

# Local Perspectives on Climate Change Mitigation and Sustainability of Clean Development Mechanism (CDM) Project: A Case Study in Thailand

S. Kittipongvises, T. Mino, and C. Polprasert

**Abstract**—Global climate change has become the preeminent threat to human security in the 21<sup>st</sup> century. From mitigation perspective, this study aims to evaluate the performance of biogas renewable project under clean development mechanism activities (namely Korat-Waste-to-Energy) in Thailand and to assess local perceptions towards the significance of climate change mitigation and sustainability of such project in their community. Questionnaire was developed based on the national sustainable development criteria and was distributed among systematically selected households within project boundaries (n=260). Majority of the respondents strongly agreed with the reduction of odor problems (81%) and air pollution (76%). However, they were unsure about greenhouse gas reduction from such project and ignorant about the key issues of climate change. A lesson learned suggested that there is a need to further investigate the possible socio-psychological barriers may significantly shape public perception and understandings of climate change in the local context.

**Keywords**—Climate Change Mitigation, Local Perspective, Sustainability, Thailand

## I. INTRODUCTION

EVIDENCE of climate change and its impacts have been generally accepted by the international community of our time. The majority of scientists acknowledge that rapid acceleration of global warming is largely caused by anthropogenic greenhouse gases (GHG) emissions, resulting in negative impacts on both ecosystem and socio-economic development [1].

Correspondingly, there are several efforts ongoing to mitigate and reduce GHGs emissions, including the initiation of clean development mechanism (CDM) activities under the Kyoto Protocol. At the international level, most mitigation projects are conducted through utilization of renewable energy resources, fuel switching and energy efficiency [2]. Similarly, over half of all registered CDM projects in Thailand are

implemented through either *biogas* or *biomass energy generation* based integrated waste management. This paper provides an overview of CDM status in Thailand and the performance of Korat-Waste-to-Energy (KWTE) project under CDM application. On the other hand, although scientific consensus increased over time, the knowledge and understanding regarding the basics of climate change by the public is still minimal [3]- [5]. For instance, the public opinion poll conducted in 15 nations over the decade from 1991 to 2001 found that, even in the most educated countries, only 15% in the U.S. and 26% in Mexico respondents could correctly identify the primary cause of global climate change [6]. In this study, the purpose of carrying out a community survey is to investigate local opinion towards the significance of climate change mitigation and sustainability of waste-to-biogas project in their community. A lesson learned suggested that there is a need for further research on perception and understanding of global climate change in local context.

## II. CDM STATUS IN THAILAND

With entry into force of the Kyoto protocol, CDM was created with the dual goals of achieving reduction targets, at least 5% below the 1990 levels by the year 2012, and promoting sustainable development in host countries [7]. As a non-annex I party, Thailand Greenhouse Gas Management Organization, established in 2007, is responsible for promoting sustainable development in country based CDM activities.

As of June 2011, there are 138 approved CDM projects being implemented in Thailand, with expected average annual carbon credits of about eight million tons carbon dioxide equivalent (tCO<sub>2</sub>e). Among these projects, about 53 projects were registered and only five projects (namely A.T. Biopower Rice Husk Power Project, Decha Bio Green Rice Husk Power Generation 7.5 MW, Korat-Waste-to-Energy, Univanich Lamthap POME Biogas Project, Bionersis Project) have received carbon credits issued by the CDM executive board. Accordingly, as seen in Fig.1, most of registered CDM projects in Thailand are implemented in either renewable biogas or biomass energy utilization. Some other projects are implemented through nitrous oxide reduction and waste heat recovery for power generation [8].

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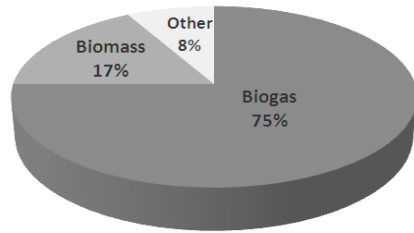


Fig. 1 Number of CDM project registered in Thailand

### III. BRIEF OVERVIEW OF THE KWTE PROJECT

KWTE was one of the first CDM projects to qualify for carbon credits in Thailand under waste handling and disposal schemes. This project site is located at tapioca processing plant of Sanguan Wongse Industries, Nakhon Ratchasima, Thailand. KWTE is considered as one of the world's largest biogas plant with a total throughput of 7,000-8,000 m<sup>3</sup>/d of tapioca wastewater. An anaerobic baffled reactor was used to treat their wastewater with 80-90% removal efficiency. Consequently, an average biogas production of 50,000-80,000 m<sup>3</sup>/d of methane is used to replace 100% of the heavy fuel oil and the excess biogas is used to supply in the electricity generation plant approximately 20,000 MWh per year which can added that amount of electricity to the national grid. Fig. 2 presents an overview diagram of wastewater treatment based biogas technology in Sanguan Wongse Industries, KWTE project, Thailand.

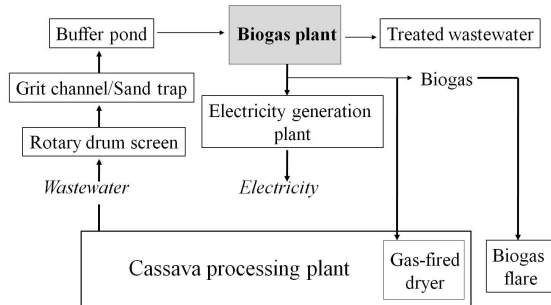


Fig. 2 Wastewater treatment system of KWTE project

Additionally, the project can reduce GHG emission by approximately 370,000 tons carbon dioxide equivalent per year [9], [10]. The significant sources of emission reduction are illustrated in Table I.

TABLE I  
EMISSIONS REDUCTIONS OF KWTE PROJECT

Sources	Emissions Reduction (t CO <sub>2</sub> e)
Fugitive pond emissions	330,000
Fuel oil heating related emissions	28,000
Grid fed electricity	17,000
<i>Total</i>	<i>375,000</i>

## IV. METHODOLOGY

### A. Study Area and Target Group

This study was carried out in Muang district, Nakhon Ratchasima province, northeastern of Thailand (Fig.3). Target population was the people who lived nearby the project area, 724 households consisting the total population of a village (Moo.4) in Nongbuasala sub district. Given that it was difficult to distribute the whole population within the time limits [11]. Among the entire population, a sample of 260 households was therefore systematically selected using probability proportionate to size with 95% confidence interval [12].

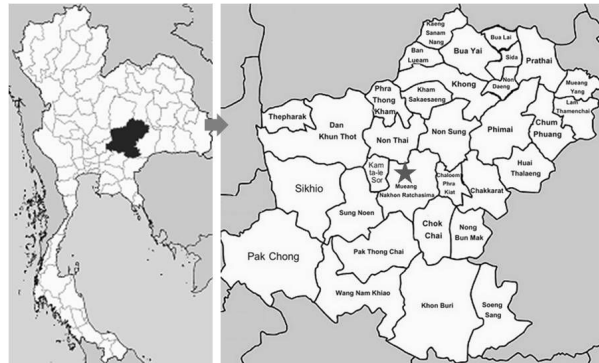


Fig. 3 Study area in Muang district, Nakhon Ratchasima province, Thailand

### B. Questionnaire Implementation

Questionnaire was developed and refined based on the national sustainable development (SD) criteria [13], as shown in Table II.

TABLE II  
NATIONAL SD CRITERIA FOR CDM PROJECT ASSESSMENT

SD Criteria	Indicators
<i>Economic aspect</i>	
Local income and living standard	Generate local income and increase local employment
National economic and security	Reduce energy import and increase energy efficiency
<i>Environmental aspect</i>	
Climate change and air quality	Reduce GHG emission and air pollution
Waste and water management	Solid waste management, water quality and consumption
Other	Odor pollution, land use, natural resources and ecosystems
<i>Social aspect</i>	
Public and stakeholder participation	Training and employment of local staff and supplier
Self sustainability	Poverty eradication
Equity and accessibility	Access to energy service

The validity of questionnaires, assessed through the Index of item Objective Congruence method was 0.83, higher than 0.50; and the reliability estimated through Cronbach's alpha coefficient was 0.76, higher than 0.7, meaning that the questionnaires had adequate validity and reliability for data collection [14], [15]. The survey was pilot under supervised in-depth interviews with the experts from extremely varied background [16]. According to the national SD criteria, respondents were asked to express their opinion on climate change mitigation, environmental and socio-economic impacts of waste-to-biogas project in their community according to five-point scale; where 1 indicates not significant (means strong disagree), 2 means disagree, 3 means neutral/not sure, 4 means agree, and 5 indicates very significant (means strong agree).

## V. RESULTS AND DISCUSSION

### A. Demographic Characteristics of Respondents

As shown in Fig.4, the sex ratio of the respondents was almost equal (52% female and 48% male). The age of respondents ranged from 20 to 65 years, about 60% were 50 or older. More than 80% of respondents had a high school education, while only a few respondents had graduate and post graduate education (10% and 1% respectively). Regarding the main occupation at the time of survey, the largest share of respondents were housekeepers (45%) and farmers (30%).

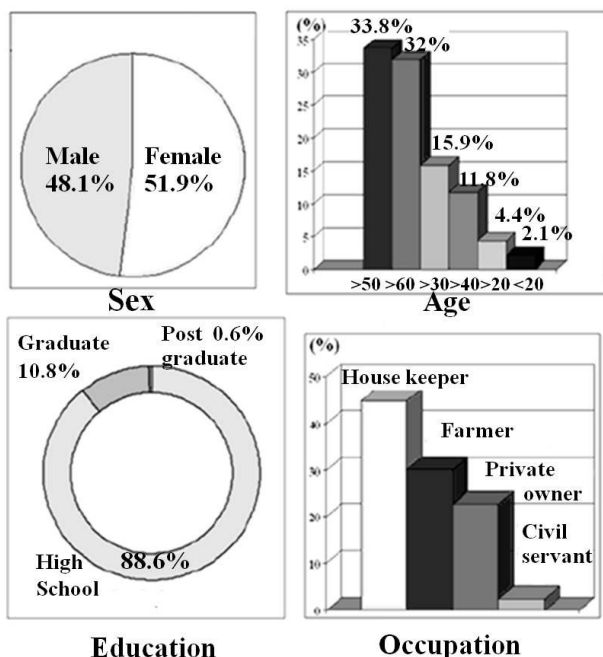


Fig. 4 Demographic background of respondents

### B. Environmental Sustainability and Climate Change Mitigation

Majority of respondents (81%) strongly agreed that the odor problems associated with wastewater collection were reduced by a covered anaerobic lagoon system. About 76% and 54% of

respondents, respectively, perceived that air pollution and wastewater problem were reduced. Most of them, however, were not sure about positive impact of solid waste management and on ecosystems in their community (Fig. 5). Of these respondents, over half were also not sure about the reduction of GHG from such project and acknowledged that they really did not know about climate change phenomenon.

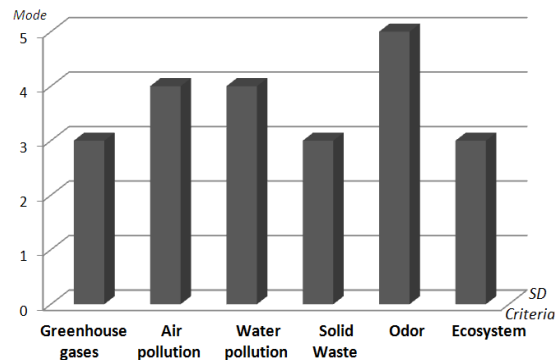


Fig. 5 Local perceptions towards environmental sustainability of KWTE project

### C. Socio-Economic Sustainability

As a result, 63% of respondents envisioned that waste-to-biogas project could create small business via cassava market in their local area. However, they still were not sure about the positive impacts in their lifestyle. Besides, in the socio-economic dimensions, 51% of respondents recognized that waste-to-biogas project could increase local income, somehow promote renewable energy (89%) and also enhance energy efficiency (74%) in their local community. Fig.6 presents the perception of local people towards social and economic impacts of KWTE project in their community.

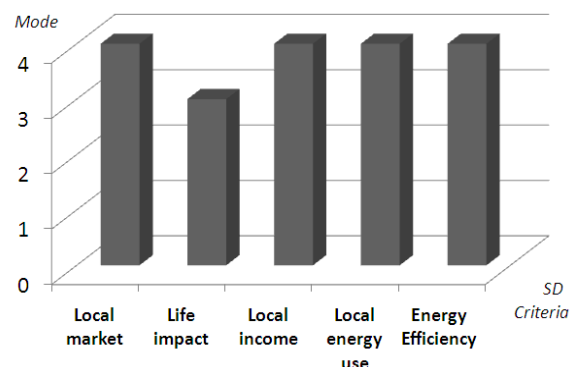


Fig. 6 Local perceptions towards socio-economic sustainability of KWTE project

## VI. CONCLUSION AND DISCUSSION

Climate change caused by anthropogenic greenhouse gas emissions is acknowledged as one of the greatest threats to human and ecosystem of our time. CDM, under the Kyoto Protocol, is considered as an alternative mechanism to help

both developed and developing countries to achieve an emission reduction target and sustainable development.

In Thailand, most of the CDM registered projects are either renewable biogas or biomass energy generation based integrated waste management. The study suggests that Thai authority should enhance the opportunities for bilateral and multilateral cooperation among the region and should extremely promote national capacity building on climate change at all levels, especially in the local context in order to increase their understanding of these issues.

This paper presents the performance of waste-to-biogas project, namely KWTE, under CDM activities in Thailand and also highlights the key findings from local perspective towards the significance of climate change mitigation and sustainability of such project in their community. Based on the benefits of project implementation, KWTE was found to be beneficial in water pollution control by converting organic pollutants in the tapioca wastewater (with 80-90% removal efficiency) into biogas energy (50,000-80,000 m<sup>3</sup> of methane per day) which is consequently being used as 100% fuel oil displacement in tapioca processing and producing electricity of 20,000 MWh per year. The amount of emission reductions is approximately 370,000 tCO<sub>2</sub>e per year that is transferred to Annex I countries. In this context, the project site boundary included three direct sources of fugitive methane emission from anaerobic wastewater treatment, fuel oil heating related emissions and grid fed electricity emission. Though the study, diesel vehicle emission that transport cassava roots and deliver to the factory were excluded from the estimation of project emissions.

From local perspective, a total representative sample of 260 households was randomly selected. In a survey, majority of respondents recognized that waste-to-biogas project could increase their local income from cassava marketing, somehow promote renewable energy and energy efficiency. Most of them also acknowledged that odor problems were significantly reduced. In contrast, most of the respondents were not so sure about GHG reduction and did not fully understand the context of climate change. In fact, some respondents were also confused between climate change and air pollution and did not have any idea what climate change and/or global warming meant. As for the effect of demographic factors, age and education level seem to be correlated with the degree of understanding on climate change.

Besides these findings, there is a need to investigate what possible barriers may significantly shape public understanding and how these may all affect their behavioral intentions in response to climate change. In particular, an individual differences perspective on behavior intentions of denying, uninterested, doubting and engaging should be more studied. Among the public, knowledge of the causes and negative consequences of climate change may influence the judgments of risk from cognitive assessment. Another possible explanation is affective factor. People experiencing cognitive dissonance may distance and block out themselves from certain information or set up barriers of denial to maintain desirable emotional states. Apart from individual level, a general lack of social support has also been identified as a

predictor of climate risk perception by the public. In conclusion, a variety of socio-psychological factors should be more considered within the theoretical underpinnings of cognitive, affective and behavioral dimensions in further studies. Understanding local community perceptions and further identification of the factors that influence climate-risk perception is important in developing management policies related to social dimension of climate change.

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#### REFERENCES

- [1] N. Stern, *Stern Review on the Economics of Climate Change*. Cambridge, UK: Cambridge University Press, 2007.
- [2] World Bank, *State and Trends of the Carbon Market 2010*. Washington, D.C.: World Bank, 2010.
- [3] K.M. Norgaard, *Cognitive and Behavioral Challenges in Responding to Climate Change*. Washington, D.C.: World Development Report Team, 2009.
- [4] R.E. Dunlap, "Lay Perceptions of Global Risk: Public Views of Global Warming in Cross-National Context." *International Sociology*, vol. 13, pp. 473-498, 1998.
- [5] A.M. Bostrom, G. Morgan, B. Fischhoff and D. Read "What do people know about global climate change?." *Mental models, risk analysis*, vol. 14, pp. 959-970, 1994.
- [6] S.R. Brechin, "Comparative Public Opinion and Knowledge on Global Climatic Change and the Kyoto Protocol: The U.S. versus the World?." *International Journal of Sociology and Social Policy*, vol. 23, pp. 106-134, 2003.
- [7] UNFCCC, "Kyoto Protocol to the United Nations Framework Convention on Climate Change." 1997 Accessed March 17, 2008, from <http://unfccc.int/cop5/resource/docs/cop3/107a01.pdf>
- [8] Thailand Greenhouse Gas Management Organization "Status of CDM projects in Thailand." 2011 Accessed July 10, 2011, from [http://www.tgo.or.th/english/index.php?option=com\\_content&task=category&sectionid=5&id=15&Itemid=29](http://www.tgo.or.th/english/index.php?option=com_content&task=category&sectionid=5&id=15&Itemid=29)
- [9] Korat Waste To Energy, "Project design document form of Korat Waste to Energy project in Thailand. (version 2)". Eco Securities Group Ltd. Oxford, United Kingdom, 2005.
- [10] S. Kittipongvises, "Potential of clean development mechanism (CDM) activities for greenhouse gases reduction at a starch-processing factory in Thailand", Asian Institute of Technology, Thailand, 2008.
- [11] A. Fink, *How to sample in surveys*, Sage Publications Inc: California, 1995.
- [12] T. Yamane, "Statistics An introduction analysis," 3<sup>rd</sup> ed., New York: Harper & Row, 1993.
- [13] Office of Natural Resources and Environmental Policy and Planning, "Integrated approaches of national climate change and CDM strategy." 2006 Accessed August 30, 2007, from <http://www.onep.go.th/cdm>, 30 August 2007
- [14] L.J. Cronbach, *Essential of psychology testing*, New York: University of Chicago, 1970
- [15] R.J. Rovinelli and R.K. Hambleton, "On the use of contest specialists in the assessment of criterion-referenced test item validity." *Journal of Educational Research*, vol.2, pp 49-60, 1997.
- [16] L.B. Bourse and E.P. Fielder, *How to conduct self-administered and mail surveys*, Sage Publications Inc: California, 1995.

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