LFGTE AND CARBON FINANCE FEASIBILITY STUDIES IN LATIN AMERICA

Eric R. Peterson
SCS Engineers
Reston, Virginia

Francisco Grajales Craviota
The World Bank
Washington, District of Columbia

ABSTRACT

The World Bank has conducted LFGTE pre-feasibility studies at 10 landfills located in five Latin American countries. A previous presentation at the LFG Symposium (by Carl Bartone, World Bank consultant) discussed the objectives and progress of these studies, which were completed in July 2005. This paper discusses specific technical and economic results of the studies, which included five pump tests.

The topic is timely with several Latin American countries (e.g., Colombia, Argentina, Brazil, and Mexico) partnering with the US in the Methane to Markets Initiative (M2M). Valuable information was obtained from pump tests relative to the impacts of climate, waste type, and leachate management practices. Economic analyses focused on projects benefiting from electricity sales as well as revenues from carbon finance through the sale of certified emissions reductions (CERs). Depending on the price of energy in a given country, CER sales may or may not be necessary for a successful project. Mexico, for example, has high electricity tariffs that are favorable to LFGTE.

With the ratification of the Kyoto Protocol by the requisite number of nations, many carbon finance projects are being pursued in Latin America. Such project development includes participation by a variety of American and Canadian firms from engineering to finance to equipment supply. Methane to Markets also is stimulating North American participation in Latin American LFGTE projects, albeit focused on energy and not carbon finance. This paper presents results from the pre-feasibility studies and discusses the relationship of various methane reduction programs (such as M2M and Kyoto), CER purchasers (such as World Bank, IFC, and private emissions brokers/developers), and ongoing research funding sources as related to LFG collection and recovery.

PROJECT OBJECTIVES

The World Bank initiated this Study as part of a broad initiative in the Latin and South American Region to promote LFG to Energy (LFGTE) projects in the region. In all, studies were conducted at landfills in Uruguay, Brazil, Peru, Mexico and Colombia. The evaluations considered project development within the framework of current international carbon markets such as the Clean Development Mechanism (CDM) of the Kyoto Protocol.

The objectives of the studies were as follows:

- Assess the technical and economic feasibility of the development of an LFG to energy project at each of ten landfills.
- To quantify the potential greenhouse gas (GHG) emission reductions and other environmental impacts of implementing a project.
- To provide the landfill owner with a tool to make informed decisions regarding additional investigations or moving forward with a project at the Landfill.

PROJECT APPROACH

The approach that was followed to evaluate each of the landfills is presented below:

- Reviewing site conditions and available background information, including waste quantities and composition, landfill type and configuration, meteorological data, and leachate management practices and generation rates.
- Visiting the site to observe site features and operations and meet with the Landfill owner and operator.

- At five selected sites, installing three test extraction wells and monitoring probes for pump testing; conducting the pump test and evaluating the results.
- Estimating the LFG recovery potential from the Landfill using computer modeling based on available information, pump test results (if conducted), and engineering experience at similar landfills.
- Quantifying energy recovery potential and environmental benefits through air emissions reductions over time.
- Identifying and reviewing energy recovery options including onsite power uses and the sale of power to the utility grid.
- Identifying institutional, market and business arrangements that would likely be involved in the implementation of a gas recovery and utilization project.
- Reviewing the in-country energy and waste management sectors to identify issues relevant to developing a LFGTE project.
- Preparing a conceptual design for the gas collection and utilization system to evaluate the capital costs required for implementing gas collection at the Landfill.
- Evaluating the project costs, including identifying capital and operational costs and sources of revenues.
- Developing an implementation plan, including identifying the general steps involved with the development of a LFG utilization project.

PRE-FEASIBILITY STUDY RESULTS

Economic Results

Of the 10 landfills studied, only one was deemed economically unattractive for development, even for the flaring only scenario to create CERs. This site, El Combeima Landfill in Colombia was small, had been closed for several years, and occupied a large area with shallow waste. These factors combined to create low potential returns against relatively high investment to collect gas from the shallow site.

All of the other sites appeared feasible for development as flaring only projects or with energy production. Power purchase pricing difficult to assess. For example, renewable energy project pricing in Brazil ranges from 2.9 to >7 ¢/kWh. Moreover, policies for independent power producers to sell to the grid are evolving.

In many Latin American countries, hydropower is the dominant generating source, making wholesale power relatively cheap. Direct use of LFG or other energy options may be more attractive than power generation.

The highest energy pricing was identified in Mexico and possibly Brazil. Mexico electricity tariffs are established by CFE, the national utility. As in other countries, the mechanism to sell or self generate power in a way that realizes a return similar to the published rates is not well established.

The economic results for flaring only and for electricity generation (both with CER sales assumed) are summarized in the tables at the end of this paper.

LFG Recovery Evaluation

Perhaps the key ingredient in any LFG pre-feasibility study is the projected LFG recovery rates over time. In Latin America, gas recovery projections are impacted by a number of factors that differ significantly from industry norms in the US and Canada. Foremost is the fact that the solid waste composition contains substantially higher food wastes and less paper waste. Waste composition data were available for all of the study sites, and they exhibited close similarities to one another along this line.

SCS employed a modified version of the EPA LandfGEM model to accommodate the differing waste types. Multiple methane decay constant (k) values were used to better analyze the waste types. This resulted in a higher equivalent k in anticipation of more rapid decay of the food and certain other organic wastes. On a wet weight basis, food waste is expected to have a lower methane generation potential (Lo) than is typical for US waste due to the higher inert water content in the incoming waste stream.

Second in importance to waste composition is precipitation impacts on LFG generation. Latin America has both very wet and very dry climates depending on region. Dry locations, like Lima and other locations in Peru and Chile, experience reduced gas generation rates. SCS conducted a pump test at the Lima landfill and discovered an apparent LFG generation rate twice that previously predicted based on the dry climate. Is appears that the moisture contained in the incoming waste stream stimulate gas production at a level associated with somewhat wetter climates.

It is important to note that professionals in the field differ in their opinions on the best way to model the different waste characteristics and climate conditions encountered. Interestingly, as long as the landfill is open

and continues to receive annual tonnages similar to the past, the model assumptions have a limited impact on the projected quantity of LFG. For example, a relatively high k and low Lo will yield similar output to relatively low k and high Lo during active years of landfilling. Unlike the US and Canada, there are very limited data from operating LFG systems against which to compare model projections. This is particularly true for closed sites where model parameter selection has the most impact.

Other factors affecting the feasibility of LFG collection include leachate management, landfill configuration, and landfill closure dates. Those sites that were subject to a pump test benefited as much by test well installation revealing subsurface leachate levels as by the pump test itself. Even in semi-arid regions, leachate levels were high enough to negatively impact gas collection from 15-meter deep wells. As appropriate, capital cost estimates for the collection system included horizontal collectors and leachate pumping for such sites.

As mentioned above, landfill closure has a significant impact on gas recovery projections, particularly given the unknowns regarding actual decay rates. Depending on location, the projected closure date may be rather ambiguous given the lack of permitted final grades, political influences, and competition or lack thereof.

Summary of Findings

The study results indicate that project viability is largely dependent on:

- Quantity of CERs (based on landfill size, life remaining, and collection system investment)
- CER price assumptions. For purposes of this study, three prices were assumed: $5, 6, and 7 per tonne of CO_2 equivalent. Since the completion of the study in July 2005, CER transaction prices are trending upwards.
- Electricity price assumptions. This is an obviously sensitive parameter, but also one that could vary considerably due to complicated utility tariffs and the limited history of independent power sales agreements in many of the study locations. Accordingly, a sensitivity analysis was conducted to quantify the impacts of energy price differences.
- The flaring only projects often exhibited higher NPV and IRR values due to lower capital expenditures.

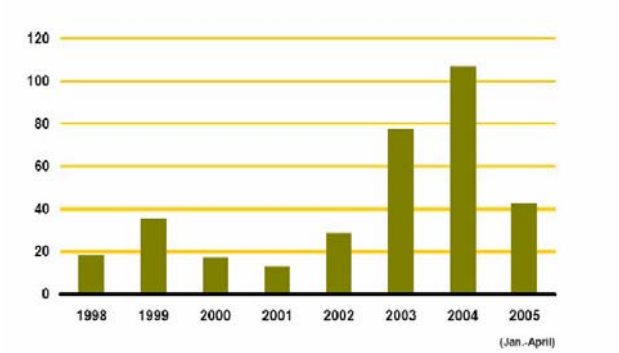

Figure 1. Annual Volumes (million tCO_2e) of Project-Based Emission Reductions Traded (up to 2012 vintages)

CARBON FINANCE

The carbon finance market is expanding steadily—107 million tons of carbon dioxide equivalent were exchanged from projects in 2004, a 38 percent increase compared with 2003 (78 million). The estimated volume exchanged halfway through 2005 was 43 million tCO2e. This surge in activity has been mostly driven by the entry into force of the EU ETS in January 2005 and the entry into force of the Kyoto Protocol in early 2005.

The World Bank has been positioning itself as one of the most important players of the Carbon Trading arena. In the last six years the World Bank involvement in carbon finance has grown from the initial conception and development of the pioneering $180 million Prototype Carbon Fund to eight carbon funds and facilities today that represent almost a billion dollars, with more than 42 private sector companies and 15 governments as participants. The most important World Bank Carbon Funds are:

- The Prototype Carbon Fund is expected to have signed emission reductions purchase agreements for most of its projects by December 31, 2005.
- Tranche One of the BioCarbon Fund closed on August 31, 2005 with a total of $53.8 million in contributions.
- At the end of two years, the capitalization of the Community Development Carbon Fund stands at $128.6 million.
- The Danish Carbon Fund was established in January 2005. As of August 31, 2005 the fund had two public sector participants (the Danish Ministry of Foreign Affairs and the Danish Ministry of Environment) and five private sector participants.

- As of August 31, 2005 commitments to the Italian Carbon Fund had risen from $15 million to $45 million. The fund is currently being opened to private sector investors. Commitments are expected in late 2005, and the fund is expected to be closed in spring 2006 with over $100 million capitalization.
- As of fall 2005, the Netherlands CDM Facility had a diversified portfolio consisting of signed emission reductions purchase agreements for a total volume of 2.9 million tCO2e, and approved carbon finance documents with a total potential volume of 31 million tCO2e.
- Three projects were approved for the World Bank project portfolio of the Netherlands European Carbon Facility which focuses on the joint implementation countries and is administered in cooperation with the International Finance Corporation.
- The Spanish Carbon Fund has approved carbon finance documents for a number of projects totaling over $68 million. The fund will purchase about 11.5 million tCO2e from these projects.

The World Bank Carbon Finance Unit, which manages all of the Carbon Funds, has reviewed approximately 800 project proposals as of August 31, 2005. Of these, 128 have proceeded to the carbon finance document (CFD) stage and been approved for further development. Of these 128 projects, 88 remain active and have progressed to the emission reductions purchase agreement (ERPA) negotiation phase. Twenty-eight projects have active signed emission reductions purchase agreements totaling $139 million, of which 13 were signed in fiscal year 2005 with a total value of $62.6 million.

Latin America represents for the World Bank the second most important market for emission reductions as shown in Figure 2. Nevertheless the trend has been a continued shift towards East Asia, particularly China, over the past year. The East Asia and Pacific region accounts for a total value of $329.4 million. The Latin America and Caribbean region, while maintaining the lead in number of projects with 35 active CDM projects, accounts for less than half of the contracted value with $120.8 million compared to East Asia.

Technological diversity is a preference of several of the funds of the Carbon Finance Unit and is exhibited in the figure below. In fiscal year 2005, HFC-23 destruction captured a large share (32 percent) of the portfolio pipeline. Waste management is very well-represented, accounting for 18 percent of the portfolio. Energy efficiency projects, including cement and other construction material efficiency improvements, district heating, steel waste gas recovery and others, represent a further 10 percent of the World Bank portfolio.

Table 1. Technological Distribution of Carbon Finance Unit Portfolio (Total $629 million)

Renewable Energy (21%)	Bagasse	<1%
	Geothermal	1%
	Biogas	1%
	Biomass	2%
	Wind	3%
	Hydro	14%
HFC-23 Destruction		32%
Waste Management		18%
Energy Efficiency		10%
Land Use, Land-Use Change and Forestry		7%
Coal Mine Methane		2%
Nitrous Oxide Removal		2%
Transportation		<1%

Source: CFU Annual Report 2005, The World Bank

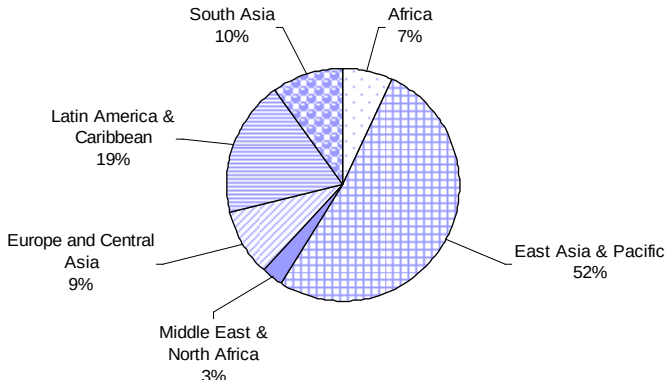

Figure 2. Geographic Distribution of Carbon Finance Unit Porfolio (Total $629 million)

Source: CFU Annual Report 2005, The World Bank