therefore, this premium stand for only the SD benefits, not including other benefits such as low Post-Kyoto risk, low methodology risk, etc. One respondent would not provide a WTP figure because he thought that it is very difficult to determine the SD value of Gold Standard project in the situation given in this research. So we got the exact WTP figures from 65 respondents who were willing to pay. Table 8.22 shows the summary statistics of the WTP values. The results show that the mean WTP was €1.12/tCO_2e with a standard deviation of €0.65 and the median WTP was €1.0/tCO_2e (At the time of study we assumed that the current CER price, without any premium, is €10.00 per tonne of CO_2e). Detailed information about the distribution of the WTP values is given in Figure 8.8, a graph of the cumulative numbers of individuals' WTP.

	Mean	Median	S.D.
WTP value	1.12	1.00	0.65

Table 8.22: WTP values

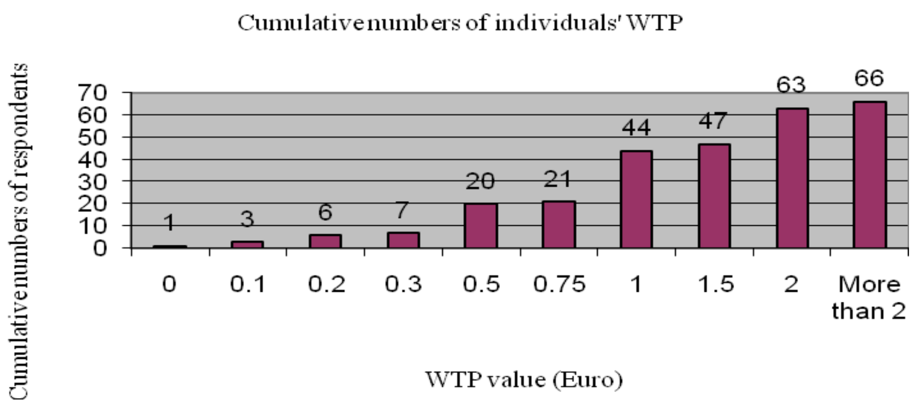

Figure 8.8: The cumulative numbers of individuals' WTP

It can be seen from this graph that the range of WTP values was wide. Most buyers (34.8%) reported €1.0 WTP per tCO_2e, followed by €2.0 WTP (24.24%), and €0.50 WTP (19.70%). Each 4.54% of participants expressed a WTP value of €0.20, €1.50, and more than €2.0 respectively. Few of them (each 1.52% of participants) expressed a WTP value of €0.00, €0.30, and €0.75. We can clearly see that more than a half of respondents (68.17%) provided a willingness to pay greater than or equal to €1.0/tCO_2e.

8.16 An Analysis of the WTP Values in Relation to the Independent Variables

This part aims to investigate trends in the WTP values in relation to the independent variables. The independent variables used in this part include nationality, type of organization, overall image of label, buyers' perception of ROI, buyers' perception of SD benefits, and knowledge in label.

8.16.1 WTP Values in Relation to Nationality of Organization

To investigate trend in the WTP values in relation to nationality of organization, the sample was grouped into two groups: European countries, and Non-European countries. Each of these two groups has the same sample sizes which are 33 participants. Table 8.23 shows the mean WTP of these two groups. Surprisingly, there was no difference between European countries and Non-European countries in the amount of money that they were willing to pay. As can be seen, the mean WTP of these two groups was €1.12/tCO_2e. Figure 8.9 is a graphical presentation of the WTP values in relation to each nationality. The analysis concerning each nationality showed that there was no obvious trend in the WTP value in relation to each nationality. The group of USA and Canada showed the highest mean WTP which was €1.31/tCO_2e, while the mean WTP of Multinationality was lowest (€0.90/tCO_2e). This implied that the mean WTP of USA and Canada was considerably higher than that of Multinationality. For other nationalities including Australia and New Zealand, Japan, and European countries, their mean WTP values are all pretty close together.

	European	Non-European
Mean WTP	1.12 (n=33)	1.12 (n=33)

Table 8.23: Mean WTP in relation to nationality

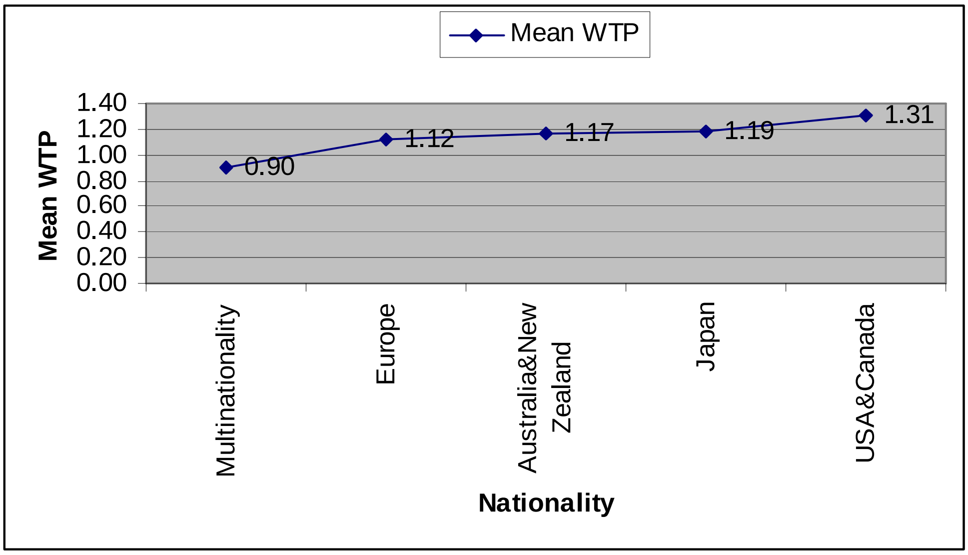

Figure 8.9: The WTP values in relation to each nationality

8.16.2 WTP Values in Relation to Type of Organization

Figure 8.10 showed the WTP values in relation to type of organization. As expected, the charity showed the highest mean WTP which was €1.50/tCO_2e. Surprisingly, the mean WTP of government was lower than that of the private. As can be seen, the mean WTP of the government was €0.93/tCO_2e, while the mean WTP of the private was €1.10/tCO_2e. Finally, the data showed that type of organization did not tend to have an influence on the WTP value.

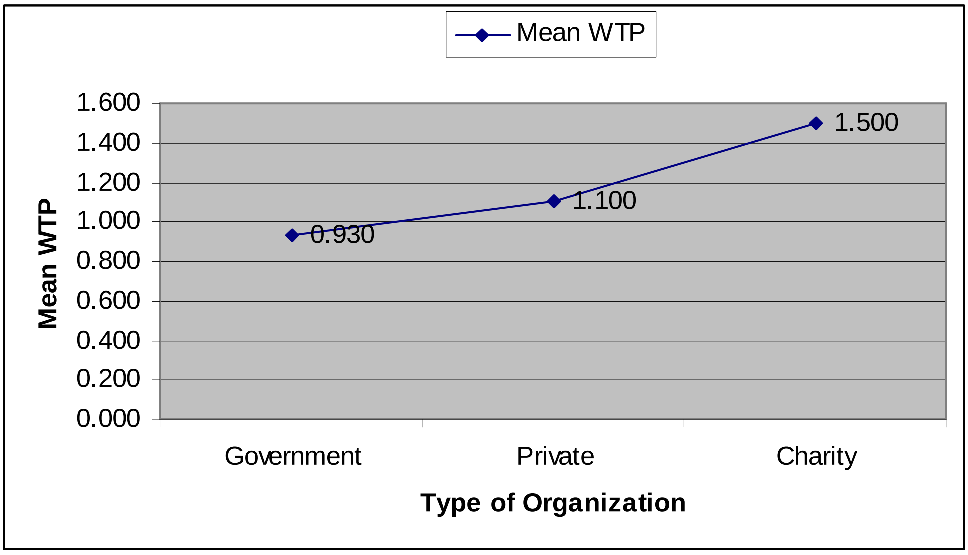

Figure 8.10: The WTP values in relation to type of organization

8.16.3 WTP Values in Relation to Overall Image of Gold Standard Label

Only the participants with the perception that overall image of Gold Standard label was "neither positive nor negative", "fairly positive", or "very positive" were willing to pay. Therefore, we apply only these three levels of image to test any trends in response that seem to influence the WTP value. Figure 8.11 show the WTP values in relation to overall image of Gold Standard label. The group of "very positive image" expressed the highest mean WTP which was €1.22/tCO_2e, while the group of "neither positive nor negative image" expressed the lowest mean WTP which was €0.80/tCO_2e. The mean WTP of the group of "fairly positive image" was €1.07/tCO_2e. The data clearly showed that there was an obvious trend in the WTP value in relation to buyer's perception of image. Buyers with an optimistic view of image of Gold Standard label tend to be willing to pay more money for the SD value than those with a pessimistic view. However, when the Pearson correlation analysis was carried out the relationship between the WTP value and buyer's perception of image was not statistically significant.

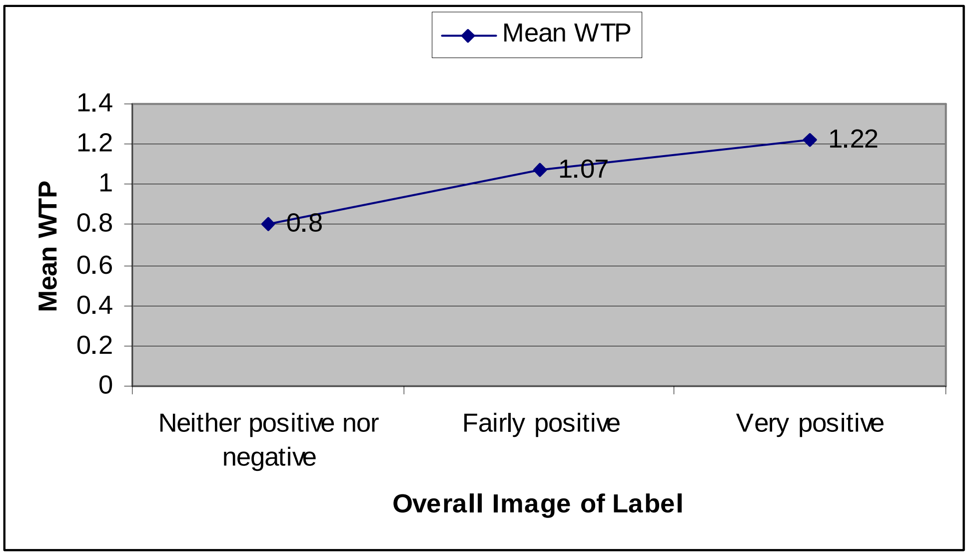

Figure 8.11: The WTP values in relation to overall image of Gold Standard label

8.16.4 WTP Values in Relation to Buyer's Perception of ROI

Considering the aspect of buyer's perception of ROI against WTP values, participants who perceived that "ROI from Gold Standard label is higher than non-labelled project" showed the highest mean WTP which was €1.22/tCO_2e (Figure 8.12). On the other hand participants who perceived that "ROI from Gold Standard label is lower than non-labelled project" showed the lowest mean WTP which was €0.80/tCO_2e. The data showed that buyer's perception of ROI tend to influence WTP value positively. When the Pearson correlation analysis was carried out the relationship between the WTP value and buyer's perception of ROI was positive (Pearson correlation 0.248) and statistically significant at the 0.05 level ($P < 0.05$). This means that with a more positive perception of ROI the maximum amount of the willingness to pay a price increases.

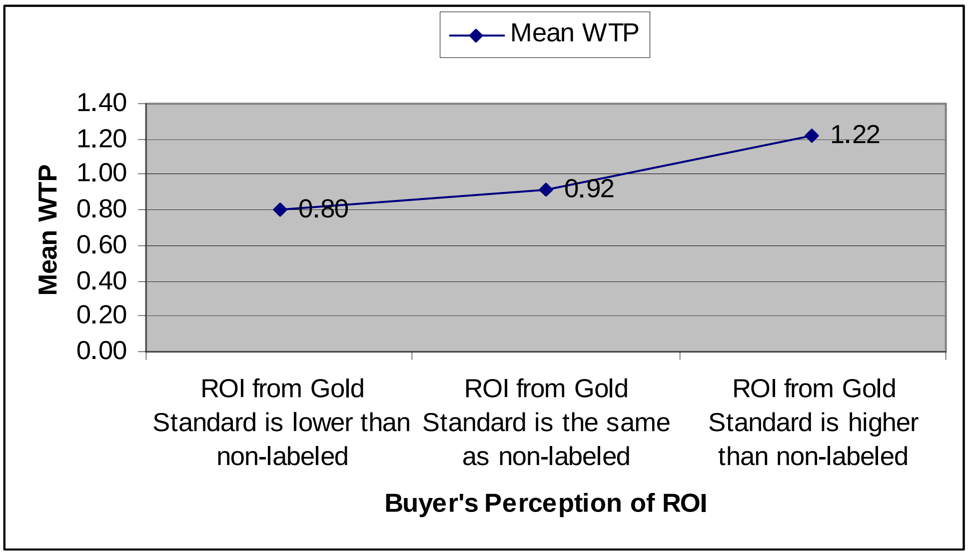

Figure 8.12: The WTP values in relation to overall image of Gold Standard label

8.16.5 WTP Values in Relation to Buyer's Perception of the SD Benefits

All buyers who perceived that "*The SD benefits generated by Gold Standard project are lower than similar non-labelled project*" were not willing to pay, so the participants in this group were not taken into this analysis. Table 21 showed the aspect of buyer's perception of the SD benefits against WTP values. Buyers who perceived that "*The SD benefits generated by Gold Standard project are higher than similar non-labelled project*" expressed the mean WTP of €1.19, while buyers who perceived that "*The SD benefits generated by Gold Standard project are the same as similar non-labelled project*" expressed the mean WTP of €0.70. Buyer's perception of the SD benefits tends to have an influence on the WTP value (Table 8.24). When the Pearson correlation analysis was carried out the relationship between the WTP value and buyer's perception of SD benefits was positive (Pearson correlation 0.260) and statistically significant at the 0.05 level ($P < 0.05$). This means that with a more positive perception of the SD benefits the maximum amount of the willingness to pay a price increase.

	The SD benefits generated by Gold Standard project are lower than similar non-labelled project	The SD benefits generated by Gold Standard project are the same as similar non-labelled project	The SD benefits generated by Gold Standard project are higher than similar non-labelled project
Mean WTP	-	0.70	1.19

Table 8.24: Mean WTP in relation to buyer's perception of the SD benefits

8.16.6 WTP Values in Relation to Knowledge in Gold Standard Label

Considering the aspect of buyer's knowledge in the GS label against WTP values, the participants with no knowledge in Gold Standard label expressed the lowest mean WTP which was €0.75/tCO_2e (Figure 8.13). Buyers with good knowledge showed the highest mean WTP which was €1.20/tCO_2e. However, there was no obvious trend in the WTP value in relation to knowledge in Gold Standard label. Similarity, when the Pearson correlation analysis was carried out the relationship between the WTP value and buyer's knowledge in Gold Standard label was not statistically significant. However, considering only the two groups between buyers with knowledge in label and buyers with no knowledge, we can clearly see that buyers with knowledge tend to be willing to pay more money for the SD value than those with no knowledge.

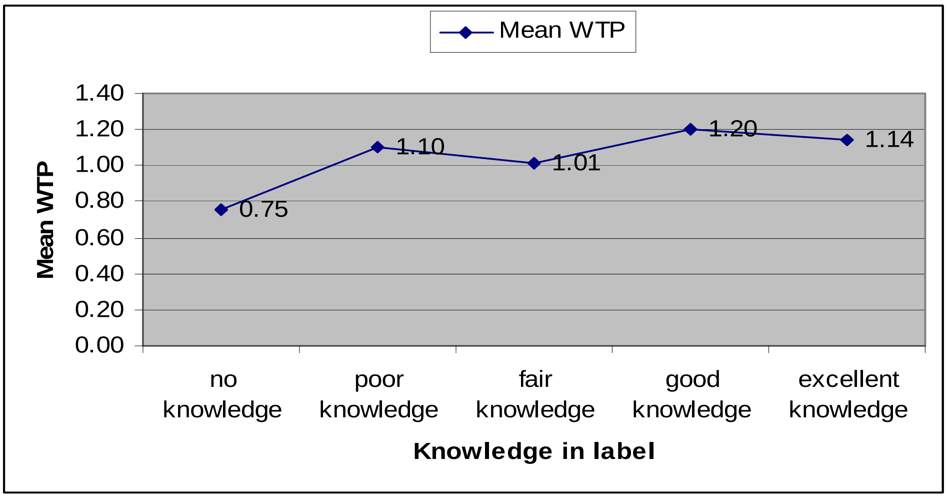

Figure 8.13: The WTP values in relation to knowledge in Gold Standard label

8.17 Factor affecting WTP for the Gold Standard Label

The final part presents the regression results. Binary regression analysis was carried out to create the equation to explore the statistical relationship between the probability of the willingness to pay a price premium and the independent variables. The regression analysis aims to see which factors might contribute positively and negatively to the probability of the willingness to pay a price premium for the GS label. The dependent variable, willingness to pay a price premium, is dichotomous, coded 0 (unwillingness to pay) or 1 (willingness to pay). The independent variables discussed earlier in Chapter 7 and that were used in the regression model include expected sustainable development benefits (ExpectedSD), expected return on investment (ExpectedROI), involvement in the Gold Standard label (Involvement), importance of the Gold Standard label (Importance), and the attitude towards the host country's duty (Attitude). Table 8.25 displays each variable name, description, and the expected sign of the coefficient.

Variable name	Description	Expected sign
ExpectedSD	Expected sustainable development benefits; "1" for respondents stating "The expected SD benefits generated by Gold Standard are lower than non-labelled project"; "2" for "The expected SD benefits generated by Gold Standard are the same as non-labelled project"; "3" for "The expected SD benefits generated by Gold Standard are higher than non-labelled project"	+
ExpectedROI	Expected return on investment; "1" for respondents stating "ROI of CERs from Gold Standard is lower than non-labelled project"; "2" for "ROI of CERs from Gold Standard is the same as non-labelled project"; "3" for "ROI of CERs from Gold Standard is higher than non-labelled project"	+
Involvement	Involvement in the Gold Standard label was measured as the sum score on a multi-item scale consisting of questions 10 and 11. The summed score falls between 2 and 10.	+
Importance	Importance of the Gold Standard label was measured as the sum score on a multi-item scale consisting of questions 12, 13 and 14. The summed score falls between 3 and 15.	+
Attitude	The attitude towards the host country's duty to assess the sustainability of CDM projects was measured as the sum score on a multi-item scale consisting of questions 15 and 16. The summed score falls between 2 and 10.	+

Table 8.25: The independent variables for regression model

8.17.1 Test for Multicollinearity

Multicollinearity is a statistical phenomenon in which two or more predictor variables in a multiple regression model are highly correlated. The problem of multicollinearity is a data problem, not a problem of model specification. Multicollinearity is a serious problem if the research objective is to understand how the independent variables impact the dependent variable. This is because the confidence intervals on the regression coefficients will be very wide. As the confidence intervals are so wide, excluding a subject or adding a new one can change the coefficients dramatically and may even change their signs (Hair *et al*. [41]). Moreover, multicollinearity limits the size of the coefficient of determination and makes it progressively more difficult to add unique explanatory prediction from additional variables. Lastly, multicollinearity makes determining the contribution of each independent variable difficult.

A test for multicollinearity aims to investigate the correlation among the independent variables. To investigate the degree of multicollinearity Hair *et al*. [41] suggested the two methods including: (1) the tolerance value and (2) the variance inflation factor (VIF). The VIF is 1/Tolerance. The VIF value is always greater than or equal to 1. The results of testing multicollinearity will be presented in terms of its degree, not in terms of the presence of the absence of multicollinearity. The small tolerance values which correspond to the large VIF values denote the degree of high multicollinearity. According to Hair *et al*. [41], a tolerance value less than 0.1 which corresponds to a VIF value greater than 10 is an indication of potential multicollinearity problem. Table 8.26 showed the results of testing multicollinearity. There are no VIF values greater than 10 (Table 8.26), so there is no multicollinearity problem.

Variable	Tolerance	VIF
ExpectedSD	0.589	1.699
ExpectedROI	0.893	1.119
Involvement	0.559	1.789
Importance	0.414	2.417
Attitude	0.942	1.062

Table 8.26: Testing for multicollinearity

8.17.2 *Estimated Binary Logistic Regression Model for Determining Factors of the Buyers' Willingness to Pay*

Binary logistic regression model is used when the dependent variable is not continuous but instead has only two possible outcomes, coded 1 {a probability of success - (P_i)} or 0 {a probability of failure – ($1-P_i$)}. Regular regression models cannot be used for such variables because the predicted value needs to be constrained between 0 and 1, which is not possible in regular regression. It also violates the assumption that the variable is normally distributed, since a binary variable has a binomial distribution (Hair *et al*. [41]). Therefore, the expected response is appropriately modeled by some curved relationship with the predictor variable. One such curved relationship is given by the logistic model. In the case of a single independent variable, the model can be written as (Hair *et al*. [41]):

$$Y = \text{Probability (event - } P_i) = \frac{1}{1 + e^{-(B_0 + B_1 X)}}$$

$$\text{Probability (no event)} = 1 - P_i$$

where B_0 and B_1 are coefficients estimated from the data, X is the independent variable, and e is the base of the natural logarithm, approximately 2.718.

Considering this model, it is bounded between zero and one. Moreover, there is a linear model hidden in the function that can be revealed with a proper transformation of the response. Finally, the sign associated with the coefficient, B_1 indicates the direction of the curve. A positive value for B_1 indicates an increasing function (see Figure 8.14) while a negative value indicates a decreasing function.

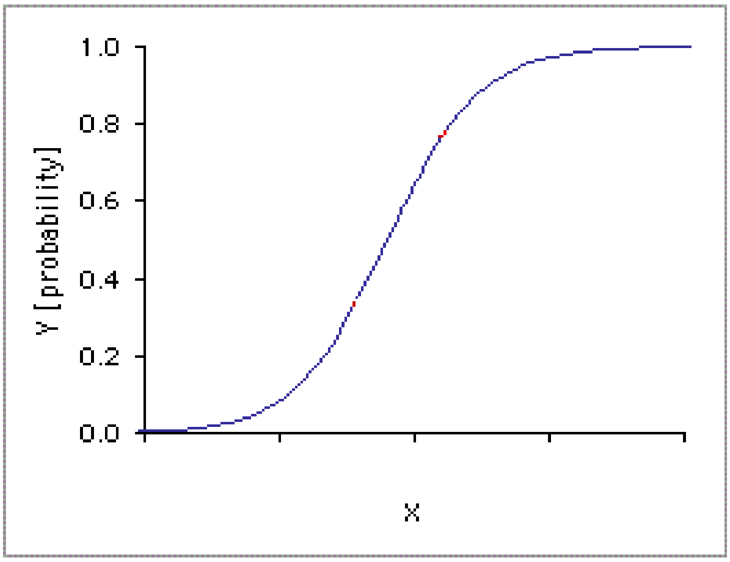

Figure 8.14: Binary logistic regression model ($B_1 > 0$)

As regular regression model cannot be used for a binary variable, logistic regression model can solves this problem by applying the logit transformation to the dependent variable. The logistic model predicts the logit of Y from X. The logit is the natural logarithm (ln) of odds ratio. Odds are ratios of probabilities of Y happening (P_i) to probabilities of Y not happening ($1 – P_i$). Odds ratio can be written as:

$$\text{Odds ratio} = \left(\frac{P_i}{1 - P_i} \right)$$

The natural logarithm of the odds ratio gives a linear model in X_i. Therefore, the simple logistic model has the form (Hair *et al*. [41]):

$$\text{Logit (Y)} = \text{the natural logarithm (odds)} = \ln \left(\frac{P_i}{1 - P_i} \right) = \beta_0 + \beta_1 X_1$$

In this study the dependent variable (Y) is the probability of being willing to pay which can be written as:

$$Y = \text{Probability of being willing to pay } (P_i) = \frac{1}{1 + e^{-z}}$$

where $Z = \beta 0 + \beta 1 ExpectedSD + \beta 2 ExpectedROI + \beta 3 Involvement + \beta 4 Importance + \beta 5 Attitude$

As previously noted, the natural logarithm of the odds ratio gives a linear model, so in this study the binary logistic regression model can be written as:

$$\text{The natural logarithm (odds)} = \ln\left(\frac{P_i}{1 - P_i}\right) = \beta 0 + \beta 1 ExpectedSD + \beta 2 ExpectedROI + \beta 3 Involvement + \beta 4 Importance + \beta 5 Attitude$$

Where

P_i = the probability of being willing to pay

1- P_i = the probability of not being willing to pay

The regression results for the model are reported in Table 8.27. Most of the tested variables were significant related to the probability of the willingness to pay a price premium (Table 8.27).

Variable	Coefficient	Significance
Constant	-10.977	0.000
ExpectedSD	1.245	0.037
ExpectedROI	0.816	0.022
Involvement	0.382	0.025
Importance	0.343	0.021
Attitude	0.071	0.664
Cox&Snell R^2 = 0.453		
Nagelkerke R^2 = 0.608		

Table 8.27: Estimated binary logistic regression model

Given these coefficients, the logistic regression equation for the probability of a positive WTP can be written as:

$$Y = \text{Probability of being willing to pay} = \frac{1}{1 + e^{-z}}$$

where $Z = -10.977 + 1.245 ExpectedSD + 0.816 ExpectedROI + 0.382 Involvement$
$+ 0.343 Importance + 0.071 Attitude$

If we apply this equation to an example of organization which has the following characteristics:

- Perceived that "The expected SD benefits generated by Gold Standard are higher than non-labelled project" (ExpectedSD = 3)
- Perceived that "ROI of CERs from Gold Standard is higher than non-labelled project" (ExpectedROI = 3)
- Totally agreed with the statements 10 and 11 (Involvement = 10)
- Totally agreed with the statements 12, 13, and 14 (Importance = 15)
- Disagreed with the statements 15 and 16 (Attitude = 4)

We find: $Z = -10.977 + 1.245 (3) + 0.816 (3) + 0.382 (10) + 0.343 (15) + 0.071 (4)$
$Z = -10.977 + 3.735 + 2.448 + 3.82 + 5.145 + 0.284 = 4.455$

The probability of being willing to pay (Y) is then estimated to be:

$$\text{Probability of being willing to pay} = \frac{1}{1 + e^{-4.455}}$$
$$= 1 / 1.011626 = 0.9885$$

Therefore the probability of being willing to pay of this sample organization is 0.9885, representing the event will occur.

According to Tohmo [118], if the estimated probability of the event is less than 0.5, we predict that the event will not occur. On the other hand if the estimated probability of the event is more than 0.5, we predict that the event will occur. Finally, if the estimated probability of the event is exactly 0.5, we can make our prediction by flipping a coin.

The coefficients for all independent variables have a positive sign as expected. The positive sign on the coefficient indicated that the probability of the willingness to pay a price premium is affected positively by all independent variables. As can be seen from Table 24, the variables ExpectedSD, ExpectedROI, Involvement, and Importance are statistically significant at the 5 percent level of significance. Only the variable Attitude is not statistically significant.

Buyer's perception of the SD benefits generated by the Gold Standard label has an influence on the probability of the WTP (statistically significant at the 5 percent level of significance). The positive coefficient for expected SD benefits indicate that buyers who have a positive perception of the SD benefits generated by the Gold Standard label are more likely to pay a price premium for the Gold Standard CERs than those who have a negative perception. This result agrees with the qualitative comments given by three participants. The first participant said "*The Gold Standard project can generate many benefits for the local people, so I would like to pay a price premium for it*". Like the first participant, the second participant said "*The reason for willingness to pay is that the Gold Standard project can generate more SD benefits than the non-labelled project*". On the other hand, the third participant said "*The SD value of a CER is the same regardless of the standard, so I am not willing to pay a price premium*". Moreover, 11.8% of participants stated their reason for unwillingness to pay which is that the SD benefits generated by Gold Standard projects are the same as similar non-labelled project. This result also agree with Getzner and Grabner-Krauter [32], confirming that the higher social benefits of product lead to higher demand for that product. Consequently, we can conclude that more positive perception of the SD benefits will lead to higher probability of the willingness to pay a price premium for the Gold Standard CERs. So the research result may induce the project developer to develop the project with high SD benefits for getting a price premium.

Buyer's perception of ROI of CERs from Gold Standard projects has an influence on the probability of the WTP. The positive coefficient for expected ROI ($P < 0.05$) indicate that buyers expecting high ROI of Gold Standard CERs have a higher probability of the willingness to pay a price premium than those expecting low ROI. The positive relationship between these two variables is supported by the result of the study on consumers' willingness to invest in "*green shares*" which was conducted by Getzner and Grabner-Krauter [32]. According to Getzner and Grabner-Krauter, purchase and investment decisions can be subsumed to be correlated with expectations of the profit (the benefits) of product. Consumers expecting higher profitability (higher benefits) might be willing to demand more of the product or investment. Finally, Getzner and Grabner-Krauter arrive at the conclusion that higher expectations for the return on investment lead to a higher probability of investment in "*green shares*".

However, in their study the expected ROI is statistically significant at the 10 percent level of significance, while in this study the expected ROI is statistically significant at the 5 percent level of significance.

An involvement in the Gold Standard label has an influence on the probability of the WTP (statistically significant at the 5 percent level of significance). The positive coefficient for an involvement in the label indicates that with more involvement in the Gold Standard label the probability of the willingness to pay a price premium increases. An involvement in the Gold Standard label represents buyer behaviors to seek out and purchase CERs from this label. The time and effort expended in finding and buying Gold Standard CERs are translated into the willingness to pay a price premium for it. Therefore, the relationship between these two variables is positive. This result is similar with the result of the study on the willingness to pay a price premium for environmentally certified wood products which was conducted by Vlosky [136]. Vlosky found that there is a positive relationship between consumer involvement in environmentally certified wood products and willingness to pay a price premium. Similarity, Jensen et al. [52] found that consumers who purchased environmentally certified products in the past have a higher probability of the willingness to pay a price premium for certified wood products.

Buyers' attitude towards an importance of the Gold Standard label has an influence on the probability of the WTP (statistically significant at the 5 percent level of significance). The positive coefficient for buyers' attitude towards an importance of the label indicates that with a more positive attitude towards an importance of the Gold Standard label the probability of the willingness to pay a price premium increase. Attitudes towards an importance of the Gold Standard label will represent buyer's consciousness in the sustainable development objectives of a CDM project. According to Vlosky [136], the positive attitude towards an importance of an environmentally certified wood product is translated into the willingness to pay a price premium for it. Therefore, the relationship between these two variables is positive. This result is consistent with Vlosky [136], confirming that there was a positive relationship between the positive attitude towards an importance of environmentally certified wood product and their willingness to pay a premium for certified wood products.

8.17.3 Goodness of Fit of the Model

We assess whether or not the model fits the data. Firstly, Nagelkerke's R^2 of the model show reliability because of its high value. In this study Nagelkerke's R^2 (the fraction of explained variation) was 0.608 (Table 8.27). 60.8% of the probability of the willingness to pay could be explained by all independents variables in this model, while the remaining 39.2% could not explain the probability of the willingness to pay which was caused by other factors which are not examined. This means that the direct relationship between the independent variables (ExpectedSD, ExpectedROI, Involvement, Importance, Attitude) and the probability of the willingness to pay is high.

Observed	Predicted		Percentage Correct
	Unwillingness to Pay	Willingness to Pay	
Unwillingness to Pay	40	11	78.4
Willingness to Pay	9	57	86.4
Overall Percentage			82.9

Table 8.28: Classification table

Secondly, according to Hair *et al*. [41], to assess the predictive ability of the binary logistic regression we will construct the classification matrices. Table 8.28 showed the classification matrix. The classification matrix showed that 86.4% of buyers who were willing to pay were correctly predicted and 78.4% of buyers who were not willing to pay were correctly predicted. In all, 82.9% of the original cases were correctly predicted. Consequently, the model showed the best in the sense of the predictive ability.

Thirdly, there is no multicollinearity problem in this study (Table 8.26). This means that the independent variables are not too highly related to each other. Lastly, the signs for the estimated coefficients are consistent with the theoretical or prior expectations.

8.18 Conclusions

8.18.1 Classification of CER Buyers by Cluster Analysis

Carbon markets are increasingly conscious of the social and environmental 'quality' of credits delivered by CDM projects. Consequently carbon credits are no longer viewed as a homogenous good and buyers now differentiate between credits supplied by different types of CDM project. According to Sutter [108], CDM sustainability labels can differentiate the market for CERs into normal CERs and premium CERs. This research tries to validate the concept of a premium market by using cluster analysis. K-means clustering was used to segment a sample of buyers into two clusters. The results clearly demonstrate that, within the sample studied, two clusters of buyers exist with distinct profile patterns. Moreover, the results of the chi-square analysis and a cross-tabulation showed that these two clusters were significantly different in: organization type; level of paid up capital; perception of sustainable development benefits; perception of return on investment; perception of image of the sustainability labeling; participation in the voluntary market; the project priority; knowledge in the sustainability label; attitude towards the host country's duty; and their willingness to pay.

The first cluster of buyers has a strong preference for CERs with CDM sustainability labels. These buyers have negative attitudes towards the host countries' capacity to assess CDM projects, so they require the additional standard to ensure the sustainability of CDM projects. They have high involvement in past purchase and purchase intention of CDM sustainability labels. These buyers have a high level of knowledge in CDM sustainability labels. They perceive that CERs with sustainability labels differ from non-labelled CERs in terms of SD benefits. They were positive about the importance of labeling and the image of SD labels. Most buyers in this group apply "*an ethical purchasing policy*" for purchasing carbon credits by giving the least project priority to the industrial gas projects. Finally, non-profit organizations and companies with small paid up capital (< 100 million Euros) tend to be the members of this group.

On the other hand, the second cluster of buyers has a strong preference for non-labelled CERs. These buyers have low involvement in past purchase and purchase intention of CDM sustainability labels. Moreover, they have a low level of knowledge in CDM sustainability labels. They view that CERs with sustainability labels are the same as non-labelled CERs in terms of SD benefits and ROI. They were negative on an importance of sustainability labels, but have a positive attitude towards the host country's duty to assess CDM projects. Finally, private companies with large paid up capital (≥100 million Euros) tend to be the members of this group.

These findings clearly agree with Sutter's recommendations, supporting that CDM sustainability labels can differentiate the carbon market. Finally, we may define this market characteristic as "*One CER Two Markets*".

8.18.2 The Willingness of Buyers to Pay a Price Premium for CERs with CDM Sustainability Label

It is increasingly clear that carbon credits generated by CDM project do not all deliver the same SD benefits, as intended by the Kyoto Protocol. GS carbon credit has now been developed to meet the needs of buyers searching for carbon credit with high SD benefits. The research presented in this thesis used the contingent valuation method to better understand the buyers' valuation of SD benefits of CDM projects through their WTP a price premium for GS carbon credits. This study finds that 56.4% of the buyers are willing to pay a price premium for GS carbon credits. The charity group and the government have a greater percentage of the "yes" WTP responses than the private group. On average, buyers are willing to pay a price premium of €1.12 per tonne of CO_2e for GS carbon credit in recognition of SD benefits. Moreover, we found that a price premium for GS CERs varies widely. A wide range of WTP values is also supported by the result of the study on buyer's willingness to pay a price premium for GS CERs which was conducted by Sterk *et al*. [105].

Chapter 9

A Conceptual Framework and Research Methodology for Assessing the Sustainability of CDM Projects

9.1 Introduction

As mentioned in Chapter 5, the vagueness of the concept of SD is the most critical problem. There is still no single universally accepted definition of the sustainability of CDM project because the Bonn Agreement assigns a duty to interpret the sustainability of CDM project to each host country. Therefore the vague concept of SD gives the opportunity, arguably it pressurizes, host countries to set the low sustainability standards in order to compete for CDM investment. This ultimately leads to the problem known as "*a race to the bottom*" in terms of SD standards (Sutter [108]). Several studies have found that the SD objectives of CDM project were not clearly interpreted by host countries (Brown *et al*. [8], Schneider [101]). Moreover, the relative importance of these SD objectives is still considerably vague. Stakeholder preferences towards the sustainable development objectives of CDM project are not explicit, and are left open for host countries to interpret. Making these objective preferences explicit will help reduce conflicts and help develop consensus as different stakeholders can evaluate their own proposals from the others' preferences (Pascoe *et al*. [88]). Finally, the question of whether host countries can ensure the sustainability of CDM projects has been widely debated. Burian [10], Kolshus *et al*. [59], Michaelowa [74], Nussbaumer [80], Olsen [84], Olsen and Fenhann [85], Schneider [101], Sutter and Parreno [109]). Burian [10] found that projects with negative ecological or social impacts have been approved by host countries. This implied that host countries cannot guarantee the SD benefits of CDM projects.

Given this context, an investigation of stakeholder preferences towards the SD of CDM projects is clearly needed. Moreover, there is a need for more specific research investigating how the CDM contributes to SD. This research tries to investigate these issues by using a case study of a biomass CDM project in Thailand.

9.2 Research Objectives, Research Questions, and Research Hypotheses

The objective of this chapter is "*to investigate the contribution of the CDM to sustainable development*." This objective can be achieved by pursuing these four research questions:

i) Are the expected SD benefits described in the PDD actually realized?

ii) How does CDM project distribute benefits and social costs to stakeholders?

iii) Were the preferences of the stakeholder for the sustainable development of CDM projects?

iv) Whether are the group's preferences are substantially different from each other, on which criteria they differ?

We can evaluate this research question by formulating the following hypothesis:

Hypothesis 5: The inter-group preference weights are different.

9.3 Prior Literature

There have been several studies of the sustainability assessment of CDM projects, but the research on stakeholder preferences towards the SD benefits of CDM project is limited to only two studies (Nussbaumer [79], Sutter [108]). This topic first discusses the literature on the sustainability assessment of CDM projects. Next, we discuss the literature on stakeholder preferences towards the SD benefits of CDM project.

The sustainability assessments of CDM projects were mostly based on the reviews of the PDDs, whereas the in-depth interviews with stakeholders were not widely used for data collection. Kolshus *et al*. [59] assess the sustainability of the Brazilian energy project candidates including: (1) ethanol (with bagasse cogeneration); (2) cogeneration from refineries; (3) biomass thermoelectricity (gasification of wood); and (4) wind energy. Kolshus et al. developed a set of indicators to evaluate non-carbon benefits of these CDM project candidates on the environment, development, and equity. The data used in this analysis was obtained by the literature review, not the interviews. Thus, this study recommended further research to collect more data from the other sources. Kolshus et al. found that the cogeneration from refineries has positive impacts on all three dimensions including the environment, development, and equity, and also seem profitable (require low carbon quota prices). Therefore, the cogeneration is the most cost-effective option. The wind energy option also has positive impacts on all three dimensions, but it requires high carbon quota prices to be profitable. On the other hand, fuel wood gasification has negative impacts on most environmental indicators, but it requires low carbon quota prices to be profitable. Finally, Kolshus et al. concluded that a high cost per ton of carbon dioxide abated was linked to a high score on sustainability indicators, whereas a low abatement cost per ton of carbon dioxide was linked to a low score on sustainability indicators.

Brown *et al*. [8] investigated the sustainability of CDM forestry projects by using the case studies in Mexico and Belize. Brown used a multi-stakeholder analysis as a method for assessing projects. This method is based on in-depth interviews and qualitative data was derived from these interviews. Finally, the research results showed that the pilot CDM projects in this study did not contribute significantly to SD in terms of income, diversification of production, and other environmental or development aspects.

Burian [10] investigated the sustainability of CDM projects by using an in-depth case study in Honduras. Burian chose Rio Blanco Small Hydroelectric Project as a case study because this project was supposed to be a best practice model concerning SD. Burian used a qualitative method to assess this project. The analysis was based on the data obtained from the PDD and in-depth interviews with project developers. This study tried to examine whether the expected SD benefits described in the PDD are actually achieved and whether there are important aspects not mentioned in the PDD. Therefore, this research requires the project visit to investigate the sustainability aspects. Finally, Burian found that this project contributed significantly to SD by being a self-sufficient source of renewable energy. The significant SD benefits generated by this project were increasing the quality of energy supply in region, creating plantation activities, and generating temporary and permanent jobs. However, this research only gathered data from the site visit, and it did not receive the information from other stakeholders such as local residents, experts, etc. We can not see the views of other stakeholders on the real SD benefits generated by this project. Consequently, this research only gives provides a crude analysis the project’s real contribution to SD.

The other three studies of the sustainability assessment of CDM projects largely rely on data available in the PDD. These studies are conducted by Nussbaumer [79], Olsen and Fenhann [85], and Sutter and Parreno [109]. Sutter and Parreno used Multi-Attributive Utility Theory (MAUT) to assess the sustainability of the CDM project. They assessed

16 officially registered CDM projects with regard to whether they fulfill the GHG emission reduction objective and SD objective. The SD indicators used for his assessment were: (1) employment generation; (2) distribution of CER returns; and (3) improvement in local air quality. The data of expected SD benefits generated by each project was obtained from the PDDs. Moreover, Sutter and Parreno sent the questionnaires to 16 project developers to find the data of SD benefits generated by these projects. However, he got only 4 responses from his survey. Thus, the data for his analysis were largely obtained from the PDDs. Finally, he found that there were no registered CDM projects that were likely to fulfill the twin objectives simultaneously. Moreover, only 1 out of 16 projects was likely to contribute significantly to SD in the host country.

Nussbaumer [79] used MAUT to assess the five case studies of CDM projects. The data of expected SD benefits generated by each project was obtained from the PDDs. Where the PDD did not provide precise data of expected SD benefits, Nussbaumer used an educated guess to find the expected SD benefits. His guess for SD benefits missing from the PDDs may not be correct, so this will affect the quality of research results. Another weak point of this research is that Nussbaumer uses only five usable questionnaires to calculate the SD criteria weighting used in SD assessment. This low participation may not represent the real criteria weighting by stakeholders. Thus, this weighting will affect the quality of research results. Finally, the research results showed that a GS CDM project and a CDM project with Community Development Carbon Fund (CDCF) perform well in terms of both overall SD benefits and the distribution between the different SD benefits. On the other hand, the HFC project in India doesn't appear to perform well because its contribution to social development is low and the environmental impact is negative.

As previously noted in Chapter 5, Olsen and Fenhann [85] conducted the sustainability assessment based on text analysis of the PDDs. They set 13 SD criteria for analyzing the expected SD benefits described in the 744 PDDs (744 CDM projects). They tried to find how many SD benefits each CDM project can generate. Consequently, this assessment relied only on data obtained from the PDDs.

Therefore, the quality of the PDD will directly affect the accuracy of these three research works. Some host countries have their poor PDDs which do not give details of sustainable development benefits generated by CDM projects (Castro and Michaelowa [13]). Some PDDs do not give enough details for the sustainability assessment.

Moreover, the SD benefits described in the PDDs are only potential benefits, not the real benefits or actual negative impacts (Olsen and Fenhann [85]). Therefore, relying only on data available in the PDD is not sufficient to investigate the CDM's contribution to SD. Besides the details available in the PDDs, researchers need to find more details about SD benefits from other sources. Moreover, researchers need to investigate whether the expected SD benefits described in the PDD are actually achieved. Given these weaknesses of relying on data from PDDs, this research will use in-depth interviews and site visits to find the SD benefits.

As previously noted, the research on stakeholder preferences towards the SD benefits of CDM project is limited to only two studies done by Nussbaumer [79] and Sutter [108]. Sutter [108] conducted the first survey on the sustainability preferences of CDM stakeholders in three host countries including South Africa, India, and Uruguay. Sutter used the direct weighting and the Analytic Hierarchy Process (AHP) to assess the sustainability preferences. The Uruguayan stakeholder survey was conducted in a weighting workshop in which 36 CDM stakeholders participated. Unlike the Uruguayan survey, the South African and Indian surveys were conducted through the face-to-face interviews and electronic questionnaires. Each of these two countries got around 30 responses from government, industry, NGOs, and academia. Indian stakeholders rate reducing dependency on fossil fuels as the highest preference, whereas South African stakeholder rate employment generation as the highest preference. Another stakeholder survey in Uruguay found that water resource (water quality and efficiency in the use of water) was the highest ranked preference. However, the distribution of participants in these surveys was not well balanced. Therefore, the assessment will get altered through biased weightings of assessment criteria. More importantly, these surveys covered only a group of expert, not the local residents in the CDM area. The CDM stakeholders include not only the experts, but also the local residents. Most stakeholder surveys on the sustainability preferences will include both a group of experts and a group of local residents (Ananda and Herath [3], Kontogianni *et al*. [60], Koontz and Hoag [61], Nielsen and Mathiesen [77], Strager and Rosenberger [107], Wattage and Mardle [138]). Therefore, the results of these three surveys did not reflect the preferences of local people for the SD of CDM project. Finally, Sutter [108] gave several recommendations for further research on the preferences of CDM stakeholders. Firstly, he recommended further research to ensure that the survey can reach a well balance between stakeholders from different groups. Secondly, he recommended further research to add a group of local residents, especially the grass-roots level into the stakeholder survey and examine whether the sustainability preferences of experts and the sustainability preferences of local residents are different. Lastly, he suggested conducting a small scale survey rather than a large scale survey because a large scale survey tends to produce equalized weightings.

More recently, Nussbaumer [79] followed Sutter [108] to conduct a survey on the sustainability preferences of CDM stakeholders. Nussbaumer used only the direct weighting to assess the sustainability preferences. This survey was conducted through electronic questionnaires and gained a small number of participants which included only 11 people (5 responses from Annex I countries and 6 responses from non-Annex I countries). Unfortunately, this research failed to clearly find the preferences of CDM stakeholders. There was no strong evidence for a group of stakeholders to significantly favor one or the other SD criteria, or even a SD category. Moreover, the results of the questionnaire were not statistically relevant. More seriously, this survey include only the participants from Annex I countries. Consequently, the results of this survey cannot really reflect the preferences of all CDM stakeholders.

There is clearly a need for further research on the stakeholder preferences towards the SD benefits of CDM project. Therefore, this research will follow Sutter [108] and use his recommendations to conduct a research on the sustainability preferences of CDM stakeholders. Hopefully this research will answer the open questions that were left by Sutter. Finally, this research will use in-depth interviews and site visits to find the SD benefits of a project case study and check whether the expected SD benefits described in the PDD are actually realized.

9.4 Research Methodologies

According to Nielsen and Mathiesen [77], the combination of qualitative and quantitative methods is useful in eliciting the preference structures within a complex group of stakeholders. The link between the qualitative and quantitative results will show whether the results of priority weights (quantitative method) are consistent with the real SD benefits and social costs we found by using qualitative interviews. This dual approach has been adopted in this research.

9.4.1 *Selecting SD Benefits and Social Costs for the Stakeholder Survey*

Quantitative methods have been used to find stakeholder preferences for the SD of biomass CDM projects while qualitative methods have been used to investigate stakeholders' perceptions of SD impacts. CDM potentially provide a wide range of environmental, economic, social, and technological benefits. However several potential CDM benefits are not relevant to biomass projects based on rice husk. Moreover including too many options in a study of stakeholder preferences increases the respondents' cognitive burdens to the detriment of the study. This is a particular problem with face-to-face interviews (Ananda and Herath [3]). We therefore follow Curtius and Vorlaufer [18] and study only the SD benefits related to biomass CDM projects based on rice husk. In order to identify SD benefits we reviewed the project design documents (PDDs) of the 11 Thai biomass projects. Finally, we arrived at six SD benefits and the three social costs. The six SD benefits are:

i. Generating extra income from selling biomass residues
ii. Avoidance of danger from the burning of biomass residues
iii. Creating jobs for local people
iv. Transfer of technology and knowledge in renewable energy
v. Increasing the usage of renewable energy and local content
vi. Reduction of GHG emissions

As for the social costs, most PDDs of the 11 CDM projects (rice husk) stated that stakeholders were worried about environmental problems including: (i) dust; (ii) noise; and (iii) waste disposal.

The Buasommai Biomass CDM Project used the GS methodology to assess the sustainability of its project and found that it has a negative score (-1) on air quality and noise pollution during the operation period [9]. Moreover, the PDDs of Thaisaree Rice Husk Power Plant, Phu Khieo Bio-Energy Cogeneration project, and Buayai Bio Power Plant revealed that their stakeholders were concerned about: (i) air quality; (ii) water quality; and (iii) noise level.

These six SD benefits and three social costs were used in a pairwise questionnaire to explore sustainability preferences. A series of pre-test meetings were held in Bannsamednoi Village (the local area adjacent to the CDM project) with 8 local people and 2 experts to discuss various aspects of the proposed research. All participants agreed that the SD benefits should not include the ‘avoidance of danger from the burning of biomass residues’. This is because the local rice mills had already stopped burning rice husks before the implementation of biomass CDM projects. Consequently this SD benefit is not relevant, and it was deleted from the pairwise questionnaire.

9.4.2 *Qualitative Method*

Qualitative method was used to gain a deeper insight. This research used multi-stakeholder analysis described by Brown *et al*. [8] as “*a system for collecting information about groups or individuals who are affected by decisions, categorizing that information, and explaining the possible conflicts that may exist between important groups, and areas where trade-off may be possible*”. A multi-stakeholder analysis largely relies on in-depth interviews together with document and policy analysis. Brown *et al*. [8] suggested that the interview structure should be developed according to an interviewee’s position and experience in the field. An interviewee with a limited experience in CDM activities will be interviewed in less detail than those with more experience. Interviews were structured by referring to the six SD benefits and three social costs mentioned above. CDM stakeholders are asked about their experiences based on the rice husk project. In-depth interviews were conducted between January and March 2010. The discussions during the in-depth interviews were audio recorded for analyzing the transcribed data.

9.4.3 *Quantitative Method: The Analytic Hierarchy Process (AHP)*

Quantitative method will be used to answer the two research questions: (1) What the preferences of the stakeholder for the SD of CDM projects are; and (2) Whether the group’s preferences are substantially different from each other, on which criteria they differ. This research will use the Analytic Hierarchy Process (AHP) developed by Saaty [98] to assess the sustainability preferences of CDM stakeholders.

AHP is suitable for complex decisions which involve the comparison of decision elements which are difficult to quantify (Saaty [98]). The AHP has proven to be a helpful tool for prioritizing the objectives of stakeholders’ preferences and exposing similarities and differences in stakeholder preferences (Nielsen and Mathiesen [77]). As

CDM project has multiple SD objectives to be prioritized, AHP is a suitable tool for this study to rank multiple SD objectives of CDM project. AHP has been used in various contexts and fields because of its user-friendly interface for multi-criteria decision-making (Nielsen and Mathiesen [77], Sato [99], Wattage and Mardle [138]). According to Pascoe *et al*. [88], Strager and Rosenberger [107], and Sutter [108], the reasons for choosing the AHP as a tool to assess the preferences of stakeholders are as follows: 1) the AHP allow for many objectives to be simplified to individual choices by using pairwise comparison. Pairwise comparison will make the process of assigning weights much easier for participants because only two objectives are being compared at any one time rather than all objectives having to be compared with each other simultaneously; 2) the availability of AHP software makes calculation easy and provides many display tools to quickly view results; 3) the AHP provides an inconsistency check that enable the elimination of unserious answers. The AHP involve the following steps:

i)   Identification of stakeholders

The first step of the AHP is to identify stakeholders. This step is aimed to ensure that all interests in the CDM area are considered within the planning and decision-making process. In this step stakeholders will be added to the list for the future interview. Most studies using the AHP have used a small sample of stakeholders (Wattage and Mardle [138]). This is because a large number of stakeholders tend to produce equalized weightings and a large number of stakeholders make the elicitation exercise unworkable (Ananda and Herath [3], Sutter [108]). The details of stakeholder selection will be shown in Topic 9.4.4

ii)   Identification of sustainable development objectives

The SD objectives of CDM project is developed for application at the project level. The SD objectives of CDM project can be synthesized from national sustainable development priorities. Moreover, the SD objectives of CDM project should create a linkage between CDM projects and national dimensions of sustainable development. The SD objectives largely overlap with national development objectives. There are synergies between CDM projects and national dimensions of SD. If the CDM project can contribute to SD at project level, it will also have a positive impact on SD at national level. The SD objectives of CDM project are often grouped in four categories covering environmental, social, economic, and technological aspects. Each objective must be translated into the sub-objectives. These SD sub-objectives will be used in an AHP pairwise comparison for measuring the weighted preferences of CDM stakeholders.

In exploring the sustainability preferences of CDM stakeholders in South Africa and India, Sutter [108] developed the three SD objectives of CDM project including environmental, social, and economic objectives. These three objectives were translated into the 12 sub-objectives which can be shown in the figure 5.3 (Chapter 5).

iii) Questionnaire Design and Data Collection

The stakeholder preferences towards the SD objectives can be elicited using the pairwise comparison questions. This step requires stakeholders to answer many pairwise comparison questions. In the pairwise comparison questions, stakeholders are asked to assess the importance of one sub-objective against another sub-objective on the 9-point scale. This 9-point scale is used to determine the weightings. According to Satty [98], the value “9” denotes “absolute importance”, whereas the value “1” represents “equal importance”. For example, if the sub-objective 1 is extremely more important than the subjective 2, the stakeholder will give the value “9” in a pairwise comparison question. Table 9.1 show the 9-point comparison scale

Scale	Definition
1	Equal importance
3	Moderate importance
5	Strong importance
7	Very strong importance
9	Absolute importance
2, 4, 6, 8	Intermediate values between the adjacent scale values

Table 9.1: The 9-point comparison scale

The number of the pairwise comparison questions depends on the number of the sub-objectives. We can calculate the number of the pairwise comparison questions by using the following equations:

$$N = \frac{n(n-1)}{2}$$

Where

N = the number of the pairwise comparison questions

n = the number of the sub-objectives

There are many ways to conduct a stakeholder survey such as focus group, internet survey, a face-to-face interview, etc. However, most studies of the sustainability preferences choose a face-to-face interview as a tool for a stakeholder survey. According to Sutter [108], the advantages of a face-to-face interview are: (1) the participants have the chance to ask a researcher about the SD objectives they do not understand; (2) a researcher can check whether participants have actually studied the SD objectives; (3) a researcher can detect and correct the obvious inconsistencies that result from simple errors or misunderstandings. Consequently, this study will use a face-to-face interview to conduct a survey. In the first version of pairwise questionnaire, participants will be asked to weight the six SD benefits and three social costs with the 9-point scale (See Appendix B). In order to ensure the validity of this questionnaire, we went to Bannsamednoi Village (the local area behind CDM project) discussing it with 8 local people and 2 experts. The villagers were very keen to comment on the questionnaire. All participants completely disagreed with this first version of questionnaire. This first version included 18 pairwise questions which were so complicated that villagers could not understand this methodology. We agreed with the villagers because there are few stakeholder surveys using a pairwise questionnaire and this research is the first to use this method for CDM stakeholders. The participants gave us the three recommendations in order to improve this questionnaire. Firstly, they all agreed that the 9-point scale made them confused with its definition and also increase their cognitive burdens. Consequently, we follow Strager and Rosenberger [107] to employ a reduced form of the traditional 9-point scale. We developed the 5-point scaling system by deleting the four middle values (2, 4, 6, 8) of the traditional 9-point scale. This 5-point scaling system is shown in Table 9.2 below.

Scale	Definition
1	Equal importance
2	Moderate importance
3	Strong importance
4	Very strong importance
5	Absolute importance

Table 9.2: The 5-point comparison scale

Secondly, all participants agreed that the SD benefits should not include avoidance of danger from the burning of biomass residues. This is because the rice mills stop burning the rice husks before the implementation of biomass CDM projects. This indicates that this is not a truly additional SD benefit, so we delete it from the pairwise questionnaire. Thirdly, they suggested us to describe more details of the five remaining SD benefits. Finally, we get the final version of questionnaire that all participants agree with (See Appendix C). This questionnaire including 13 pairwise questions asking the participants to weight the five SD benefits and three social costs with the 5-point scale. On an average, a participant need almost a minute to answer one pairwise comparison question, so it will take about 15 – 20 minutes for one participant to complete a survey.

iv) The analysis of stakeholders' priority preferences

We can compute the pairwise comparison score between two sub-objectives (a) by using the law of reciprocal comparison. For simplicity, we assume that there are two sub-objectives including O_i and O_j and a_{ij} is a pairwise comparison score between the sub-objective i and the sub-objective j. By reciprocal comparison, if $a_{ij} = 3$, then $a_{ji} = 1/3$. These pairwise comparison scores will be concluded in form of a pairwise comparison reciprocal matrix shown in the table 9.3. All scores in the matrix are positive.

	Sub-Objective i	Sub-Objective j
Sub-Objective i	1	3
Sub-Objective j	1/3	1

Table 9.3: The pairwise comparison reciprocal matrix

The next step is score normalization. To normalize these pairwise comparison scores, we will compute the sum of each column and then divide each column by the corresponding sum. For example, the sum of column-j = 3 + 1 = 4, so the normalized score of a_{ij} = 3/4 = 0.75 and the normalized score of a_{jj} = 1/4 = 0.25. The normalized scores can be shown in the table 9.4.

	Sub-Objective i	Sub-Objective j
Sub-Objective i	0.75	0.75
Sub-Objective j	0.25	0.25

Table 9.4: The normalized scores

The final step is to compute the average values of each row in the Table 9.4, and use these as the preference weights for each sub-objective. For example, a preference weight for sub-objective i = (0.75+0.75)/2 = 0.75 (75%) and a preference weight for sub-objective j = (0.25+0.25)/2 = 0.25 (25%). These values represent stakeholder priority preferences towards the sub-objectives.

Finally, Saaty suggested that a consistency ratio is used to measure how consistent the judgements have been relative to large samples of purely random judgements. Normally, each participant has a consistent decision. For example, one participant judges that criteria A is more important than criteria B and criteria B is more important than criteria C. If this participant has a consistent decision, participant will judge that criteria A is more important than C. However, not all participants have consistent decision. Therefore, we calculate a consistent ratio to measure the consistency of the pairwise comparisons. As a rule of thumb, a consistency ratio of 0.10 (10%) or less is considered acceptable. If a consistency ratio is greater than 10%, we need to revise the pairwise comparison scores in a matrix. However, Sutter [108] set the cut-off at 0.20 (20%) in exploring the sustainability preferences of CDM stakeholders.

9.4.4 Identification of Stakeholders

CDM project involve a wide range of stakeholders. According to Ananda and Herath [3] and Grimble and Wellard [40], *stakeholder is any group of people, organized or unorganized, who share a common interest or stake in a particular issue or system.* CDM stakeholders are the individuals, groups and communities who are affected by projects such as non-governmental organizations (NGOs), local residents, and employees. In the design phase of the CDM project, the stakeholder participation focuses on the impacts of the CDM project and the project's contribution to SD. In the validation phase of the CDM project, stakeholders comment on whether the project qualifies as a CDM project.

In this research representative stakeholders will be added to the list for in-depth interview. However, selection of representative stakeholders is a difficult task (Ananda and Herath [3]). In the early stage of this research, we will identify stakeholders through a review of the PDD and a project site visit conducted in January to March 2010. As the research progressed, we will follow Brown *et al*. [8] to identify stakeholders by asking relevant stakeholder groups to identify individuals and organizations that have close relationships with them in terms of CDM activities.

Most studies of the sustainability preferences of CDM stakeholders have used a small sample of stakeholders. Nussbaumer [79] and Sutter [108] used a sample of 11 and 30 people respectively. According to Sutter's recommendations, we will add a group of local residents, especially the grass-roots level into the stakeholder survey, so the stakeholder include both a group of experts and a group of local residents. For ensuring a well balance between these two groups, we will survey 40 experts and 56 local residents. Finally, the list of organizations participating in this research is shown in Table 9.5 and 9.6.

Name	Organization Type
Agrinergy (Thailand) Co.Ltd.	Private – CDM Business
South Pole Carbon Asset Management Ltd. (Thailand)	Private – CDM Business
The Department of Alternative Energy Development and Efficiency	Government - Regulator
Energy Policy and Planning Office	Government - Regulator
Regional Energy Coordination Office 6 (Surin)	Government - Regulator
Office of Natural Resources and Environmental Policy and Planning	Government - Regulator
Ram Tambon Administrative Organization	Government - Regulator
Prasart Tambon Administrative Organization	Government - Regulator
Burusi Tambon Administrative Organization	Government - Regulator
Energy for Environment Foundation	NGO – Research
Northeast Development Foundation	NGO – Energy Policy
Walailak Energy Research Unit	Government – Research
Local Environmental Watch Network	NGO – Environmental Policy
Chaipakoom Temple	Local resident
Surin Electricity Co. Ltd.	Private – CDM Business
Agriculture Office of Surin	Government – Regulator
Metropolitan Electricity Authority	State Enterprise – Energy Business
Public Relation Office of Surin	Government – Regulator
Electricity Generating Authority of Thailand	State Enterprise – CDM and Energy Business
Provincial Electricity Authority	State Enterprise – Energy Business
Khanom Electricity Generating Co. Ltd.	Private – Energy Business
Surin Sustainable Energy Working Group	NGO – Energy Policy

Table 9.5: List of stakeholder organizations

Name	Organization Type
Bannburusi School	Government – Academic
Bannbutom School	Government – Academic
Ramwittaya Rachamunghalapisek School	Government – Academic
Bannsamednoi School	Government – Academic
Mungcharoen Green Power	Private – CDM Business
The Clean Energy Fund Committee	NGO – Energy Policy
Silpakorn University	Government – sustainable development policy
Charoen Energy and Water Asia Co. Ltd.	Private – CDM Business
EM Group Co. Ltd.	Private – CDM Business
Carbon Partners Asiatica (Thailand) Co. Ltd.	Private – CDM Business
Foxsys Co.,Ltd.	Private – CDM Business
Khon Kaen Sugar Power Plant	Private – CDM Business
Local residents in Bannsamednoi Village	56 local residents around CDM project area

Table 9.6: List of stakeholder organizations (Cont.)

From Table 9.5 and 9.6, a group of experts include 15 government organizations, 5 NGOs, 3 state enterprises, and 10 private organizations. We have interviewed at least one representative from these organizations (Table 9.5 and 9.6). For the group of local residents, we have selected the residents who live near the CDM project area (less than 2 miles from the CDM project area). Therefore, Bannsamednoi Village was selected as the representatives of local residents. This village was most directly affected by the CDM project (both positive and negative impacts). Bannsamednoi village is located behind Mungcharoen Green Power, about 2 miles away from the project. It is very difficult to go to this village without the help of local residents. The Regional Energy Coordination Office suggested us to call to Mr.Wichai Laithong, one of the Clean Energy Fund Committee, who lives in this village for leading us to the village. We found that this project is the second group to assess the project area (The first group is NHK Television who came to see local stakeholders). Surprisingly, Thai DNA never goes to assess the project area, so the regulators do not know whether the expected SD benefits and the social costs described in the PDD are actually realized.

9.5 Country Context: The Kingdom of Thailand

The issue of CDM's contribution to sustainable development will be addressed in the context of a case study conducted in Thailand. We have selected a biomass (rice husk) CDM project as a case study. The Kingdom of Thailand is located in the heart of the Southeast Asian mainland, and covers an area of 513,115 square kilometres. Its size is equivalent to the size of France and California. Thailand has seventy-six provinces that are further divided into districts and sub-districts. The country is divided into five main geographical regions: the North, the Central Plain, the Northeast, the East, and the South. Unlike the provinces, the five regions have no administrative character, but are used for geographical purposes only. The map of Thailand can be shown in Figure 9.1.

Figure 9.1: Map of Thailand

Thailand has a tropical climate and three seasons: rainy season (June to October), cool season (November to February), and hot season (March to May). According to Thailand Board of Investment, the population of Thailand reached 64.86 million in 2004, of which eight million people live in Bangkok and its vicinity.

Thailand is a middle-income country. Thailand is one of the most successful developing countries. Thailand was known as one of Asian tiger economy with rapid economic growth beginning in 1985, followed by an economic crisis beginning in 1997. Bangkok is an economic centre of Thailand and heavily dominates the national economy. Thailand has had success with reducing poverty headcount ratio from 42.21% in 1988 to 8.48% in 2007. In other words, the number of poor people in Thailand has dropped to 5.4 million in 2007 from 22.1 million in 1988 (see Table 9.7). In 2007 national poverty line is THB1,443/head/month (GBP22/head/month). Poverty is expected to continue to fall in 2008 with farm incomes continuing to rise sharply as a result of the recent rise in crop prices.

Poverty Index	1988	1990	1992	1998	2004	2006	2007
Poverty line (Bath/head/month)	633	692	790	1,130	1,242	1,386	1,443
Poverty headcount ratio (%)	42.21	33.69	28.43	17.46	11.16	9.55	8.48
the number of poor people (million)	22.1	18.4	15.8	10.2	7.0	6.1	5.4

Table 9.7: Thailand Poverty Index; (source: [114])

Agriculture was traditionally the major economic activity of Thailand. However, the acceleration of economic growth in the boom period (1985-1996) caused rapid changes in Thailand's economic structure. Currently, Thai economy is largely dependent on manufacturing and services (see Table 9.8)

Sector	GDP by sector (%)	Labor force by occupation (%)
Agriculture	8.8	38.8
Manufacturing	39.6	15.8
Wholesale and Retail trade	13.6	15.6
Services	37.9	23.4

Table 9.8: Thailand's economic structure in 2007; (source: [115])

Manufacturing has created Thailand's rapid economic growth. According to Bank of Thailand, the manufacturing's share of GDP rose from 22% in 1980 to 39.6% in 2007. However, manufacturing employed only 15.8% of the labor force in 2007. Major manufacturing include motor vehicles and parts, food processing, electronics, textiles and clothing, and petroleum. Thailand is becoming a centre of automobile manufacturing for the Association of Southeast Asian Nations market.

The service sector is another economic sector which helps Thailand to achieve rapid economic growth. The service sector includes financial services, education, restaurants, and hotels. The service sector has shifted from low-skilled jobs to high-skilled jobs in financial services, trade, and management. In 2007 the service sector contributed 37.9% of GDP and employed 23.4% of the labor force. Tourism is a major activity within Thailand's service sector. According to Tourism Authority of Thailand, 14.46 million international tourists visited Thailand in 2007 and generated THB547,782 million (GBP8,425 million) in revenue for Thailand in 2007.

Agriculture becomes less important in Thailand today. The agriculture's share of GDP fell from 23% in 1980 to 8.8% in 2007. However, agriculture accounts for the highest share of the labor force. As of 2007, 38.8% of the labor force is employed in agriculture. Rice is still the Thailand's most important crop. Thailand is the world's leading exporter of rice. Other major crops include rubber, coconuts, corn, soybeans, sugarcane, and other tropical fruits.

9.6 Thailand's Energy Policy and Situation

Thai economy quickly rebounded from the crisis period of 1997 - 1999. Indeed, Thailand's growth recovery was driven largely by the growing exports and the growing investments. In the period of 2000 - 2006 Thailand’s annual real GDP growth averaged 5%; whereas world’s annual real GDP growth averaged 3%. The national energy consumption increases in line with this growth. Therefore, the energy consumption keep rising after the crisis period of 1997 – 1999. From 1984 to 2008, final energy consumption has grown annually at 6%.

In 2009, the final energy consumption in Thailand was 66,339 ktoe (kilo-ton-oil-equivalent) with the rate of increasing 0.7% from the previous year (DEDE [20]). The total value of the final energy consumption was 1,032 billion Baht (or about GBP21 billion; exchange rate: GBP1 = THB50.00). Considering the final energy consumption by economic sector, industrial sector accounted for the largest proportion of the total final energy consumption (36.6%), followed by transportation sector (35.7%), residential sector (14.9%), commercial sector (7.6%), and agricultural sector (5.2%).

Thailand is a net energy importer and largely depends on crude oil imports for power generation. More clearly, crude oil accounted for 67.66% and 68.15% of the total energy imported in 2007 and 2008 respectively. Therefore, Thailand is affected severely by oil price volatility. This will also make Thailand face a huge foreign currency loss. In 2009, the total energy imported was 59,386 ktoe with the rate of decreasing 0.1% from the previous year, while the total energy exported was 12,712 ktoe with the rate of increasing 8.5% from the previous year. The commercial energy (petroleum products, crude oil, electricity, natural gas, and coal) accounted for about 99% of both total energy imported and total energy exported. In 2009, crude oil played the greatest proportion or 67.50% of the total energy imported.

Considering the fuel consumption for electricity generation, fuel oil and diesel oil accounted for the largest proportion or 59.8% of the total fuel consumption of electric generation in 1981, but the share of fuel oil and diesel oil for electricity generation was continuously decreased while increasing that of other fuel types such as natural gas, coal, lignite, nuclear, etc. In 2009, fuel oil and diesel oil accounted for only 0.7% of the total fuel consumption of electric generation. According to Thailand Power Development Plan (PDP) during 2008 – 2021, the share of fuel oil and diesel oil for electricity generation will be reduced to 0% by 2021 (Chongpeerapieng [15]) (see Table 9.9). On the other hand, natural gas accounted for the largest proportion or 73.7% of the total fuel consumption of electric generation in 2009.

	1981	1987	1998	2008	2016	2021
Natural gas	10.0	54.5	53.8	70.0	63.4	47.1
Lignite	10.9	23.4	18.1	12.6	7.8	5.9
Imported coal	-	-	0.5	8.2	15.0	15.0
Hydro	19.3	14.2	5.5	4.7	2.7	2.0
Fuel oil	58.4	7.6	19.2	1.0	-	-
Diesel	1.4	0.2	1.1	0.2	-	-
Renewable energy	-	-	0.2	1.4	2.7	2.3
Nuclear	-	-	-	-	-	5.3
Imported electricity from other countries	-	-	1.8	1.9	7.0	9.7

Table 9.9: Share of fuels used for power generation in Thailand; (source: Chongpeerapieng [15])

In Thailand, there are many renewable energy resources such as biomass, solar, and hydro, but Thailand so far exploits only a small portion of the full potential of these resources. However, the percentage share of renewable energy is continuously rising because there are many policies to encourage the production and use of renewable energy. In 2009, Thailand’s renewable energy consumption was 5,861 ktoe with the rate of increasing 21.7% from the previous year. Of this amount, renewable energy consumption as electricity energy, thermal energy, ethanol, biodiesel, and NGV (Natural Gas Vehicle) accounted for 8.8% of the total final energy consumption. The electricity consumption produced from renewable energy was 279 ktoe. The thermal consumption was 3,537 ktoe. The biofuel consumption as ethanol was 334 ktoe, and 478 ktoe as biodiesel. Finally, NGV consumption was 1,233 ktoe. However, the increasing use of renewable energy has caused the rising price of biomass residues. Figure 9.2 showed the historical prices of biomass residues. The price of rice husk rises to 1,200 Baht per tonne in 2010 from 500 Baht per tonne in 2006, showing an increase of 140%. Moreover, the price of oil palm shell rises to 1,500 Baht per tonne in 2010 from 1,100 Baht per tonne, representing an increase of 36% [46]. According to Gervasoni [31], the increased price of the rice husks will significantly raise the income of farmers. We will discuss this effect on the farmer’s income in the next chapter.

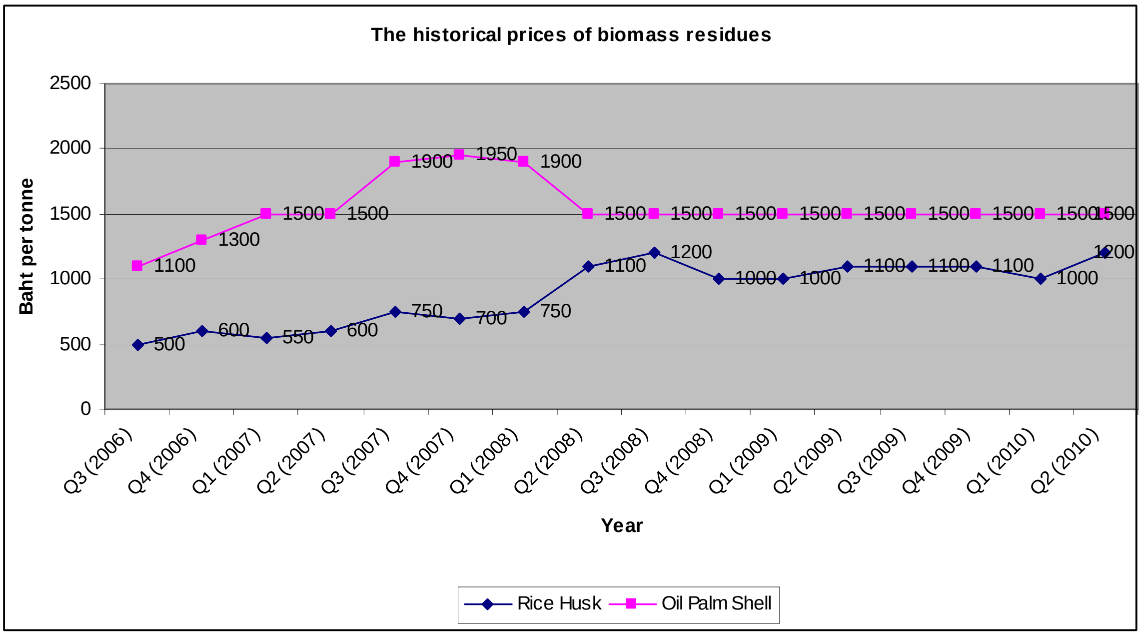

Figure 9.2: The historical prices of rice husk and oil palm shell; (source: [46])

As discussed above, Thailand largely depends on imported energy, especially fossil fuels. In order to minimize dependency on imported energy and simultaneously reduce the environment impact of using conventional fossil fuels, Thailand has recently announced the 15-year Alternative Energy Development Plan (AEDP) during 2008 – 2022. The AEDP's target is to increase a share of alternative energy mixed to be 20.3% of the country final energy demand in the year 2022 [20]. This target is equivalent to total oil consumption of 19,799 ktoe. Moreover, this target will help Thailand avoid the addition of 42 $MtCO_2e$ GHG emissions per year. The objectives of the AEDP are:

i) To utilize alternative energy as a major energy supply of the country for replacing oil import.

ii) To increase energy security of the country.

iii) To promote an integrated green energy utilization in communities.

iv) To enhance the development of alternative energy technology industry.

v) To research and encourage high efficiency alternative energy technologies.

In the AEDP, Thailand has an estimated renewable energy potential of around 57,210 MW for electricity generation. Of this potential, Thailand has the highest potential for solar power, followed by biomass, and wind energy (see Table 9.10). Solar power has the potential to provide 50,000 MW for electricity generation of which only 32 MW has been developed. The majority of electricity generated by renewable energy comes from biomass. This is because Thailand is an agricultural country and has many agricultural residues such as rice husks, bagasse, coconut husks and shells, palm oil fibre, etc. According to the AEDP, biomass has the potential to provide 4,400 MW for electricity generation of which 1,610 MW has been developed. Considering the wind power, its estimated potential is 1,600 MW of which only 1 MW has been developed. Based on the estimated renewable energy potential, the 15-Year ADEP is divided into three phases (see Table 9.10):

(1) The short term from 2008 to 2011

The short term is emphasized on the promotion of commercial alternative energy technologies and the high-potential renewable energy resources such as biofuels and thermal energy from biomass and biogas with full financial support. The short term goal is to develop renewable energy to a level equivalent to 10,961 ktoe or 15.6% of the total energy consumption (see Table 9.10).

(2) The mid-term from 2012 to 2016

The mid-term aim to: (1) promote the renewable energy technology industry; (2) support the new renewable energy technology prototype development in order to make it economically sound; and (3) encourage new technologies in the biofuels production, the green city model development, and the strengthening of the local energy production. The mid-term goal is to develop renewable energy a level equivalent to 15,579 ktoe or 19.1% of the total energy consumption (see Table 9.10).

(3) The long term from 2017 to 2022

The long term aim to: (1) enhance utilization of new available alternative energy technologies such as hydrogen, bio hydrogenated (BHD), etc.; (2) extend the green city model throughout Thai communities; and (3) promote Thailand as the ASEAN biofuels and renewable technology export hub. The long term goal is to develop renewable energy equivalent to a level 19,799 ktoe or 20.3% of the total energy consumption (see Table 9.10).

	Potential	Existing	2008 - 2011		2012 - 2016		2017 – 2022	
	MW	MW	MW	ktoe	MW	ktoe	MW	ktoe
Solar	50,000	32	55	6	95	11	500	56
Wind	1,600	1	115	13	375	42	800	89
Hydro	700	56	165	43	281	73	324	85
Biomass	4,400	1,610	2,800	1,463	3,220	1,682	3,700	1,933
Biogas	190	46	60	27	90	40	120	54
Solid waste	400	5	78	35	130	58	160	96
Hydrogen							4	1
Total		1,750	3,273	1,587	4,191	1,907	5,608	2,313
Thermal	ktoe	ktoe		ktoe		ktoe		ktoe
Solar	154	1		5		18		38
Biomass	7,400	2,781		3,660		5,000		6,760
Biogas	600	224		470		540		600
Solid waste		1		15		24		35
Total		3,007		4,150		5,582		7,433
Biofuel	m lt/d	m lt/d	m lt/d	ktoe	m lt/d	ktoe	m lt/d	ktoe
Ethanol	3.00	1.24	3.00	805	6.20	1,686	9.00	2,447
Biodiesel	4.20	1.56	3.00	950	3.64	1,145	4.50	1,415
Hydrogen							0.1	124
Total			6.00	1,755	9.84	2,831	13.50	3,986
Total energy consumption		66,248		70,300		81,500		97,300
Total energy from renewable energy (ktoe)		4,237		7,492		10,319		13,709
Renewable energy ratio		6.4%		10.6%		12.7%		14.1%
NGV (mmscfd – ktoe)		108.1	393.0	3,469	596	5,260	690	6,090
Total energy from renewable energy and NGV (ktoe)				10,961		15,579		19,799
Alternative energy ratio				15.6%		19.1%		20.3%

Table 9.10: Goals of the 15-Year ADEP; (source: [20])

In order to achieve the goals of these three phases, biomass energy is expected to provide a share in excess of 60% of alternative energy mix, reflecting the fact that Thailand is a country highly dependent on the agricultural sector and hence has access to the large amounts of the waste agricultural residues.

9.7 CDM Implementation in Thailand

Thailand signed the United Nations Framework Convention on Climate Change (UNFCCC) in June 1992 and the Convention was ratified on December 1994. The ratification went into effect in March 1995. Later, Thailand signed the Kyoto Protocol on 2 February 1999 and ratified it on 28 August 2002. After the ratification of the UNFCCC and the Kyoto Protocol, Thailand developed the Principles of climate change policy which was based on the objectives of stabilizing GHG emissions, and, at the same time, recognizing economic development needs (IGES [49]). The principles of Thailand's climate change policy are concluded in Table 9.11.

No-regret option	Thailand should participate and cooperate with other parties to achieve the common objective of reducing GHG emissions, but the same time it should recognize economic development needs.
Precautionary	Thailand should take precautionary measures against the potential adverse impacts of climate change.
Common but differentiated responsibilities	As a non-Annex I country, Thailand does not have emission reduction target obligations under the UNFCCC. Thailand anticipates that Annex I countries will take the lead in GHG emissions reduction both domestically and abroad. Sufficient support provided for voluntary action and public participation is preferred.
Equity	It should address inequalities in health status and access to adequate food, clean water, and others due the adverse effects of climate change.

Table 9.11: The principles of Thailand's climate change policy; (source: IGES [49])

As a non-Annex I country, Thailand has no commitment to reducing GHG emissions under the Kyoto Protocol and is eligible to host the CDM projects. The Thailand Greenhouse Gas Management Organization (TGO) was established under the Ministry of Natural Resources and Environment to work as the Designated National Authority for CDM (CDM-DNA). TGO is the newly established autonomous governmental organization. The Objectives and duties of TGO include: (1) analyzing and screening the CDM projects for issuance of the Letter of Approval (LOA) and monitoring the projects; (2) promoting CDM projects and the carbon market; (3) being the National Information Clearing House of Greenhouse Gas; (4) managing all information regarding the approved CDM projects and CERs' value; (5) enhancing the capacity building of the government and private sectors on greenhouse gas management; (6) promoting public outreach regarding greenhouse gases; and (7) promoting and supporting all activities related to climate change mitigation.

As Thailand's energy policy aim to increase the use of renewable energy in order to prevent an energy shortage, the top priority will be given to the following CDM project types:

- Energy sector including energy production and energy efficiency improvement projects such as fuel switching, conversion of industrial waste to energy, improvement of cooling system effectiveness, improvement of energy efficiency in buildings, etc.
- Environment sector including production of heat and electricity from municipal solid waste and wastewater treatment for energy production.
- Transport sector including improvement of fuel efficiency and demand side management.
- Industrial sector including emission reductions from manufacturing process.

In order to ensure the projects' contribution to SD in Thailand, the TGO Board of Directors developed the procedures for screening, evaluating, and approving CDM projects. The CDM project approval procedures are shown in Figure 9.3.

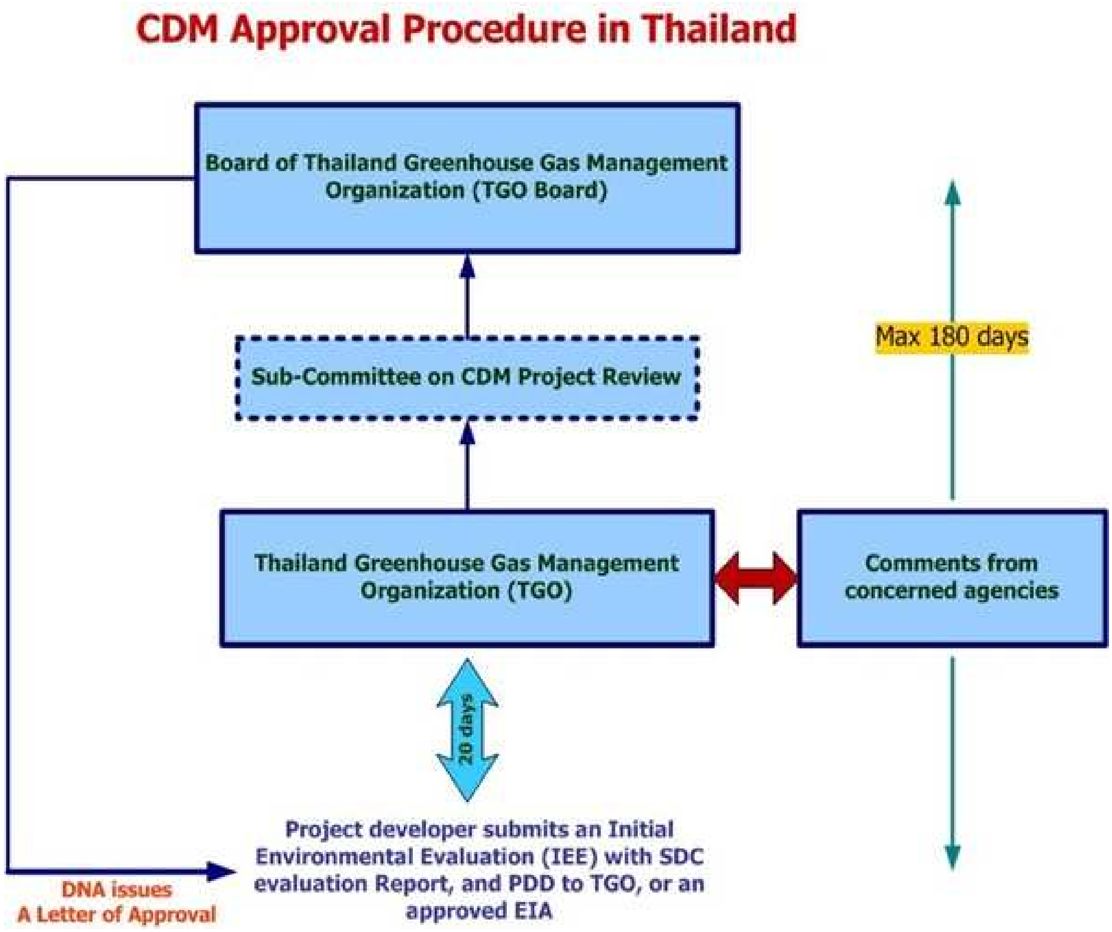

Figure 9.3: CDM Approval Procedure in Thailand; (source: [113])

Briefly, the CDM project approval procedures are as follows:

i) Project proponent submits the PDD and all documents related to CDM project to TGO

ii) TGO checks the completeness of these documents and send these to the relevant Ministries which will evaluate the project eligibility.

iii) TGO uses comments from the relevant Ministries to evaluate whether the Letter of Approval shall be issued.

iv) Finally, TGO reports the final decision to the project proponent. If a project candidate contribute to SD in Thailand and meet all the evaluated requirements, it will be approved and get the Letter of Approval.

The above procedures are regulated to complete within 180 working days. The Letter of Approval (LOA) is to be signed by the Permanent Secretary of the Ministry of Natural Resources and Environment.

9.8 The Sustainable Development Criteria and Indicators for Assessing CDM projects in Thailand

A duty to assess the sustainability of CDM projects is assigned to a host country, so a host country must develop its own criteria for ensuring the SD benefits of CDM projects. In Thailand, the SD criteria for assessing CDM projects are developed by TGO. As mentioned in Chapter 5, Thailand is categorized as country with well defined sustainability criteria in Asia-Pacific. The SD objectives of CDM project are grouped in four categories covering environmental, social, economic, and technological objectives. These four objectives are translated into 24 criteria. These objectives and criteria have been defined as follows:

9.8.1 Environmental Objective: This objective is translated into 15 criteria as follows:

1) Reduction of greenhouse gas emissions: This criterion is assessed by the amount of reduction of greenhouse gas emissions compared with baseline. This criterion is scored between 0 to +1.
2) Reduction of air pollutant emissions: Standards concerning air pollutants and air additives should be in compliance with the laws announces by authorities such as the Ministry of Natural Resources and Environment, the Pollution Control Department, the Department of Industrial Works, etc. This criterion is scored between -1 to +1.
3) Noise pollution: This criterion is assessed by sound level in the project site. This criterion is scored between 0 to +1.
4) Odour pollution: Odor pollution control should be in compliance with the laws announces by authorities such as the Department of Industrial Works, Ministry of Public Health, etc. This criterion is scored between 0 to +1.
5) Wastewater quality: Standards of wastewater quality should be in compliance with effluent standards stipulated by relevant authorities such as the Department

of Industrial Works, Harbor Department, etc. This criterion is scored between 0 to +3.

6) Waste management: In this criterion, waste means material which cannot be reused and is a burden of management. This criterion is assessed by waste output per raw material input. This criterion is scored between -1 to +2.
7) Soil pollution: Soil pollution standards should be in compliance with the government standards. This criterion is scored between 0 to +1.
8) Groundwater contamination: This criterion is scored between -1 to 0.
9) Reduction of hazardous waste: Hazardous waste should be in compliance with the laws announces by authorities such as the Department of Industrial Works, the Pollution Control Department, etc. This criterion is scored between -1 to +1.
10) Water demand and efficiency of water usage: This criterion is scored between -2 to +2.
11) Soil, coastal and river bank erosion: This criterion is scored between -1 to 0.
12) Increase in green areas under the project's initiative: This criteria aim to promote the development of green area. Green area means any vegetated land managed according to silviculture and landscape principles. Green areas can be located inside or outside the project site as long as it is the project's initiative. This criterion is scored between 0 to +3.
13) Ecosystem diversity: This criterion is scored between -1 to +1.
14) Species diversity: This criterion is assessed by population size and species of flora and fauna. This criterion is scored between -1 to +1.
15) Usage of GMO and/or alien species in the project site: This criterion is scored between -1 to 0.

9.8.2 *Social Objective:* This objective is translated into 3 criteria as follows:

1) People's participation: This criterion is assessed by the level of organized participation. This criterion is scored between -1 to +2.
2) Activities promoting social development, culture, and sufficiency economy philosophy: This criterion is assessed by many activities such as protection of natural and cultural heritage; scholarship award; religious, arts, and cultural activities; healthcare support; activities based on sufficiency economy philosophy; child nursery care, etc. This criterion is scored between 0 to +3.

3) Workers' health and surrounding community health: This criterion is assessed by workers' health and community health plan. This criterion is scored between 0 to +2.

9.8.3 Technological Objective: This objective is translated into 3 criteria as follows:

1) Technological development: This criterion is assessed by the usage of appropriate technology. This criterion is scored between -1 to +2.
2) Post project implementation plan: This criterion is assessed by post project implementation plan or post crediting period plan as outlined by a project. This criterion is scored between 0 to +1.
3) Capacity building: This criterion is assessed by the number of well skilled employees. This criterion is scored between -1 to +1.

9.8.4 Economic Objective: This objective is translated into 3 criteria as follows:

1) Increasing income of stakeholders: This criterion is assessed by workers' annual income and income of other stakeholders. This criterion is scored between -1 to +1.
2) Energy: This criterion is assessed by the amount of alternative energy usage and percentage of energy usage efficiency. This criterion is scored between 0 to +1.
3) Increasing in usage of local content: This criterion is assessed by the proportion of local content compared to import content. This criterion is scored between -1 to +3.

The score used for evaluating each criterion range from a negative score to a positive score, with a middle value at zero. A positive score (+1, +2, +3) indicates positive impact to the area. A zero score indicates no impact to the area or equivalent to the baseline scenario. A negative score (-1, -2) indicates negative impact to the area. Thailand allow the project candidates to have a negative score for any single criterion, however the project candidates must have the total positive score in each group of criteria. In order to receive the Letter of Approval from Thailand, a project candidate must have the total positive score (more than zero). Finally, the SD objectives and criteria developed by TGO are summarized in Table 9.12.

Objectives	Environment	Social	Technology	Economic
Sub-objectives	• Reduction of GHG emissions • Reduction of air pollution • Reduction of noise pollution • Reduction of odor pollution • Reduction of soil pollution • Reduction of hazardous waste • Wastewater quality • Waste management • No groundwater contamination • Efficiency of water usage • No soil, costal, and river bank erosion • Increase in green area • Ecosystem diversity • Species diversity • No use of GMO and/or alien species	• Public participation • Activities promoting social development, culture, and 'sufficiency economy' philosophy • Public health quality for workers and surrounding communities	• Technology development • Implementation plan for post-project life or post-crediting period • Capacity-building activity	• Increasing income of stakeholders • Increase in energy efficiency and usage of alternative energy • Increase in usage of local content

Table 9.12: Thailand's objective hierarchy for CDM project; (source: [116])

9.9 Background on a Case Study: Biomass CDM Projects in Thailand

According to UNEP-Risoe [126], as of July 2010, there are 122 CDM projects in Thailand. These projects are at different stages: 36 projects have been registered; 83 projects are in validation and 3 projects have requested registration. These 122 CDM projects are expected to generate 6,817,000 Certified Emission Reductions (CERs). Currently methane avoidance projects account for the largest number of CDM projects in Thailand (74 projects). Globally biomass CDM projects are concentrated in Asia. Thailand has fifth largest number of biomass CDM projects in the world (22 projects). Thailand is a major producer of rice and the majority of biomass projects are based on rice husks (11 projects). These projects are concentrated in rice producing areas (the central, north, and northeastern of Thailand).

The PDDs of these 11 biomass CDM projects, state that the technology for rice husk power plant is unavailable in Thailand. Consequently, these projects depend on imported technology. The principal technology components are: (1) a combustion system to generate thermal energy from the rice husk; (2) a boiler to generate steam from the thermal energy; and (3) a steam turbine generator to generate electricity using the steam. A low calorific fuel means the boiler system is large in terms of its fuel and ash handling capability. As the rice husk has a high silica content, the boiler combustion chamber is large relative to fossil fuel boilers. This results in a higher initial investment for rice husk boilers. Fly ash is removed from the flue gases using an ash separator that is composed of pre-separator system (Multi-Cyclones) and electrostatic precipitator (ESP). This technology can eliminate up to 99.6% of dust (> 0.1 micron).

In Thailand the baseline assumption used by biomass (rice husk) CDM projects is that any biomass residue that was not used for heat generation was dumped, left to decay or burnt in an uncontrolled manner prior to the project implementation. Before the implementation of biomass CDM projects, the existing rice husk power plants received subsidies from different sources and therefore have a different initial financial situation than biomass CDM projects. For example, Roi-Et Green Power Plant received funds from the Energy Policy and Planning Office (EPPO) and the Global Environment Facility (GEF), whereas PRG Granary Co., Ltd. received subsidies under the Energy Conservation Promotion Fund. This implies that without subsidy biomass (rice husk) power is not viable. This is due to high initial investment costs and a high cost of electricity production. According to Prasertsan and Sajjakulnukit [93], financiers consider bioenergy projects as high risk investments mainly because transaction costs are high. CDM projects need the sale of CERs to overcome these financial barriers.

The increasing use of renewable energy has caused the price of rice husk to rise. This has increased the cost of electricity production from rice husks. The collection and transportation costs of rice husks are also high because rice husks are bulky and widely dispersed. The high price of rice husks and the high collection and transportation costs will decrease project Internal Rates of Returns (IRR). Consequently, the sale of CERs will help the projects to overcome this barrier. Finally, the expected value of CERs generated by these 11 rice husk projects is about 24.8 million Euros per year (CER price is about €12.00 per tonne of CO_2e).

9.10 Study Area

In this study we have selected Mungcharoen Green Power Project (Figure 9.4) in Thailand as a case study. Mungcharoen Green Power (MGP) was awarded *“the Best ASEAN Renewable Energy Project”* and *“the Best Thailand Renewable Energy Project”* in 2008 by the Association of Southeast Asia Nations (ASEAN) and the Thai government. By these awards, it is noted for its operation with the most environmentally friendly and social responsible manner. MGP is the first large scale biomass project developed by a rice mill owner in Thailand. MGP use rice husks, which are wastes by-product from the rice milling process, as fuels for 9.9 MW power generation. It is located in Surin province (Figure 9.1), northeastern province of Thailand, about 286 miles away from Bangkok. The province covers a total area of 8,128 square kilometers and the project covers approximately 240,000 square meters of land.

Figure 9.4. Mungcharoen Green Power Project

Surin province is one of the major producers of rice and is particularly well known for its jasmine rice. Therefore, rice is a major crop grown in the project area and farmers are the major stakeholders of the project. This project converts the agricultural waste into eco-friendly electricity. MGP aims to reduce GHG emissions by displacing part of electricity from the national power grid whose electricity is predominantly derived from fossil fuels. The project activity is expected to reduce 38,033tCO_2/annum over a crediting period of 7 years. MGP sell electricity to the Electricity Authority of Thailand (EGAT) under the contract of the Small Power Producer Program (SPP) for 21 years.

As previously noted, Bannsamednoi Village was selected as the representatives of local residents because it is located behind CDM project (Figure 9.5 and 9.6), about 2 miles away from the project.

Figure 9.5: Bannsamednoi village behind the CDM project; (source: author's survey)

Figure 9.6: Bannsamednoi village behind the CDM project; (source: author's survey)

Figure 9.7: Rice growing area behind the CDM project; (source: author's survey)

There are around 100 households in Bannsamednoi village. The village was predominantly occupied by rice landowners, who cultivated their own land. Therefore, CDM project is surrounded by rice growing area (Figure 9.7 and 9.8). Their ancestor came form Cambodia, about 40 miles away from this village. Therefore, most villagers still speak Cambodian (Khmer language). In in-depth interviews, we therefore must hire local translator to communicate with the local residents. The villager has had on average only 9 years of schooling (a minimum of nine years' school attendance is mandatory in Thailand). The average personal income in this village is about GBP100 per month.

Figure 9.8: Rice growing area behind the CDM project; (source: author's survey)

Most residents are farmers who have a close relationship with the project owner. This is because the project owner has his own rice mill and all farmers in this village sell the rice paddy to the project owner. More importantly, the project owner is a national politician who works closely with the local residents. One villager said "*If the villagers need the money, they can borrow the money from the project owner. Moreover, the project owner always supports the money to the villagers when they organize a religious ceremony such as the wedding ceremony, the funeral ceremony, a Buddhist ordination ceremony, etc*." This evidence shows the Patronage System (sometime known as "Spoil System") in Thai society. In the Patronage System, Thai politician always strongly support the local people by giving the money, giving a job, etc. Therefore, the villagers in this area have an excellent relationship with the project owner. In this village, the major institutions include:

1) Chaipakoom Temple (Figure 9.9): This temple is the centre for villagers to organize social meeting. Thai people always go to a temple to make a merit.

There are four monks in this temple. All participate in the in-depth interviews. A Buddhist always pays respect to a monk. The monks always give a social consultancy to villagers. When the villagers have a problem, they always go to the temple for consulting with the monks. This temple is the centre for communication between the project owner and villagers. The project owner will inform the project's activities affecting the life of residents through the two stereo speakers inside this temple. This temple provides a place for public consultation in the process of CDM implementation.

Figure 9.9: Chaipakoom temple; (source: author's survey)

2) Bannsamednoi School (Figure 9.10): There are about ten teachers and 200 students in this school. This school provides six years of primary education. The villagers always pay respect to the teachers who provide the knowledge to their children.

Figure 9.10: Bannsamednoi School; (source: author's survey)

3) A nursery school (Figure 9.11). This school take care of children between the ages of 2 to 6 years. There are about 50 children in this school, but only one teacher manages all activities. This school charge only GBP0.4 (40 pence) per day for taking care of children. All villagers take their children to stay in this school.

Figure 9.11: A nursery school; (source: author's survey)

The next chapter will describe how the CDM project affects these major institutions. The villagers use a two-lane concrete road (Figure 9.12) for their transportation and a motorcycle is the major vehicle for them.

Figure 9.12: A two-lane concrete road in the village; (source: author's survey)

When considering about the environmental condition in this village, all villagers agree that the environmental condition is excellent before the CDM implementation. There are two ponds in this village. Before the CDM implementation the villagers can use these ponds for drinking and taking a bath. Like the water condition, the air condition is excellent because there is no dust in this village. The next chapter will describe how the CDM activities can affect the environmental condition in this village.

Chapter 10

Research Results: The Sustainability of CDM Projects in Thailand: A Case Study of Biomass (Rice Husk) Project

This Chapter presents the research results from the in-depth interviews conducted between January and March 2010. Both qualitative data and quantitative data derived from the face-to-face interviews. More than 30 organizations participated in this survey. This research employed a mixed methodological approach to study the sustainability of CDM projects. We will therefore present both qualitative and quantitative results. This chapter first discusses whether the expected SD benefits and the social costs described in the PDD are actually realized and how these benefits and costs are allocated. Then, we present the quantitative outcomes related to the sustainability preferences of CDM stakeholders.

10.1 Qualitative Analysis and Results

According to Schenk *et al.* [100], the aim of qualitative research is not to obtain a representative sample, but rather to gain insights into the subject. Between January and March 2010, we conducted in-depth interviews with 21 stakeholders (see Table 10.1 for details). The in-depth interviews were audio recorded and transcribed. Finally, qualitative results are presented in five themes.

No.	Sex	Organization	Professional/occupation
1	m	Government	Energy
2	f	NGO	Energy and environment
3	m	Private	CDM consultant (Biomass project)
4	m	Local resident	Farmer
5	f	Local resident	Farmer
6	m	Local resident	The Clean Energy Fund Committee
7	m	Local resident	teacher
8	m	Private	CDM project manager
9	f	Private	CDM project manager
10	m	Private	Employee in CDM project
11	m	Government	Community development
12	m	Government	University lecturer
13	f	Local resident	teacher
14	m	Local resident	farmer
15	m	Government	Energy (Biomass technology)
16	m	Local resident	farmer
17	m	Local resident	farmer
18	m	Local resident	farmer
19	m	Private	CDM project manager
20	m	Government	Energy
21	m	Private	CDM consultant (Gold Standard)

Table 10.1: Overview of the participants

10.1.1 Theme I: Generating Extra Income for the Farmers

The PDDs of 8 (out of 11) projects based on rice husk stated that their project will give an extra income to Thai farmers by paying a price premium for the rice husks. This benefit involves three groups of CDM stakeholders: (i) project developers; (ii) rice mills; and (iii) farmers.

Thailand is one of the major world producers of rice. Agriculture is economically, socially and cultural importance to the country and this is reflected in the common Thai saying that *"Farmers are the backbone of Thailand"*. However, Thai farmers are the least powerful group in the rice supply chain.

New harvested rice is known as 'paddy rice' or 'rough rice'. Paddy rice still has its hard protective husk. The rice husk is removed by milling which requires large machinery which individual farmers cannot afford. Therefore, most farmers will sell the paddy rice to the rice mills which are often owned and operated by a wealthy elite in the local area. The rice mill owners have more negotiation power than the farmers and they determine the buying price. After milling, we obtain white rice and rice husk. Rice husk is the main by-product of milling rice. For every one tonne of paddy rice milled about 0.22 tonnes of rice husk is produced (EFE [24]). When the rice mills buy the paddy rice from farmers, the price reflects only the value of the white rice, not including the value of the rice husk. The rice mills control the rice husk resource.

In the past rice husks were used for low value agricultural purposes: e.g. animal bedding or compost. It is also used as fuel for cooking in rural households. Traditionally demand for the rice husks was very low because it was not used for industrial purposes. Although farming households can utilize rice husk, they are poor and not prepared to pay for it. Rice mills generally got rid of the rice husks by giving it away or burning it in open fields. Most Thai people are familiar with the saying, "*Poor people eat the rice husk*". Indicating a popular belief that rice husk is worthless.

Papong et al. [87] found that about 30.8% of the rice husk is not used and the remaining 69.2% is used for various purposes such as fuel, fertilizer, soil conditioner, animal feed etc. Currently, the rice husk has a monetary value as an important raw material for many industries. Rice husks are currently used for steel making, building, generating electricity, etc. Considering the commercial use of rice husks, the sellers of rice husks are the rice mills, not farmer. We found that the rice husks are sold to the local buyers near the rice mill because of the transportation costs.

Although the rice mills can sell the rice husks to these industries, they still have not paid a price premium for the rice husks to farmers. Rice husks are currently traded between $32 and $39 per tonne [46]. The details of historical prices of rice husk and white rice are shown in Figure 10.1. Clearly, the price of rice husk is positively correlated to the price of white rice (see Figure 10.1).

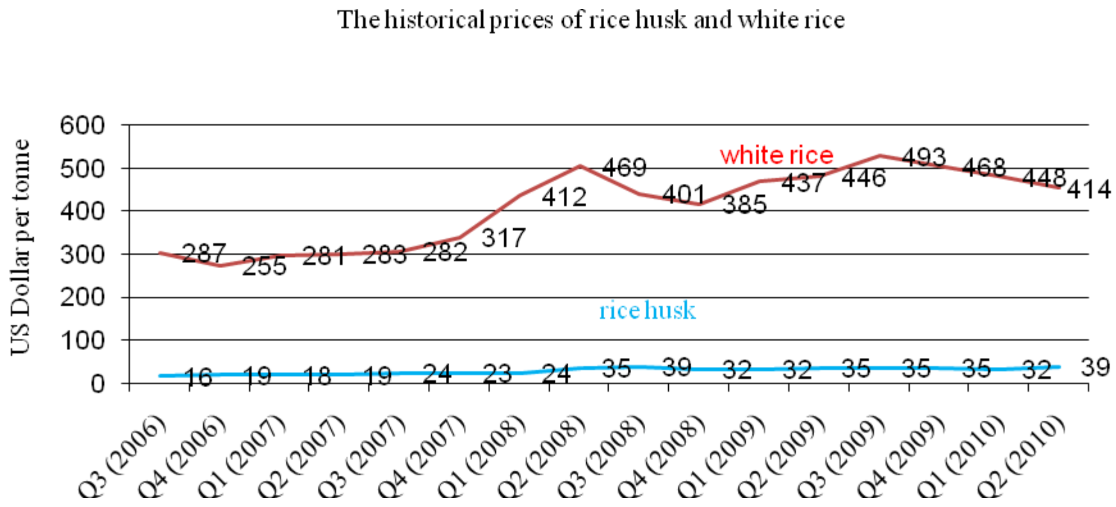

Figure 10.1: The historical prices of rice husk and white rice; (source: [46], [47])

Therefore, CDM projects based on rice husk have created a new business opportunity for rice mills as one participant said:

"*The rice mills see rice husks as their treasures that god gives to them. They get a free rice husk from the milling process and they can make profit by selling the rice husks with no costs. Please imagine how large the profit can be made….*" (No. 6)

It is very clear that CDM projects based on rice husk does not give an extra income to farmers- 19 interviewees (90%) agreed that this benefit, described in the PDDs, is not actually realized, 1 interviewee disagreed and 1 interviewee declined to discuss this issue. One participant noted:

"*Rice husk project does not give an extra income to the farmers in the form of a price premium. Surprisingly, it gives an extra income to the rice mills (rich people) rather farmers (poor people).*" (No. 1)

Indeed rice husk projects make local people lose benefits because of the withdrawal of free rice husk. As one participant noted:

"In the past farmers can request a free risk husk from the rice mills, but now farmers no longer get the rice husks for free. The rice husk was utilized by poor people in the past, but now it is used by rich people. Currently the rice husk is not the symbol of poverty, but it is the symbol of wealthiness. Therefore, low income people cannot use the rice husks as fuel for cooking and as fertilizer for their crops." (No.13)

One consequence of rice husk CDM projects is that poor farmers are losing a previously unpriced resource and the wealthy elites who control rice mills are gaining an extra income. It is clearly arguable that the redistribution of the rice husk resource has increased inequality in rural Thai society.

Given these reasons, we have come to the conclusion that Biomass CDM projects cannot give an extra income to the farmers by paying a price premium for the rice husks. Surprisingly, it gives an extra income to the rice mills (rich people) rather farmers (poor people). Therefore, this benefit described in the PDD is not actually realized. We have wondered why many project developers and CDM consultants stated this benefit in the PDDs. So we discussed this point with Mr.Sittisak Sugsaisakon, the CDM consultant of Agrinergy (Thailand) Co.Ltd. Mr.Sittisak said, "*All project developers and CDM consultants know that this benefit is not true in Thai society, but we must write this benefit in the PDDs in order to meet the SD criteria of Thai DNA.*"

However, in exploring the sustainability of Biomass CDM project in Thailand, Gervasoni [31] found that the increased price of the rice husks will significantly raise the income of farmers. On the other hand, we found that the increased price of the rice husks will significantly raise the income of the rice mills, not farmers. Consequently, this research result presented here contradicts the result of Gervasoni.

10.1.2 Theme II: Employment Creation

In terms of SD benefits, employment creation is the most visible benefit to local people. The PDDs of all 11 Thai rice husk projects stated that their project created jobs. All CDM projects are located in rural areas and create temporary jobs in the construction period and permanent jobs in the operating period. The Buasommai Biomass CDM Project hired 150 local workers during construction and thereafter 20 local people as permanent employees. In the first instance these projects offer jobs to local people. One rice husk project gave a chance for local people to set up their own business to serve the CDM. As one participant noted:

"*My project can really create the new jobs for the local people. For example, the local people have formed the security guard company in order to do the business with my project. This company is owned many local residents in the project area."* (No.9)

We visited two biomass CDM projects including Mungcharoen Green Power Project (MGP) and Surin Electric Project (SEP). We requested MGP and SEP to see their employment policies. Their employment policies clearly state that the first priority for the job is given to the local people. Clearly, Mr.Poramin, the project manager of SEP, said:

"*My CDM project gives a chance for the local people to work in their hometown. My project hired 15 truck drivers, 10 security guards, 5 maids, and 20 clerical officers. All these positions are new employment resulted from the implementation of CDM project*."

Finally, all 21 interviewees agreed that this benefit is actually realized as described in the PDDs and the local people get many benefits from the employment creation as one participant said:

"*The project created new jobs for local people. The villagers can get the jobs in their hometown, so they can stay close to their family. If there is no project, the local people may go to find the jobs in Bangkok."* (No. 5)

However, we found that the new employment for local people is limited to the low-level jobs such as truck drivers, security guards, maids, clerical officers, etc. These positions require the basic education (below the bachelor's degree). More surprisingly, all three CDM project managers we have interviewed came from Bangkok, not local people. These managers stated that most power generation engineers also came from Bangkok. One participant said:

"*I cannot find the local people to work in the high positions such as project manager, power generation engineers, etc. My project is located in the rural area far from*

Bangkok, so the educational institutions don't offer the programs in the power generation or the renewable energy. We always hire people from Bangkok to work in these positions." (No.9)

These confirmed that the positions requiring expertise in power generation were taken by people from Bangkok, not local people. This is because the local people don't have the sufficient knowledge and experience in the field of power generation and renewable energy.

10.1.3 Theme III: Increasing the Usage of Renewable Energy and Transfer of Knowledge in Renewable Energy

As previously noted, the 15-year AEDP aims to increase the share of alternative energy mixed to 20.3% of the country's final energy demand by 2022. Biomass CDM is one of the tools being used to achieve this target. This will result in an increasing usage of renewable energy in Thailand. According to a survey done by the office of agricultural economics, Surin produces about 1,289,249 tons of rice in 2009, making it to be the second largest rice producing province in Thailand. Therefore, the rice husks are abundant in Surin. This means Surin has the high potential for biomass-based electricity generation. According to the Ministry of Energy , the province has the highest potential for solar power (259,734 ktoe), followed by biomass (97.23 ktoe), and biogas (12.27 ktoe) in 2006 [117] (see Table 10.2). Considering only biomass energy, the rice husk has the highest potential for electricity generation.

Type	Potential (ktoe)
Solar	259,734
Hydro	0.50
Biomass	97.23
Biogas	12.27

Table 10.2: Renewable energy potential in Surin; (source: [117])

All participants completely agreed that biomass CDM projects can increase the usage of renewable energy and local content in Surin. Mr.Bandit Chusap, the power plant manager of MGP, stated that they use about 85,000 tons of rice husks in Surin per year.

Moreover, he said that around 185,000 tons per year of rice husks from Surin were transported to other provinces for electricity generation. One participant said; "*Surin now become Thailand's export hub for the rice husks*." (No.11)

However, increasing usage of renewable energy is leading to competition for rice husk. This in turn is leading to conflict between the CDM projects and the rice mills. The project developers of biomass (rice husk) CDM projects are often rice mill owners. Therefore, the project developers act as both buyers of rice husks (from other mills) and sellers of rice (from their own mill). These developers are in competition with the other rice mills because of their rice business. When they act as sellers of rice, they tend to compete against each other in order to get the highest market share. Our qualitative interviews found that A.T. Biopower CDM project has such a conflict with other rice mills in its province because of the competition in rice business[5]. The other rice mills collectively refuse to sell their rice husks to this CDM. Now this CDM has shut down. One participant said:

"*One CDM project based on rice husk decided to shut down because of the shortage of the rice husks. Therefore, this project cannot deliver the carbon credits to the buyer as it promised. I was surprised with the project's inability to find the rice husks because this project is located in the major area of rice growing and rice milling. Finally, I found that this CDM has a conflict with many rice mills. Therefore, these mills refuse to sell the rice husks to this CDM*." (No.15)

There is a possibility that this conflict may occur again in other project areas. This could be a barrier to the further development of biomass CDM projects in Thailand. The Thai government has created many policies to increase renewable energy development, but it does not address anti-market behavior resulting from these policies. At the moment it is not clear how the government will develop the market for biomass residues guaranteeing the supply of rice husks to the biomass power plant. These results are consistent with ONEP [82] who reported that the lack of a biomass commodity market is one of the barriers to biomass energy implementation in Thailand.

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[5] Interview with Mr.Yaowateera Achawangkul, The Department of Alternative Energy Development and Efficiency, Ministry of Energy, Thailand.

The final benefit relates to biomass CDM projects and their potential for transfer knowledge in renewable energy. According to ONEP [82] and Prasertsan and Sajjakulnukit [93], lack of public support is one of the barriers to biomass energy implementation in Thailand. There is a lack of confidence and misperceptions of biomass technology among Thai people. The public image of biomass power plant is not good and there's regular opposition to biomass power plant in many parts of central Thailand. The protesters are almost always the villagers from the project area. They are deeply concerned about the project's potential effects on their health and environment. This is because they are not confident of the technology or environmental management. However, their protests have little impacts on the biomass power plant. Protesters can only deter the developers from building on their lands, but not stop the project implementation. We are aware of only one opposition which successfully stopped a project. The Nam Song villagers protested against an A.T. Biopower CDM project proposal leading to the withdrawal of the project application in October 2007. However, the project was successfully constructed in the community of Sa Luang.

In order to remove this barrier, the biomass project developers need to transfer knowledge and information on biomass technology to local people. This may help build the confidence of local communities in biomass energy (ONEP [82], Prasertsan and Sajjakulnukit [93]). All 21 interviewees agreed that the rice husk CDM projects could help address public opposition through knowledge transfer. As one participant pointed out that:

"*We have two biomass CDM projects in our province* [Surin province]. *Now our province is widely accepted as the learning center of renewable energy in Thailand. Before the construction of the biomass power plants in other provinces, the project developers always take the villagers to see these two CDM in order to build the confidence in biomass technologies. So the CDM can definitely spread the knowledge to many stakeholders*." (No.11)

A good example is the Mungcharoen Green Power Project (MGP), which is widely accepted as the best CDM project in terms of the knowledge transfer. The MGP project tries to engage with stakeholders at local, regional, national, and even international levels. This includes local people, students, researchers, government officers, project developers, and businessmen. Japan's NHK Television, visited this project to produce a

TV program in the topic of Asian biomass power plant. The MGP annual report indicates that there were a total of 4,161 visitors from 2007 to 2009. There were 956 visitors, 1,191 visitors, and 2,014 visitors in the years 2007, 2008, and 2009 respectively. This indicates that CDM projects can be successful in knowledge transfer

10.1.4 Theme IV: Environmental Risk

Despite the fact that rice husk CDM biomass projects provide carbon neutral energy new proposals have difficulty gaining acceptance from communities because of negative fears about environment impact (ONEP [82]). Most PDDs of the rice husk projects stated that their stakeholders were worried about the problem of dust and waste disposal. Meetings with Bannsamednoi villagers revealed that they face the dust problem from the CDM project. One villager said:

"*We used face the dust problem resulted by the project. The dust came from two major sources including: (1) rice husk; and (2) ash. Both rice husk and ash were dispersed by the strong wind. This problem affected the quality of water, so we cannot drink the water from the public well. Finally, the project installed the public water purifiers in front of the well in order to improve the quality of water. Currently, villagers can drink the water from this well by using the public water purifiers."* (No.6)

The PDD of Buasommai Biomass CDM Project revealed similar problems receiving a negative score (-1) on air quality [9]. These results also agree with general observations by Kolshus *et al*. [59], confirming that biomass CDM projects regularly have a negative impact on air quality.

More recently, Gilbertson [33] found that A.T. Biopower CDM project dumped the rice husk ash from the power plant next to the residents' houses. Moreover, Tangwisutijit [111] found that rice husk ash from Buasommai Biomass CDM project is dispersed into the houses near the project. According to Gilberson, rice husk ash contains silica that is known to cause silicosis, an irreversible lung disease. After silica particles are inhaled, the smallest particles work their way to the lower respiratory tract. Once in the lungs the particles cause acute toxicity damage to the lung cells. The silica particles are quickly attacked and ingested by the body's defense releasing enzymes and radicals. This release of these by products can result in death of the lung and white blood cells cell which causes inflammation which can result in silicosis. Silicosis is classified into three types:

chronic /classic, accelerated, and acute (WHO [141]).

- Chronic Silicosis occurs after long term exposure (over 10 years) of low concentrations of silica dust. This type of the disease severely hinders the ability of the body to fight infections because of the damage to the lungs, making the person more susceptible to other lung illnesses, including tuberculosis.Accelerated silicosis can occur after 5–10 years of high exposures to respirable crystalline silica. Symptoms include severe shortness of breath, weakness, and weight loss.Acute Silicosis occurs after heavy exposure to high concentrations of silica. The symptoms can develop within a few weeks or as long as 5 years after the exposure. Symptoms of acute silicosis include severe disabling shortness of breath, weakness, and weight loss, which often leads to dead.

Consequently, this will affect the health of local people if the project developers do not manage the ash disposal properly. Gilbertson found that biomass (rice husk) CDM projects in Thailand never address the health risk caused by silica. In our case study the Bannsamednoi villagers complain about the health impacts from silica including respiratory problems and aggravation felt in their skin.

These findings clearly supported that there are at least three CDM projects in Thailand (A.T. Biopower CDM project, Buasommai Biomass CDM project, and Mungcharoen Green Power project) increasing the health risk. Although these three CDM projects based on rice husks claim that rice husk ash will be used for many purposes: (1) soil improvement; (2) cement production; and (3) steel production, they do not sell rice husk ash to these users. Finally, we find that there is limited demand for rice husk ash and the buyers of rice husk ash are often distant from the projects[6]. The project developers cannot transport it to the end users because of high transportation costs and buyers are not prepared to absorb the transportation costs. Therefore, in Thailand the supply of rice husk ash exceeds the demand for it. These projects try to get rid of rice husk ash with least costs, so they dump it in the open fields near the project (see Figure 10.2 and 10.3). This indicated that the project developer does not manage the ash disposal properly.

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[6] Interview with Mr.Yaowateera Achawangkul, The Department of Alternative Energy Development and Efficiency, Ministry of Energy, Thailand.

Figure 10.2: The ash dumped in the open field; (source: author's survey)

Figure 10.3: The ash dumped in the open field; (source: author's survey)

As previously discussed, Bannsamednoi villagers face the dust from rice husk and ash. All villagers stated that they cannot drink the water from the wells (see Figure 10.4 and 10.5) and rain water collected from the roof because the water is contaminated with high levels of dust from rice husk and ash. Moreover, many villagers complained that they need to clean their houses more frequently because of dust problem.

Figure 10.4: The first pond in the village; (source: author's survey)

Figure 10.5: The second pond in the village; (source: author's survey)

As discussed in the chapter 9, there are three public institutions in this village including: (1) Chaipakoom Temple (4 monks); (2) Bannsamednoi School (10 teacher; 200 students); and (3) a nursery school (1 teacher, 50 children). All these institution faced the dust problem. The dust came from two major sources including: (1) rice husk; and (2) ash. Both rice husk and ash were dispersed by the strong wind. Considering the rice husks, this project uses the rice husks for electricity generation and it has a poor system to stockpile these raw materials. The storage space in the plant doesn't have any cover. This results in rice husk dispersion. Moreover, the transportation of rice husks from the mill's storage and from other mills nearby to the plant also results in rice husk dispersion. Considering the rice husk ash, the project developer dumps the large amount of ash in the open fields of the village (See Figure 10.2 and 10.3). They expect the farmers to come to the open field and quickly take ash to their rice growing areas, but the large amount of ash is still left in the open field. This indicated that the project developer does not manage the ash disposal properly. Finally, ash is dispersed by the wind, making it to be the dust problem. The dust was dispersed throughout the classrooms. The teachers were worried about the health of their students, especially children under 6 years old in the nursery school. Moreover, the teachers stated that it was very difficult for the students to study in this poor environment, but we cannot stop teaching or postponed the class. In order to solve the dust problem for these schools, they hang black nets around the buildings to block out the dust from rice husk and ash. One participant said:

"*The black nets were erected around the building to prevent the dust dispersion. Normally we use black nets in the plantation system but now we need them to protect human."* (No.7)

As for the drinking water, the villagers must buy the drinking water with their own money. They spend GBP4.00 per month on the drinking water. Moreover, they need to pay a higher water meter bill because they use more water for cleaning their house and taking a bath. Therefore, only villagers who have a low income must absorb these social costs, while the project developer who has a high income does not absorb any social costs. In order to improve the quality of water, the government installed the public water purifiers in front of the well (see Figure 10.6). The money for the installation of these purifiers came from the Clean Energy Fund which aims to solve the environmental problems caused by the power plants. Currently, villagers can use these public water purifiers and do not buy the drinking water (see Figure 10.7).

Figure 10.6: The public water purifiers installed in the village; (source: author's survey)

Figure 10.7: Villagers were taking the drinking water from the public water purifiers; (source: author's survey)

However, this environmental situation tends to get better in the future. In order to prevent the dust dispersion, the project developer decided to plant Eucalyptus trees in a long line behind the power plant. Hopefully, this can prevent the dust dispersion in the future.

Considering the noise pollution, it is not a main problem. The noise pollution occur occasionally when the project developer perform an engine flush. The project will flush its engine around two or three days per year. At this time the villagers will hear the loud noise from this operation. The villagers suggested that the project developer should remind the villagers about the loud noise from the flushing operation in order to protect themselves from this pollution. Therefore, this social cost is actually realized, but the villagers face noise problem only two or three days per year.

There is another social cost raised by the local residents. This problem is the rising price of the land around the project site. The project developer needs to buy the large land area for building the power plant. The project developer bought the lands from many local landlords. Therefore, the high demand for land areas caused the rising price of land. When land is expensive the villagers cannot afford to buy it. They believe that the next generation will not be able to afford the price to purchase land anymore.

Finally, Mr.Payut and Mr.Yaowateera concluded that the dust problem is not caused by the biomass technology but by the management of the project developer. They said:

"*Biomass technology itself is environmentally friendly and does not cause the dust problem, but the project developer does not have a proper dust management plan*."

Ultimately, we have to conclude that these social costs (dust problem, waste disposal, noise pollution) is actually realized. The allocation of these social costs is unfair. Only villagers who have a low income absorb these social costs, while the project developer who has a high income does not absorb any social costs. Indeed, CDM project has changed their way of life.

10.1.5 The Roots of Environmental Problems Generated by Biomass CDM Projects

We tried to investigate why biomass CDM projects cause the environmental problems including dust, ash disposal, and noise pollution. As discussed above, Mr.Payut and

Mr.Yaowateera concluded that all problems are not caused by the biomass technology, but by the inappropriate management of the project developer. Finally, we found that not all CDM projects are required under Thailand's environmentally related laws and regulations to conduct an Environmental Impact Assessment (EIA). EIA is a well established systematic process which should identifiy environmental impacts and options mitigate these problems. EIA is an important first step towards ensuring that projects are developed in a sustainable an environmentally responsible manner. Without the information contained in an EIA it is difficult for any regulator to make an informed decision about environmental (or social) impact. According to Thai regulations, an EIA is required for projects with an installed capacity of 10 MW or larger and these projects must submit the EIA report to the Office of the Natural Resources and Environmental Policy and Planning (ONEP), under the Ministry of Natural Resources and Environment, for review and make any necessary recommendations. Unlike the GS, all GS CDM projects are required to conduct an EIA if the stakeholders indicate significant environmental impacts. According to Sterk *et al.* [105], there were only two counties that apply an EIA to all CDM projects. These countries are Nicaragua and El Salvador.

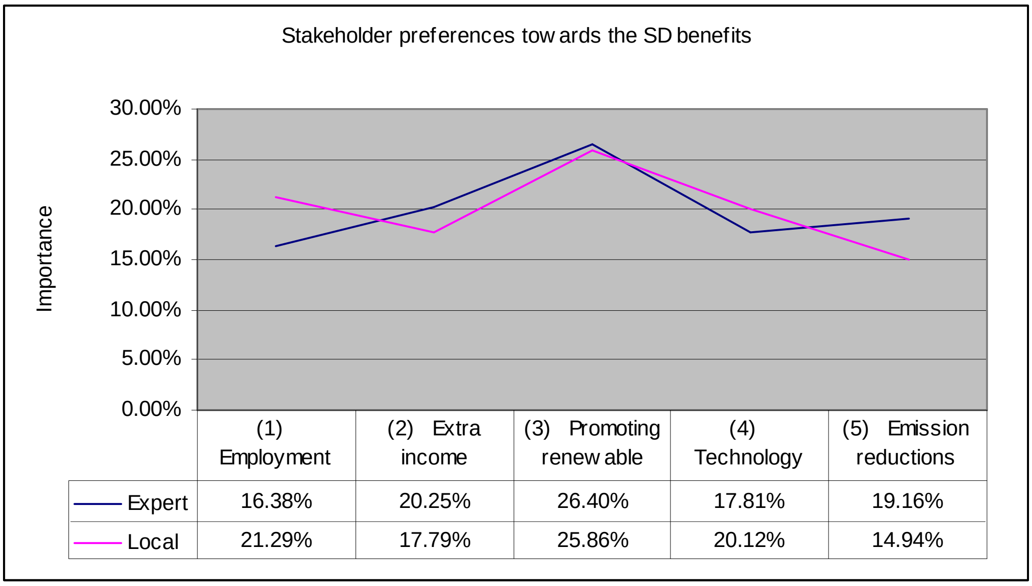
Consequently, an EIA exemption for projects with an installed capacity below 10 MW gives an opportunity for project developers to avoid performing an EIA. Two experts stated that some CDM projects look likely to avoid conducting an EIA by designing their installed capacity close to 10 MW. According to UNEP-Risoe [125], as of December 2009, there are three biomass CDM projects which have an installed capacity of 9.9 MW (very close to 10 MW). Most villagers agree that the SD assessment by Thailand DNA is not sufficient to guarantee the SD benefits of CDM projects. As previous discussed in the previous chapter, this project is the second group to assess the project area (The first group is the Japan's NHK Television). This indicate that the government relating to CDM activities never goes to assess the polluted village, so the regulators do not know whether the expected SD benefits and the social costs described in the PDD are actually realized. Finally, the villagers need an EIA as the additional assessment to ensure the sustainability of CDM projects. Therefore, Thailand should cancel an EIA exemption and apply it to all CDM projects.

10.2 Quantitative Analysis and Results

The survey conducted between January and March 2010 resulted in 96 usable questionnaires from 40 experts and 56 local residents. In order to ensure the consistency of the pairwise comparisons, a consistency ratio of 0.10 (10%) or less is considered acceptable. The analysis of our responses, revealed ten responses (2 experts and 8 local residents) with a consistency ratio of more than 10%. The results and analyses undertaken in the following section were completed with the 86 remaining responses.

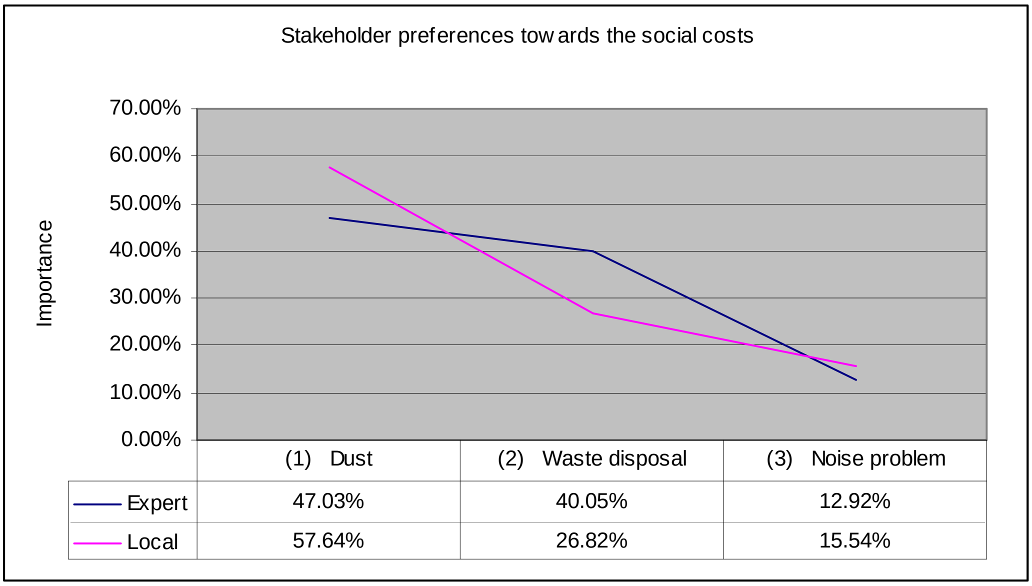
Benefits and Costs	Expert	Local Resident	Aggregated
<u>SD benefits</u>			
(1) Employment	16.38%	21.29%	19.12%
(2) Extra income	20.25%	17.79%	18.88%
(3) Promoting renewable energy	26.40%	25.86%	26.10%
(4) Technology transfer	17.81%	20.12%	19.10%
(5) Emission reductions	19.16%	14.94%	16.80%
<u>Social costs</u>			
(1) Dust	47.03%	57.64%	52.95%
(2) Waste disposal	40.05%	26.82%	32.66%
(3) Noise problem	12.92%	15.54%	14.39%

Table 10.3: The priority weights for the SD benefits and social costs



	(1) Employment	(2) Extra income	(3) Promoting renewable	(4) Technology	(5) Emission reductions
Expert	16.38%	20.25%	26.40%	17.81%	19.16%
Local	21.29%	17.79%	25.86%	20.12%	14.94%

Figure 10.8: Comparison of the priority weights for the SD benefits by stakeholder group



	(1) Dust	(2) Waste disposal	(3) Noise problem
Expert	47.03%	40.05%	12.92%
Local	57.64%	26.82%	15.54%

Figure 10.9: Comparison of the priority weights for the social costs by stakeholder group

10.2.1 Stakeholder Preferences towards the SD Benefits

Data for pairwise comparisons were analyzed using Microsoft Excel. Table 10.3 shows the priority weights for the SD benefits and social costs generated by biomass CDM projects. Considering the priority weights by experts, increasing the usage of renewable energy was ranked as the highest priority with a mean weight of 26.40%, followed by generating extra income (20.25%), and emission reductions (19.16%). As for local residents, they ranked increasing the usage of renewable energy as the highest priority with a mean weight of 25.86%, followed by employment (21.29%), and technology transfer (20.12%). Finally, the aggregated weights by all stakeholder groups showed a similar trend with the priority weights by local residents (see Table 10.3). Clearly, both experts and local residents considered increasing the usage of renewable energy and local content as the most important SD benefits of CDM projects.

The preference towards increasing the usage of renewable energy (26.10%) is substantially higher than other benefits. Both experts and local residents gave us their reasons for ranking this benefit as the highest priority. Local residents noted how the rise in oil prices during 2007-2009 affected them personally with a substantial increase in their living costs. Therefore, local residents agreed that Thailand should reduce dependency on crude oil. These local people considered increasing the usage of renewable energy (and the price stability they believe it would bring) as the most important SD benefit.

The experts interviewed suggested that an increase in the use of renewable energy could help Thailand gain a surplus in balance of payments by reducing oil imports. They stated that a deficit in balance of payments resulted in Thailand's economic crisis during 1997 – 1999. Therefore, Thailand should promote the use of renewable energy in order to reduce its dependency on imported energy. Like local residents, they believed that Thailand has high potential for biomass resources and they ranked this benefit as the highest priority.

Although emission reduction is one of the twin objectives of CDM projects, most local people ranked it as the lowest priority. This is because most local stakeholders view climate change as a distant problem not affecting them personally. Emission reductions were more strongly supported by experts, than local residents. Experts allocated 19.16% of their weights to emission reductions, making it the third highest preference; the local residents allocated 14.94%, making it the lowest priority (see Figure 10.8).

Experts and local residents have different views about employment generation. Local residents ranked employment generation as the second highest priority with a mean weight of 21.29%, while experts recorded 16.38% making it their lowest priority.

These results are similar with the results of the survey on the sustainability preferences of CDM stakeholders in South Africa and India conducted by Sutter [108]. Sutter found that Indian stakeholders rate reducing dependency on fossil fuels as the highest preference, whereas South African stakeholders rate employment generation highest.

10.2.2 Stakeholder Concerns in the Social Costs

Both experts and local residents considered the dust problem as the most important social cost (see Table 10.3). Experts expressed the highest concern about the dust problem with a mean weight of 47.03%, followed by waste disposal (40.05%), and noise (12.92%). Local residents ranked dust as the most important problem with a mean weight of 57.64%, distantly followed by waste disposal (26.82%), and noise (15.54%) (see Figure 10.9).

10.2.3 Test of Statistical Differences

This section aims to evaluate the difference in the perception of SD benefits and social costs between experts and local residents Following Ananda and Herath [3] we used the paired sample t-test to compare the mean weights. This was computed using SPSS (Statistical Package for the Social Sciences). Table 10.4 shows the results.

Benefits and Costs	t-statistic	Significance
Employment (local) – Employment (expert)	2.035	0.049*
Income (local) – Income (expert)	-1.484	0.146
Renewable energy (local) – Renewable energy (expert)	0.257	0.799
Technology transfer (local) – Technology transfer (expert)	1.509	0.140
Emission reductions (local) – Emission reduction (expert)	-2.309	0.027*
Dust (local) – Dust (expert)	4.217	0.000**
Waste disposal (local) – Waste disposal (expert)	-4.854	0.000**
Noise (local) – Noise (expert)	2.775	0.009**

** Significant at $P < 0.01$ level; * Significant at $P < 0.05$ level

Table 10.4: The statistically significant mean weight differences

All social costs were statistically different in the preference weights expressed by expert group and local resident group at the 99% confidence level (see Table 10.4). Local residents gave higher importance to dust and noise problems than experts. Local residents are directly affected by dust and noise from the project, while experts rarely visit the village. Consequently, these two groups may have different views on an importance of these social costs.

Only two of the five SD benefits - emission reductions and employment generation - had statistically different preference weights (at 95% confidence level). Face-to-face interviews with local residents revealed the belief that climate change problem is subjective and that global warming will not affect them personally. Consequently they ranked the reduction of GHG emissions as the lowest priority. On the other hand, experts believed that climate change is real and will affect all individuals irrespective of location.

Many local residents in this village have been offered employment by the CDM project. Moreover, the projects allow local people to work in their hometown and stay close to their families. They see this benefit more clearly than experts. Experts were of the view that the new employment created is limited to low-value jobs. Therefore, this makes local residents rank this benefit as the second most important SD benefits, while experts consider it as the lowest priority.

These differences indicated an information gap between the experts and the local residents. The government which is expert in the science and impacts of climate change should inform local residents how climate change affects them personally. Conversely, the local residents should inform the experts how they benefit from the employment.

Finally, we investigate how the types of criteria (subjective or quantifiable) affect the differences in the preference weights. Strager and Rosenberger [107] found that most criteria that are subjective or are difficult to measure will be statistically different in the preference weights expressed by different stakeholder groups. Conversely, in this research most quantifiable benefits and costs were found to be statistically different in the preference weights. Therefore, the results of this research are different from those reported by Strager and Rosenberger [107].

10.3 Discussion and Conclusions

Clearly, biomass CDM projects under this study do not contribute significantly to SD in terms of extra income and avoidance of danger from the burning of biomass residues. Moreover, the allocation of extra income is unfair. However, CDM stakeholders rank these two benefits as the low priority. These results contradict Gervasoni [31] who found that these two benefits are actually realized in Thailand. Considering other SD benefits, we found that biomass CDM projects can contribute significantly to SD in terms of promoting renewable energy, employment, technology transfer, and emission reductions. These benefits (except emission reductions) were ranked as the top three highest priorities. These results indicate that biomass CDM projects can generate the SD benefits which are the most important to CDM stakeholders.

Considering the social costs, biomass projects create a potential negative impact on air quality. The dust and noise problem are actually realized in Thailand. Dust was ranked as the most important social costs. Therefore, the results of priority weights for the social costs are consistent with the real environmental problem we found in the project area. In our case study we found that the dust problem is mainly caused by the ash and rice husk. The project developer has a poor system to stockpile these raw materials and this results in rice husk dispersion. Moreover, the project developer does not manage the ash disposal properly by dumping it in the open fields near the project. Finally, both rice husks and ash are dispersed by the wind, making it to be the dust problem. This finding is consistent with Gilberson [37] and Tangwisutijit [111] who found other two rice husk CDM projects generating the dust problem from the rice husk ash. Finally, it is apparent that the burden of social costs is unevenly speead. Only low income villagers bear these social costs, while the project developer who has a relatively high income does not absorb any social costs.

All these results strongly support the conclusion that host countries cannot guarantee the SD benefits of CDM projects. Moreover, the quality of PDD is poor in terms of the description of actual SD benefits. Although the contribution to SD is one of the twin objectives of CDM projects, most PDDs do not give comprehensive details of SD benefits and social costs. Worse than this, some SD benefits described in the PDDs are not actually realized. There is an incentive for project developers to ignore the social costs and do not describe these in their PDDs. Therefore, we cannot rely on the data given in the PDDs to give an accurate assessment of SD benefits. However, we found that the PDDs of GS CDM projects give enough details of SD benefits and social costs. Moreover, the PDDs of GS CDM projects show both positive and negative impacts of CDM projects. This concurs with the findings of Castro and Michaelowa [13], and Curtius and Vorlaufer [18], who found examples of poor project PDDs which did not give accurate details of sustainable development benefits. Instead of reviewing PDDs to assess SD benefits, our research strongly suggests that future studies into the sustainability assessment of CDM projects should use the in-depth interviews and site visits.

Finally, our results suggest that host countries should be required to assess the sustainability of CDM projects using, *inter alia*, in-depth interviews with a range of stakeholders supported by project site visits. This is particularly important in areas that may be affected by negative impacts. Moreover, an EIA should be required for all CDM projects as this would better inform the PDD process.

Chapter 11

Conclusions and Recommendations

This thesis is a systematic attempt to increase the understanding of the SD benefits of CDM projects, by directly involving CDM stakeholders involved at various levels in the process. Consequently, this study has covered various points of view including those of international stakeholders, local stakeholders, and carbon market stakeholders. This thesis has sought to meet the five key objectives:

1. Create an understanding of the concept of sustainable development applied to CDM projects and the methodology for assessing the sustainability of CDM project;
2. To classify CER buyers according to their attitudes towards and involvement in CDM sustainability labels;
3. Investigate the value of sustainable development benefits generated by CDM projects through the willingness of buyers to pay a price premium for CERs with CDM sustainability label;
4. Identify the factors influencing buyers' willingness to pay a price premium for CERs with CDM sustainability labels;
5. Investigate the contribution of the CDM to sustainable development.

Finally, we connect the research results to the research objectives mentioned above and draw the following conclusions and recommendations:

11.1 Conclusions

11.1.1 The Concept of SD Applied to CDM Projects and the Contribution of the CDM to SD (Objective One and Objective Five)

The Kyoto Protocol designed the three flexibility mechanisms under the concept that GHG emission reductions taking place anywhere in the world will have the same environmental effects. The CDM is one of the three flexibility mechanisms which allows Annex I countries to invest in emission reduction projects in developing countries. In each CDM host country a Designated National Authority (DNA) is directly responsible to ensure that CDM projects attain two objectives: (1) to assist Non-Annex I countries achieve SD; (2) to assist Annex I countries achieve their emission reduction targets in a cost effective way. Although the CDM is generally considered a success in the number of registered projects and the credits generated, the CDM's contribution to SD is being questioned. Finally, we found that the CDM is facing three major problems related to the concept of SD. These problems are identified as follows:

i) An ill-defined definition of SD

The application of SD is within to CDM projects, it is still an elusive and ill defined concept. CDM projects' contribution to SD is interpreted and assessed by the host country designated authority. However, there are no common international standards for the host country approval processes and/or the development of SD criteria. As CDM project is a market-based mechanism operating at the project level, the SD criteria for CDM projects should also be developed for application at the project level. Consequently, the clear defined sustainability criteria should incorporate clearly identified and quantifiable indicators to be relevant at the project level. In Chapter 5 we reviewed the recent CDM sustainability criteria defined by the Asia-Pacific host countries. We found that 12 countries have their own specific SD criteria for assessing CDM projects. However, 7 countries do not have specific CDM sustainability criteria with significant room left for interpretation. Consequently, it is very difficult to understand the preferences of these countries towards the SD of CDM projects. Even China and South Korea hosting a large number of CDM projects still have no specific sustainability criteria for assessing CDM projects. These results are consistent with Brown *et al*. [8], Schneider [101], and Sterk *et al*. [105], confirming that the SD criteria were not clearly defined by host countries. Currently, we found that CDM sustainability labels, especially the Gold Standard label, can clearly define the concept of SD applied to CDM projects. All CDM sustainability labels have well defined sustainability criteria for assessing CDM projects.

However, we found that having the clear defined sustainability criteria does not mean that host countries can guarantee the sustainability of CDM projects. This is reflected in the Thai case study (Chapter 10). Although Thailand has well defined sustainability criteria (26 specific indicators), we found that biomass CDM projects in Thailand can create potentially negative impacts on air quality. Furthermore some SD benefits that are described in the PDDs of these projects are not realized in practice. These results also reflect that the quality of PDDs is poor in terms of the assessment and verification of SD benefits. Some project developers write unreal benefits in the PDDs and hide the negative impacts of their projects in order to meet the SD criteria of Thai DNA. We cannot rely on the data given in the PDDs. In order to ensure the sustainability of CDM projects, the real practice of host country to assess CDM projects is therefore more important than the SD criteria designed by host country.

ii) The poor method of sustainability assessment applied by host countries

The methods for assessing the sustainability of CDM projects are not clearly defined; in contrast to GHG emissions whose assessment and monitoring are standardized. Therefore, host country practices for sustainability assessment vary widely. We found the three weaknesses of host country practices for sustainability assessment and approval processes. Firstly, most host countries assess the sustainability of CDM projects by a desk review of the PDDs and an interview with the project developers. This means that host countries really trust the data provided by the project developers. This practice may encourage project developers to put some unreal benefits into the PDD in order to easily meet the SD criteria of host countries.

Secondly, CDM projects are not required to conduct an EIA in most host countries. Currently, there are only two counties (Nicaragua and El Salvador) that apply an EIA to all CDM projects (Sterk *et al*. [105]). Unlike the Gold Standard (GS), all GS CDM projects are required to conduct an EIA if the stakeholders indicate significant environmental impacts. Consequently, we found some projects create a potential negative impact on environment. Lastly, it appears that the DNA rarely visits the local areas around the project site. After the commissioning of CDM projects, DNA never visits the local areas. This reflects poor monitoring of the SD benefits. Currently, host countries are required to conduct only one sustainability assessment of CDM project before the operation of the project. Consequently, DNA record ex-ante potential benefits, not the ex-post actual benefits. This contrasts sharply with the rigorous monitoring of GHG emission reductions. Ex-post SD benefits are not required to be monitored during the operating period.

These three weaknesses are reflected in the Thai case study. In Thai case study, we found that we are the second to assess the village affected by the project (the Japan's NHK Television is the first), whereas DNA never visits this area.

iii) The lack of sustainability additionality applied to CDM projects

The results of the literature review show that the requirement of additionality as defined in the Kyoto Protocol does not cover the sustainability. The concept of additionality focuses on GHG emission reductions, whereas the SD benefits do not appear in this concept. Additionality is used as criteria to determine whether GHG emission reductions are real, measurable, reasonable, and in addition to what would have happened. However, the concept of additionality is not used as criteria to assess the sustainability of CDM projects. Moreover, a baseline is used to determine only the volume of GHG emission reductions from project activity, not the SD benefits. We found only environmental additionality, financial additionality, and technical additionality addressed in the PDDs, whereas sustainability additionality does not appear in the PDDs. Finally, the lack of sustainability additionality resulted in the difficulty in monitoring the real SD benefits of CDM projects.

iv) A conflict between the simultaneous objectives of "ensuring cost-effectiveness of GHG emission reductions" and "promoting sustainable development"

The results of the literature review shows that there is a conflict between the simultaneous objectives of "*ensuring cost-effectiveness of GHG emission reductions*" and "*promoting sustainable development*". Each ton of GHG emission reduction is given a monetary value through the CERs, but the CDM's contribution to SD is not given a monetary value. The missing value of SD benefit has resulted in a trade-off between the CDM target of supplying cheap emission credits and the promotion of SD making projects with high SD obligations unattractive to investors. On the other hand, the monetary value placed upon carbon reductions arouses investors interest in CDM projects which deliver large volumes of CERs. There is a widespread perception that projects that deliver large volumes of CERs cannot deliver other SD benefits. In particular, industrial gas projects (HFCs, N_2O, PFCs) can generate high CER volumes, but do not create many jobs or contribute directly to community development. Consequently, these two objectives of the CDM cannot be achieved simultaneously. However, this research found that the Gold Standard label can solve this conflict by giving a monetary value to the objective of promoting SD (Chapter 7). Moreover, we found that CER buyers are becoming more concerned with ethical behavior in purchasing carbon credits by giving the first priority to high quality carbon credits in terms of SD benefits.

Finally, these four problems affect the CDM's contribution to SD. The first two problems are directly related to host countries and these two problems make host country cannot guarantee the SD benefits of CDM projects. In every era of the Kyoto Protocol, the Conference of the Parties focuses on the Protocol's exemption of developing countries from binding obligations, not the SD issue. Now is the time to raise an issue of CDM's contribution to SD. The existing CDM framework should be reformed in order to guarantee the SD benefits.

11.1.2 Classification of CER Buyers: One CER Two Markets (Objective Two)

Sutter [108] suggested that CDM sustainability labels can differentiate the market for CERs into two (i) normal CERs, and (ii) premium CERs. However, there is no research to validate the concept of a premium market. This thesis is the first to validate this concept. Finally, we found that CER buyers can be classified into two distinct groups: (1) buyers favoring CERs with sustainability labels; and (2) buyers favoring non-labelled CERs. This result confirms that the carbon market is separated into two markets: a premium market; and a normal market or may be defined as "*One CER Two Markets*".

The first cluster of buyers has a strong preference for CERs with CDM sustainability labels. These buyers have negative attitudes towards the host countries' capacity to assess CDM projects, so they require the additional standard to ensure the sustainability of CDM projects. They have high involvement in past purchase and purchase intention of CDM sustainability labels. These buyers have a high level of knowledge in CDM sustainability labels. They believe that CERs with sustainability labels differ from non-labelled CERs in terms of SD benefits. They were positive about the importance of labeling and the image of SD labels. Most buyers in this group apply "*an ethical purchasing policy*" for purchasing carbon credits by giving the least project priority to the industrial gas projects. This group is mainly comprised of, non-profit organizations and companies with small paid up capital (< 100 million Euros)..

The second cluster of buyers has a strong preference for non-labelled CERs. These buyers have low involvement in past purchase and purchase intention of CDM sustainability labels. Moreover, they have a low level of knowledge about CDM sustainability labels. They believe that CERs with sustainability labels are the same as non-labelled CERs in terms of SD benefits and ROI. They were negative about the importance of sustainability labels, but have positive attitudes towards the host country's duty to assess CDM projects. This group is mainly comprised of private companies with large paid up capital (≥100 million Euros).

These findings clearly agree with Sutter's recommendation, that CDM sustainability labels can be used to differentiate the carbon market. Based on buyers' attitudes towards and involvement in CDM sustainability labels, the present carbon market is clearly separated into two markets: a premium market, and a normal market. These buyer profiles will be useful in developing targeted marketing strategies in order to increase the market share of a premium market.

11.1.3 The Willingness of Buyers to Pay a Price Premium for CERs with CDM Sustainability Label (Objective Three and Objective Four)

According to Sutter, if CDM sustainability labels can attract a price premium, it will induce project developers to develop projects with high levels of SD benefit. A price premium for high SD CERs would create a strong inventive for project developers to invest in CDM projects with sustainability labels. This would help the CDM achieve its SD objective. However, the willingness to pay a price premium for SD labelled CERs was unclear. Our research results clearly show that CDM sustainability labels can attract a price premium. We found that 56.4% of the buyers were willing to pay a price premium, whereas the remaining 43.6% were not willing to pay. The charity groups and the governments have a greater percentage of "yes" WTP responses than the private sector group. Paying a price premium as the tool for public relations and branding and paying a price premium as the reward for the project developers are the main reasons for the willingness to pay. Meyrick [73] and Sutter [108] made an assumption that buyers may pay a price premium because they may use it for public relations activities. Therefore, our findings proved that their assumption about this reason for willingness to pay is correct. Considering the reasons for the unwillingness to pay, the main three reasons are: (1) not believing that paying a price premium can help CDM projects achieve SD objectives; (2) they are not interested in SD benefits, but they would like to pay a price premium for Gold Standard CERs in recognition of its other benefits such as low methodology risk, low Post-Kyoto risk, etc. and (3) paying a price premium will result in higher costs of acquiring carbon credits.

Considering WTP value, the mean WTP was €1.12/tCO_2e with a standard deviation of €0.65 and the median WTP was €1.0/tCO_2e. However, we found that a price premium for GS CERs varies widely. This may be because the SD is an elusive concept. Consequently, different views on the SD benefits may make buyers give different monetary values to SD benefits of CDM projects. There was no difference between European countries and Non-European countries in the amount of money that they were willing to pay. As expected, charities showed the highest mean WTP, but the mean WTP of government was lower than that of the private sector group.

In this study, most participants have a strong intention to buy CERs from the GS label in the future. Moreover, most buyers were becoming more concerned with ethical behavior in purchasing carbon credits by giving the least project priority to the industrial gas projects. This result implies that future market demand for CERS generated by industrial gas projects may decrease. We found that the key strengths of the GS label are its positive image and its contribution to SD. Although the past research results clearly show that the SD profile of the labelled projects is better than the non-labelled projects, some buyers did not know about this. Consequently, some buyers believed that the expected SD benefits generated by project with GS label are the same as or lower than similar non-labelled project. These results indicated an information gap among buyers and this resulted in the differences in buyers' WTP. Finally, we found that buyers' knowledge in each CDM sustainability label is substantially different. Clearly, the majority of buyers have a high level of knowledge in the GS label, but they have a low level of knowledge of other labels e.g. the CCB Standards. Therefore, we see that the GS label is a market leader in the CDM sustainability labels, others labels only have a small market share in the compliance market. Knowledge level is therefore an important factor that helps CDM sustainability labels succeed in the compliance market.

Finally, we apply a binary logistic regression to investigate which factors might contribute positively and negatively to the probability of the willingness to pay. The regression results showed that the probability of the willingness to pay a price premium is affected positively by the four factors. These factors are:

- *Buyer's perception of the SD benefits:* Buyers who have a positive perception of the SD benefits generated by CDM sustainability labels are more likely to pay a price premium than those who have a negative perception.
- *Buyer's perception of ROI:* Buyers expecting high ROI of CERs with CDM sustainability labels have a higher probability of the willingness to pay a price premium than those expecting low ROI.
- *An involvement in CDM sustainability label:* With more involvement in CDM sustainability labels the probability of the willingness to pay a price premium increase.
- *Buyers' attitude towards an importance of CDM sustainability labels:* With a more positive attitude towards an importance of CDM sustainability labels the probability of the willingness to pay a price premium increase.

These four factors are useful for CDM sustainability labels trying to develop marketing strategies to increase market penetration. Finally, these findings support Sutter's recommendation to use CDM sustainability labels for giving the monetary value to the SD objective. Moreover, these findings may induce project developers to develop projects with high SD benefits in order to get a price premium as Sutter suggested.

11.1.4 The Disparity between the Claimed Carbon Emission Reductions and the SD Benefits: A Synthesis of Results from the Contingent Valuation and Cluster Analysis (Objective Two and Objective Three)

We found that CDM sustainability labels only gives a clear reward to sellers, not buyers. Based on the reasons for willingness to pay and unwillingness to pay, we found that CER buyers get a small benefit from buying CERs with sustainability labels. The only direct benefit that the buyers get from buying labelled CERs is making their organization to have a better image. However, we found that using labelled CERs as a tool for public relations is not an effective tool for promoting the company compared to other eco-friendly marketing tools such as Fair trade label, Eco-friendly label, etc. When buyers pay a price premium for labelled CERs, they will get the same CERs as non-labelled CERs that can be claimed for one tonne of CO_2e. Therefore, they feel that buying a labelled CER resulted in the higher costs of acquiring carbon credits. Finally, this small benefit may not cover the high cost of acquiring labelled CERs. This is an obstacle to promote the premium carbon market. On the other hand, the sellers (the project developers) get a significant price premium from selling labelled CERs (based on the results of WTP). Consequently, CERs with CDM sustainability labels may be unattractive to buyers. These benefits can be illustrated in Figure 11.1.

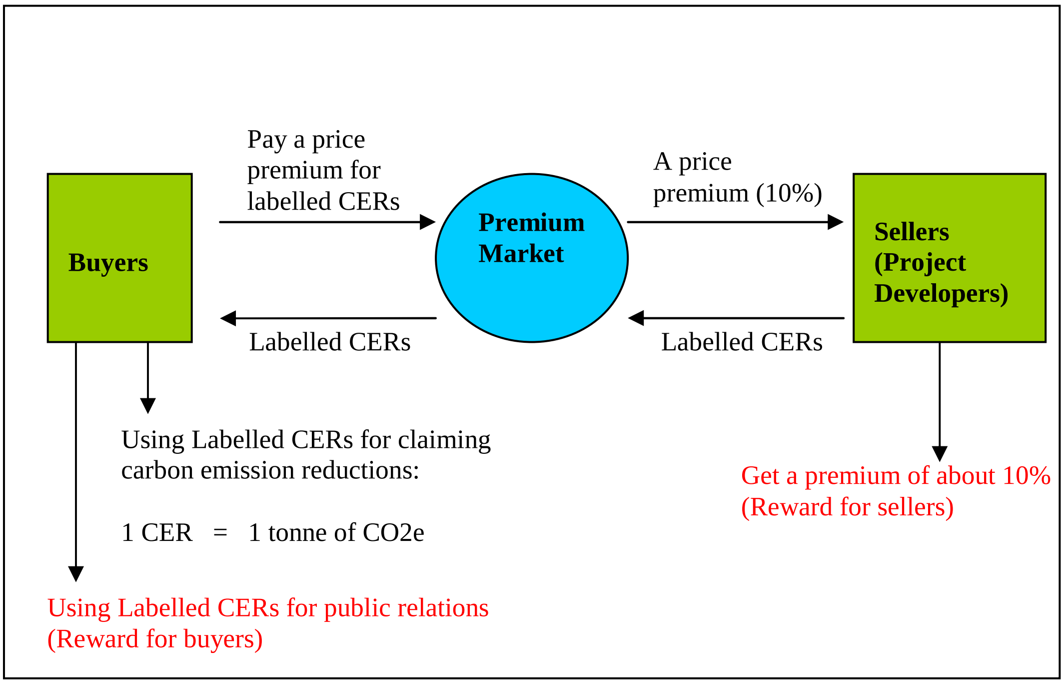


Figure 11.1: The benefits of buyers and sellers in the premium carbon market

Clearly, CDM sustainability labels can give a monetary value to the SD objective. In order to promote a premium market, the UNFCCC should give a direct benefit to buyers. Currently, the reward is given to only sellers, not buyers. This reward may be given to the buyers in form of the claimed carbon emission reductions. As the labelled projects generate more SD benefits than the non-labelled projects, labelled CERs should be different from non-labelled CERs in terms of the claimed carbon emission reductions. Now each CER (labelled CER or non-labelled CER) is equivalent to one tonne of CO_2e. Based on the SD profile of labelled CERs, one labelled CERs should be equivalent to more than one tonne of CO_2e. The UNFCCC should revise the claimed carbon emission reductions from the labelled project. Based on our research results, the monetary value of SD benefits is about 10% of the CER price without any premium.

Consequently, we suggest that one labelled CERs should be more than to 1 tonne of CO_2e. This will be the benefit given back to the buyers who pay a price premium for labelled CERs. Finally, the premium carbon market will induce both buyers and sellers to invest in CDM projects with high SD benefits. This will really help the CDM to achieve the simultaneous objectives of "*ensuring cost-effectiveness of GHG emission reductions" and "promoting sustainable development*".

11.1.5 Stakeholder Preferences towards the SD of Biomass CDM Projects in Thailand (Objective Five)

We investigate the attitudes of stakeholders for the SD of CDM projects by using a case study of a biomass CDM project in Thailand. Following previous research recommendations (Sutter [108]), 'grass-roots' local residents were included in the stakeholder survey. The Thai study clearly answer Sutter's open question on whether the sustainability preferences of experts and local residents differ. Our results demonstrate different priorities regarding the importance of: (i) employment generation, (iii) emission reductions, (iii) air quality (dust), (iv) waste disposal, and (v) noise. Adding a group of local residents into the stakeholder surveys provides a clearer understand of sustainability preferences and highlights conflicting opinions.

Our results revealed a similar pattern of priority weighting to Sutter's research in South Africa and India. Sutter [108] concluded that the specific energy situation in a host country will influence the SD priorities of CDM stakeholders'. According to Sutter, India which is heavily dependent on fossil fuel imports, ranked the replacement of fossil energy with renewable energy as the most important SD benefit. Conversely in South Africa, which has abundant coal reserves, this criterion had the lowest priority. Thailand depends heavily on fossil fuel imports and our results showed that Thai stakeholders give the highest priority to increasing renewable energy production. This suggests that host countries dependent on fossil fuel imports should include '*increasing the use of renewable energy*' as a criterion for assessing CDM projects. Finally, we agree with Sutter's conclusion that SD of CDM projects can only be properly understood at the level of the case study. These results will be useful for Thai Government to apply these importance weights to assess the sustainability of Biomass CDM projects.

The qualitative results indicate that some SD benefits described in PDDs may not be realized in practice. Specifically: (i) rice husk CDM projects may not give an extra income to farmers and the allocation of this benefit is unfair; (iii) rice mills stopped burning rice husks before the implementation of the CDM; and (iii) rice husk CDM projects can have a negative impact on air quality (dust problem and waste disposal). In theory rice husk ash can be used for many purposes: (1) soil improvement; (2) cement production; and (3) steel production, but in reality it is very difficult for CDM project developers to find buyers. In Thailand there is very small demand for rice husk ash and the buyers of rice husk ash are very far from the projects. Therefore, some CDM projects dispose of rice husk ash with least costs by dumping it in the open fields near the project area. However, projects do contribute significantly to SD in terms of: (i) employment generation; (ii) increase in renewable energy; and (iii) transfer of knowledge and technology.

Clearly, these results confirm that the quality of PDDs is poor in terms of the assessment of SD benefits. According to Sterk *et al*. [105], most host countries assess the sustainability of CDM projects by desk-based review and an interview with the project developers. Consequently, the results of a sustainability assessment conducted by host countries may be incorrect. This conclusion is supported by the Thai case study, suggesting an inability of host countries to ensure the sustainability of CDM projects.

11.1.6 Integrating Stakeholders' Views on the Sustainability of CDM Projects

As previous noted, this study tried to increase the understanding of the SD benefits of CDM projects, by directly involving CDM stakeholders involved at various levels. Consequently, CDM stakeholders' views on the SD benefits of CDM projects are concluded in Table 11.1.

Stakeholder Group	View on the Sustainability of CDM projects
The Host Country Designated Authority	• According to our review of the SD criteria used by Asia-Pacific countries, we found that the SD benefits are equally important in the specific context of project type. • According to our qualitative interviews with Thai CDM stakeholders, we found that the sustainability of CDM projects can be assessed by a desk review of the PDDs and an interview with the project developers.
Carbon Credit Buyers	• Based on the quality of carbon credits in terms of SD benefits, the carbon market is separated into two markets: a premium market; and a normal market.
Local Stakeholders	• The SD benefits are not equally important in the specific context of project type. • Based on a Thai case study, local stakeholders view that rice husk CDM projects can create potentially negative impacts on air quality.

Table 11.1: CDM stakeholders' views on the sustainability of CDM projects

Host countries have different views on the sustainability of CDM projects. Therefore, the sustainability of CDM projects is differently defined by host countries, resulted in different SD criteria designed by host countries. Moreover, most host country designated authorities view that the SD benefits are equally important in the specific context of project type, so we cannot clearly understand the preferences of DNAs towards the SD of CDM projects. Finally, they view that the sustainability of CDM projects can be assessed by a desk review of the PDDs and an interview with the project developers.

Considering the CER buyers' views, they view that CERs are different in terms of SD benefits, so the carbon market is separated into two markets: a premium market; and a normal market. Moreover, they are willing to pay a price premium for the premium

CERs in terms of SD benefits, representing how they value the sustainability of CDM projects. This clearly shows that the premium CERs should be worth more than the normal CERs.

Finally, local stakeholders view that the SD benefits are not equally important in the specific context of project type, opposing the original view of the host countries designated authorities. Based on a Thai case study, stakeholders view that rice husk CDM projects can create potentially negative impacts on air quality. However, projects do contribute significantly to SD in terms of: (i) employment generation; (ii) increase in renewable energy; and (iii) transfer of knowledge and technology.

11.2 Recommendations

11.2.1 Recommendations for International Regulations under the UNFCCC

1) The case study provides further evidence that the quality of PDDs is poor in terms of the assessment of SD benefits. This is because PDDs do not give enough detail of SD benefits and social costs. Furthermore, some SD benefits that are described in the PDDs are not realized in practice. This will affect the execution of the host countries' duty to assess the sustainability of CDM projects. Consequently, these results suggest that host countries should be required to assess the sustainability of CDM projects *inter alia* by in-depth interviews with a wide range of stakeholders supported by project site visits. This is particularly important in areas that may be affected negative impacts.
2) We found the poor monitoring of the SD benefits by host countries. Currently, host countries record only ex-ante potential benefits, not the ex-post actual benefits. Ex-post SD benefits are not required to be monitored during the operating period. In order to check whether the claimed SD benefits are actually achieved, ther should be a requirement to monitor these benefits during the operating period. Therefore, we suggest that host countries should be required to conduct the two assessments of CDM projects, one before the project implementation, and another one after the project implementation. Moreover, the sustainability assessment during the operating period should be conducted by both DNA and local stakeholders. It should give an opportunity for local stakeholders to participate in the monitoring process.

3) The case study provides evidence that biomass CDM projects can create a potential negative impact on environment. Currently, CDM projects are not required to conduct an EIA in most host countries. Therefore, we suggest that an EIA should be required for all CDM projects in order to ensure the environmental sustainability of CDM projects.
4) This study finds that SD of CDM projects can only be properly understood at the level of a case study. Moreover, all SD benefits are not equally important in the specific context of project type. These results agree with Sutter [108]. Before DNAs use SD criteria to assess CDM projects, each SD criterion should be given a weight based on its importance by CDM stakeholders. In other words, DNAs should use the weighted criteria to assess the sustainability of CDM projects. DNAs should develop specific sets of weighted criteria for each specific type of CDM project. The weighted criteria give better results than the unweighted criteria. The weighted criteria can help the host countries to choose projects that maximize the social welfare. Weighting the SD criteria may be easily conducted through the stakeholder consultation process where a wide range of stakeholders are invited to discuss.
5) We found that the requirement of additionality defined in the Kyoto Protocol does not cover sustainability. Consequently, we suggest that the concept of additionality should be applied to determine whether SD benefits are real, measurable, reasonable, and in addition to what would have happened. The UNFCCC should add the aspect of SD into the concept of additionality. Finally, the concept of additionality should be applied by the project developer to measure the change in SD benefits observed when comparing the benefits in the baseline scenario with the benefits in the project scenario. The concept of sustainability additionality will help the project developer provide clearer details of SD benefits. Moreover, it will help DNAs monitor the SD benefits during the operating periods.
6) As previously noted, there is a disparity between the claimed carbon emission reductions and the SD benefit. Currently, labelled CERs and non-labelled CERs are the same in terms of the claimed carbon emission reductions, but these two types of CERs are different in terms of SD benefits. Buyers pay a price premium for labelled CERs, but these CERs can be claimed for the same amount of emission reductions as non-labelled CERs. This resulted in the high cost of

acquiring labelled CER. In order to promote the premium market, our results suggest that the UNFCCC should revise the claimed carbon emission reductions from the labelled project. Based on WTP value, we suggest that one labelled CERs should be more than 1.0 tonne of CO_2e. This will help high quality carbon credits to gain more market share.

7) Based on the results of cluster analysis, the two buyer clusters exist with distinct profile patterns, confirming that the carbon market is currently divided into two markets: the premium market; and the normal market. The premium market will help the CDM achieve its SD objective. Consequently, the concept of two carbon markets should be applied to set the CERs portfolio of buyers. We found that governments tend to be the members of the premium market. Therefore, it may be easy to require the government of Annex I countries to set a minimum quota of labelled CERs in their portfolio. As for the private organizations, they may use their commitment in a minimum quota of labelled CERs in their portfolio to promote the corporate social responsibility (CSR).

11.2.2 Recommendations for Thai Government

1) This study finds that most local stakeholders consider emission reductions as the least important benefit. Most local stakeholders view the climate change as a distant problem that will not affect them personally. Therefore, Thai Government should launch public relation campaign to help the local stakeholders understand and realize the climate change problem. Moreover, the government should inform these people how CDM projects can help solve the climate change problem.
2) Although Thailand has well defined SD criteria for assessing CDM projects, each SD criterion is not given a weight based on its importance. This is because Thailand view that all SD benefits are equally important. However, this study finds that all SD benefits and social costs are not equally important in stakeholder viewpoints. Finally, this research shows an importance weight of each SD benefit and social cost. Based on this result, we suggest that Thai Government should apply these importance weights to assess the sustainability of Biomass CDM projects.

3) This study finds that CDM projects based on rice husk does not give an extra income to farmers and the allocation of this benefit is uneven. The financial benefits are allocated to the rice mills, but the local people lose local benefits due to their inability to use a free rice husk. We suggest that farmers could form cooperatives that would force the price of paddy rice to the mills higher, i.e. to include the true value of the rice husk in the price paid.
4) The Thai Government has created many policies to increase the use of renewable energy, but it has not created a biomass commodity market to support the high demand for the rice husks resulted by these policies. The lack of a commodity intermediary is resulting in anticompetitive behavior with some biomass power plant unable to source enough rice husks to generate electricity. This could result in a small number of companies monopolizing the market. Therefore, we suggest that the Government should consider developing a biomass commodity market to support the high demand for the rice husks created by Thailand's renewable energy plan.
5) This study finds that biomass projects create a potential negative impact on air quality and the dust problem is mainly caused by the rice husk ash dumped in the open field. Therefore, we suggest that Thai government must act as regulator and force the power plants to find a better disposal method.

11.2.3 Recommendations for CDM Sustainability Labels

Although CDM sustainability labels have significant strength in their image and contribution to SD, some buyers do not know about this. Except for the GS label, most buyers have a low level of knowledge in CDM sustainability labels. This reflects the information and knowledge gap among the buyers. Therefore, some buyers have a little confidence in CDM sustainability labels and have a negative attitude towards an importance of labels. We found that both buyers' perception of the SD benefits and buyers' attitude towards an importance of labels have a positive influence on the probability of the WTP and participation in the premium market. Consequently, the labeling organizations should undertake marketing to improve knowledge levels about labels throughout the carbon market. In particular, any public relation campaign should target buyers helping them understand the strength and importance of labels.

11.2.4 Recommendations for Further Study

1) Most existing research into the sustainability assessments of CDM projects has been based on a desk review of the PDDs. As previous noted, the quality of PDD is poor in terms of the details of actual SD benefits. A desk review of the PDDs is not a suitable research method. Therefore, we suggest the future research on sustainability assessments of CDM projects should use the in-depth interviews with a wide range of stakeholders.
2) In order to clearly understand sustainability preferences and see the conflicting opinions, we suggest the future research on the sustainability preferences of CDM stakeholders should include both a group of experts and a group of local residents.
3) The AHP method has proven to be a helpful tool for revealing stakeholder preferences towards the sustainability of CDM projects and it can be used for developing policy with respect to establishing local acceptance. However, we found problems when implementing the AHP. The first problem is that it is very difficult for local residents to remember the definition of the traditional 9-point scale. The second problem is that stakeholders cannot spend too much time completing the pairwise questionnaire. Therefore, we suggest the future research on AHP should design user friendly pairwise questionnaire concerning these two problems. However, we found that participants' involvement in designing the pairwise questionnaire help us to get a good response rate. Therefore, we suggest the future research should give an opportunity for the local stakeholders to comment on the questionnaire.
4) We suggest the future research on the sustainability assessments of CDM projects should implement similar study in other CDM project types in order to fully understand the CDM's contribution to SD at project level.
5) We suggest the future research should implement similar study of the WTP for the GS Voluntary Emissions Reductions (VERs) in order to compare the results with this study and more fully understand the value of SD benefits of the carbon offset projects. As the carbon credit buyers tend to be busy all the time, we suggest that the WTP questionnaire is not too time-consuming to complete and should be the multiple choice format. Moreover, the online survey should be a method for data collection.

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