Feasibility Study of Clean Development Mechanism On Electric Power Generation Facility using Methane Gas From Waste Disposal Sites in Thailand

Summary Edition

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Introduction

For developed countries, Annex I countries, the Kyoto Protocol adopted at the 3rd Conference of the Parties (COP3) in 1997 set the goal of reducing greenhouse gas (GHG) emissions by average 5% of each country's respective 1990 emission amount (6% for Japan) by 2008 – 2012.

The Government of Japan has adopted the Climate Change Program that stipulates policies and measures considered necessary for the achievement of the emission reduction commitment under the Kyoto Protocol. And various environmental measures are now in progress based on the Program. Since Japan is already advanced in the implementation of energy conservation measures, it is understood that further conservation measures in Japan will be more costly than those in overseas. So, if we only rely on the domestic measures, it is concerned that it will lower Japan's competitiveness in the international market and could even put a grave impact upon the domestic economy. Consequently, Kyoto mechanism, particularly clean development mechanism (CDM), is of increasing importance for meeting the goals under the current circumstances.

The Methane Emission Reductions projects, ones of the highest profile CDM projects, are regarded as highly effective, since methane has twenty-one times more potential as a greenhouse gas compared with carbon dioxide and its collection technologies are comparatively inexpensive. Therefore, it is understood that the knowledge about the Methane Emission Reduction projects is very meaningful for possible CDM projects.

In the 1994 Greenhouse Gas Inventory, Thailand predicts a large increase in methane emissions due to the increase in solid wastes by its population growth and the switch from open dumping to sanitary landfills. The use of methane as energy is considered to be an effective way to mitigate methane release, and it is expected that methane emissions originating from solid wastes can be reduced by up to 79% in the future.

Thus, the goals of this feasibility study are,

(1) To examine issues in the recovery of landfill gas (LFG), the principal component of which is methane (approximately 50%), from solid waste landfills in Thailand
(2) To examine the feasibility of a project, in which LFG, currently unused energy source, be recovered and converted to electric power, as a CDM project
(3) To identify issues in practical use of LFG for electricity generation.

A new landfill site presently under construction in Nontaburi Province, a province neighboring Bangkok on the northwest is selected as a model project for this study. Thai Obayashi Corp., Ltd., our local subsidiary and Kasetsart University, which has extensive experience in technologies for LFG use in Thailand, are selected as our local counterparts.

1. Overview of Locale

1) Thai approach in measures to reduce global warming

Thailand signed the United Nations Framework Convention on Climate Change (UNFCCC) in June 1992 and ratified the Convention on August 28, 2002. Thailand is not an Annex 1 party, and therefore it has no obligation to reduce GHG emissions. Thailand thus fulfills the requirements to receive CDM project. Thai efforts with relation to global warming are overseen by the Office of Environmental Policy and Planning (OEPP) of the Ministry of Science, Technology and Environment (MOSTE).

2) Greenhouse gas emissions

The 1994 GHG Inventory was prepared as Thailand's Initial National Communication in 2000 by MOSTE and is the latest version. The total GHG emissions reported are 286 million tons in CO_2 equivalent (CO_2 and CH_4 account for approximately 71% and 23%, respectively).

Some 20,000 tons, approximately 6% of the total methane emission originate from solid wastes. Generally, solid wastes are burned, open dumped or filled in sanitary landfills; sanitary landfills account for approximately 25% of all solid waste disposals. However, sanitary landfills are the origin of some 43% of the total methane gas emissions from solid waste. It indicates that sanitary landfill has high rate of methane generation compare to the other solid waste disposal methods.

It is predicted that the shift from open dumping to sanitary landfills and the increase in solid wastes due to population growth will result in a sharp rise in methane emissions from waste sectors (solid wastes and wastewater), from 35,000 tons in 1994 to 102,000 tons in 2010.

The use of LFG for production of electricity is considered as an effective technical option in reducing methane emission, as it could reduce up to 79% of solid wastes-derived methane emissions. Electricity generation plants utilizing LFG are considered to be promising as Small Power Producers (SPP) projects, and its potential generation capacity is estimated to be about 75 MW in total.

3) Situation of LFG utilization in Thailand

① Approach to LFG use in Thailand

A study on LFG utilization in Thailand was initiated in 1996, simultaneously with the opening of a pilot electrical generation project utilizing LFG (LFG-to-electricity project) at a sanitary landfill in Kampensaen, Nakhon Pathom Province, which receives solid wastes from Bangkok Metropolitan. Though the currency crisis occurred in 1997 slowed the project progress, the project is now close to completion through financing support from Global Environmental Facility (GEF) fund by the World Bank.

It is reported that water infiltration of landfills (leachate), a characteristic problem of LFG-to-electricity projects in Thailand, which interferes with LFG collection has been solved by switching LFG extraction wells from vertical typically used in the West, to horizontal.

Besides the project in Kampensaen, there is an electricity generation plants utilizing LFG at Rachatewa Sanitary Landfill, in Bangplee, Samutprakern Province, which receives solid wastes from Bangkok. The facility is scheduled to begin selling power to the Electricity Generating Authority of Thailand (EGAT) in early 2003.

② Polices and subsidies supporting LFG-to-electricity project

Thai government is encouraging the development of renewable energy sources as part of energy security management, and has established an energy conservation fund for financial incentives for this type of project. Also, Small Power Purchase Agreements program has been established to provide a premium price for electricity produced by Small Power Producer as renewable energy projects. It is expected that LFG-to-electricity project will also be promoted as a renewable energy source, but at present, no energy conservation fund has been yet established for this type of projects. The Energy Policy and Planning Office (EPPO), formerly the National Energy Policy Office (NEPO), has a plan to found a fund when the pilot project at Kampensaen sanitary landfill successfully complete. According to the Master Plan for the next 10 years, half of local governments, 50 out of 99 local governments, will have such funds for electricity generation plants utilizing LFG. The next Master Plan was scheduled to be made open for public in September 2002, but has not yet been open at the time of this study.

2. LFG-to-electricity project in Nontaburi

1) Overview of project

A sanitary landfill site in Solid Waste Disposal Center, a solid waste disposing & recycling facility currently under construction in Nontaburi Province, northwest of Bangkok is assessed as a CDM project. The sanitary landfill site is composed of three landfills; two are already under construction, and the remaining location is currently used for open dumping. Those two landfills under construction are selected for this study.

Table 2-1 shows some basic specifications on the landfills under construction.

Note: It was assumed that local authorities would perform the landfill construction, operation, such as waste collection and facility management. Thus, these activities are assumed as out of the scope of this feasibility study.

Table 2-1 Outline of Sanitary Landfills Currently Under Construction

Schedule	Fill start, 2003; Fill complete, 2006
Total Fill Capacity	Approximately 1.2 million tons
Fill Volume per year	Approximately 300,000 ton/year
Fill Area	36 *rai* (14.23 acres)
Fill Configuration	9 lifts (30.5 m high)

2） Electricity generation system utilizing LFG

① Estimation of recoverable LFG

Recoverable LFG volume is calculated using Landfill Gas Emission Model “LandGem”, software developed by the American Environmental Protection Agency (USEPA), and modified by a collection efficiency rate of 80% (Figure 2-1). This % of efficiency is assumed based on MOSTE data and the landfill configuration characteristics such as shape and structure.

② Electricity generation system

The system plan is established as follows:

A Project lifetime / Crediting period

- 10 years (Operation to begin in 2007 and end in 2016), construction of the electricity generation plant is scheduled in 2006.

B System operating conditions

- All the electricity generated, except that used within the facility, is to be sold to the grid.
- All LFG not used for power generation is to be burned at the flare system.

C Generation capacity

- Total power capacity of 1070 kW (power production in 2016 is estimated at 870 kW, due to decrease in recovered LFG volume)

D System configuration

The system components are as follows: LFG collection system, LFG treatment system, electricity generation system, and LFG combustion system for extra gas (flare system). The generation system would have a capacity of 1070 kW (2 sets x 435kW gas engine generator and 2 sets x 100kW gas engine generator). Figure 2-2 shows the assumed flow diagram of the system.

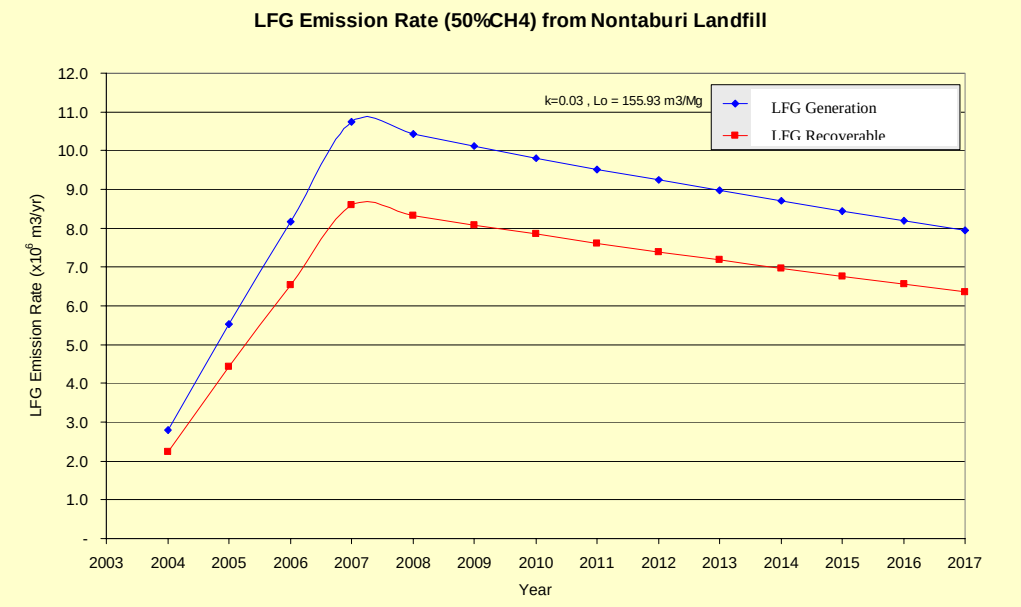

Figure 2-1 Estimation of recoverable LFG

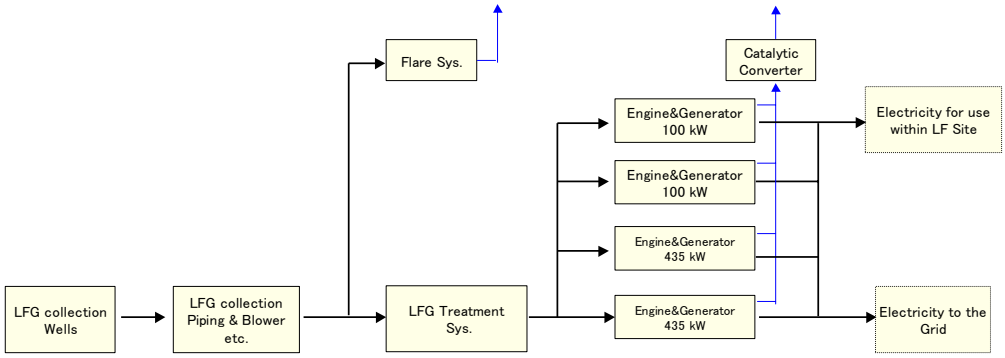

Figure 2-2 System flow diagram

3) System boundaries

Environmental impacts relating to this project are investigated and the following two are identified as the system boundaries:

① Direct impact – impact relating to primary objective:
> Emission reduction of GHG by capture and combustion of LFG

② Indirect impact – impact relating to primary objective:
> Emission reduction of GHG by substituting conventional electricity produced by fossil fuels with LFG-generated electricity.

Note: The following are excluded from the impacts considerations.

A Electrical consumption for the plant operations
(Electricity for the plant operation is to be provided by LFG-generated electricity)

B Impacts on waste collection vehicles and waste collectors (scavengers)
(Construction and operation of the landfill, and waste collection are out of the scope of this study)

4) Baseline

"LFG release to the atmosphere" is used as the baseline for this project for the following reasons:

① The landfill site selected for this feasibility study was originally designed to release LFG through exhaust pipes installed. Therefore, LFG will be released to the atmosphere if this project is not implemented.

② Situation of LFG utilization in Thailand

A LFG utilization in Thailand is in a pilot plant stage.

B No assistance program for electricity generation plants utilizing LFG has been announced, and also its schedule is not yet available .

3. Evaluation of the project feasibility

1) Expected GHG emission reductions by the project

The results of calculations for LFG (50% methane) emission reductions are shown in Table 3-1.

Through the 10-year lifetime of the project, it is estimated that the total methane emission reductions would be approximately 550,000 CO_2-tons. While approximately 500,000 CO_2-tons out of the total reduction would be by capture and combustion of LFG , the remainder of approximately 50,000 CO_2-tons would be by substituting conventional electricity with LFG-generated electricity. The emission reductions effective for the first commitment period of Kyoto Protocol (from 2008 to 2012) would be 350,000 CO_2-tons and 200,000 CO_2-tons would be effective for the second commitment period.

The GHG emission reductions by LFG collection are calculated as the sum of A and B, as described below.

A Methane emission reductions by electricity generation using LFG.

B Methane emission reductions by burning of LFG via the flare system.

The CO_2 emission reduction by substituting conventional electricity with LFG-generated electricity is calculated by using carbon intensity, 0.6 CO_2-kg/kWh, of the electrical power generation sector in Thailand.

2) Economic feasibility of the project

The economic feasibility of this project is assessed for two cases, one is with CO_2 credits provision, and the other without that provision . On the assumption that the credit is \$3/CO_2-ton, the results are summarized as follows:

① No CO_2 credit:
FIRR: 15.51%, Investment payback period = 5 year- 10 month.

② CO_2 credit of \$3/CO_2-ton:
FIRR: 29.18%, Investment payback period = 4 year- 1 month.

These results show that while the CO_2 credit causes no dramatic change in the investment payback period, the financial internal return rate (FIRR) is being greatly improved. Therefore, it is concluded that this type of LFG-to-electricity project has a great deal of attraction as a CDM project.

However, it is noted that the assessment above does not consider those costs for LFG use (purchase), land rental, financial loan and other expenses, if any, relating to a CDM project.

3) Issues for executing LFG-to-electricity project in Thailand

The following issues have been brought to light in the course of this study.

① Issues associated with LFG generation and collection.

LFG volume generated in landfills and to be collected is essential for the design of its electrical generation system, which also determines the income and, as a result the feasibility of this project. However, such information as to properly assume the LFG volume is not yet available at this time, because the study on LFG use has only just begun in Thailand. Therefore, the figures assumed in this study for generated and collected LFG are of low confidence. Therefore, it is strongly recommended that further surveys be locally conducted for necessary and reliable data.

② Collection efficiency of horizontal wells

One of the characteristics of Thai landfills is the high level of leachate. Since high levels of leachate cause a severe impediment to LFG collection, a single layer of horizontal wells, a unique horizontal configuration, has been adopted in order to avoid this problem in this study. However, the collection efficiency of the single layer would be lower than that of ordinary horizontal well design, which has wells every 2–3 lifts. For practical LFG-to-electricity projects, further investigations for more efficient LFG collection methods and appropriate measures for handling leachate are necessary.

③ LFG purchase cost

In this study, payment to the landfill owner for use of LFG is not considered. However, it must be noted that if LFG purchase payment is assumed at a maximum of the light oil (diesel) price, the viability of the project feasibility is greatly reduced. Therefore, the ownership of LFG or how the profits are to be divided must be clarified for actual implementation of this type of projects.

④ Issues regarding landfills

Capacity and configuration of landfills affect the viability of LFG-to-electricity project, because those impact the cost for materials, installation and maintenance of LFG collection system, and other factors. Similarly, landfill operation and maintenance, which are excluded from this study, also affects LFG collection and, in turn, the project viability. Therefore, these issues must be carefully studied in planning such projects.

4) Expected ripple effects on other regions

According to the information gathered in the course of this study and the literature, handling of solid wastes in Thai is much like that in other Southeast Asian nations and is considered relatively advanced in the region. The World Bank, as a GEF's implementing agency, anticipates replicating the project at Kampensaen Sanitary Landfill to elsewhere in Thailand as well as other Southeast Asian countries. Therefore, once the technologies of LFG-to-electricity project are established in Thailand, those technologies are expected to ripple especially in Southeast Asian countries, where the geographical conditions are similar to those in Thailand.

5) Assessment of viability

Considering the economic viability and the local environmental circumstances , it could be concluded that LFG to-electricity projects are attractive as well as beneficial to Thailand as CDM projects. And also, this type of projects as CDM projects is attractive to Japan, which faces high costs to accomplish the same reduction performance domestically.

Nevertheless, in view of the issues involved, it is rather difficult for private enterprises to conduct this project on their own. Therefore, it would be advisable for Japan to provide assistance to resolve the issues highlighted in this study so as to make LFG-to-electricity projects viable. Particularly, assistance targeted at such issues as LFG generation and collection fundamentals (LFG volume generated, collection efficiency, leachate management and collection wells) would be considered valuable.