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The status and future of methane destruction projects in Mexico

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ABSTRACT

Of the Clean Development Mechanism projects that exist in Mexico, methane destruction from hog farms dominates the landscape with 56% of the projects developed and 49% of the certified emission reductions that will be generated within the country by 2012. These biodigesters, however, have experienced many technical difficulties that place their future viability and continued development in question. Because of these challenges, future methane capture in the country may focus around other agro industries or landfills.

1. Introduction

Mexico has a well-developed hog industry with five million farms and over 18 million pigs that has been able to capitalize on the revenues from the Kyoto Protocol's Clean Development Mechanism (CDM) [1]. This mechanism, which is overseen by the United Nations Framework Convention on Climate Change (UNFCCC), allows developed, annex I countries that have ratified the protocol to make emission reductions by having an equity stake in or purchasing emission reductions from projects in developing countries. The emission reductions derived from these projects have to be considered additional to what would have occurred in a business-as-usual situation. This study analyzes the ability of these hog farms to successfully earn emission reductions and current barriers to project implementation.

Hog farms in Mexico were an area ripe for development because none had advanced wastewater treatment for pig excrement. Some farms simply let the waste spill directly into waterways. Others allow it to pool in lagoons where methane from the excrement off-gasses into the environment before it is discharged into a local waterway, evaporated, or sprayed on crops. These lagoons were a rudimentary way of preventing water contamination. Only the hog farms with lagoons that produced methane are eligible for CERs since preventing the release of this methane presented an opportunity for CDM project development. Farms that did not have these lagoons and simply released the excrement immediately into the local waterway were not eligible for project development since there was no methane being produced onsite as the excrement entered a moving waterway and was oxygenated [2].

These projects are not only considered desirable from a financial perspective, but they also provide local farmers with a solution to the odor and water contamination problems that had begun to create tense relationships with neighbors. Those farmers without biodigesters occasionally have to pay fines for the polluted water they discharged from the waste lagoons, which must be 90% free of solid organic matter [2].

Of all of the CDM projects in Mexico, 56% involve methane capture from hog farms and these projects constitute 49% of the country's emission reductions that will be generated by 2012. These emission reductions, known as Certified Emission Reductions (CERs), can be used to fulfill the Kyoto Protocol reduction targets. Mexico has also benefited from more biogas capture projects than any other country in the region, with a predicted 11,000 more CERs that will be derived from their closest competitor, Brazil, by 2012 [3]. Mexico has enjoyed such success for several reasons. Mexico, unlike its neighbors to the south, has hog farms with the critical mass of animals that is enough to make a digester viable. Also, most hog farms belong to a group of farms pertaining to the same owner like Granjas Carroll Mexico (GCM) and Socorro Romero Sanchez. Multiple farm sites that belong to the same owner are easier to bundle together in order to take advantage of the small-scale methodology. It is less risky to bundle several biodigesters with the same owner because compliance and communication with farm doctors and operators are simplified. Projects that emit a total of less than 60,000 tons of carbon dioxide destroyed annually can be

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combined for the sake of lowering project costs by creating only one project design document (PDD) and being evaluated by one auditor and verifier [4].

These farms have also enjoyed success in Mexico because Ag Cert, the self-proclaimed "worldwide leader in agriculturally derived emission reductions," set up operations in the country and aggressively pursued projects there with more than 120 staff serving the country [5]. As some farmers began to take advantage of the opportunity to earn money from their hog waste, the word spread, and more hog farmers became interested.

Despite Mexico's important role in the market, technical problems with the operation of these farms have placed their future in jeopardy. Future methane capture opportunities in the country could be focused on other types of agro industries or landfills.

2. Digester functioning

To understand the technical barriers facing biodigesters in Mexico, one must first have an idea of how a digester operates. Excrement or blood from a slaughterhouse falls or is swept into pits that are sent by gravity or a pump to a large container. Here the excrement is collected and allowed to sit for approximately 30 days in a plastic-lined and capped container. Depending on the density of the excrement, plastic walls are sometimes placed inside the digester to slow the movement of the excrement through the process so that it produces sufficient methane. In Mexico, positive pressure systems are usually used to trap the methane. In these systems a bubble of methane forms on top of the container. In negative pressure digesters, which are more commonly used in Brazil, the plastic cover touches the excrement and not bubble forms on top [6].

After methane is produced, it runs through pipes and a meter to a flare where it is burnt to produce carbon dioxide, a greenhouse gas that is 21 times less potent when considered in a 100-year time scale [7]. Sometimes, fans that blow the methane from the digester to the flare must be turned on to ensure that too much methane does not accumulate under the plastic cover. This seemingly simple system is a relatively new technology that has been implemented in several places throughout the world from India to the United States. However, each digester is different because of the animals that contribute to its contents and its location; therefore, each system must be considered individually in order to ensure proper functioning [8].

3. Prerequisites

The site of the digester is perhaps the most important parameter for digester functioning since digesters that are located at high altitudes or in cool weather have a hard time maintaining the 25–30 °C temperatures needed. Hog farms in the state of Puebla near the town of Perote have had difficulty maintaining a constant temperature. To remediate this problem, operators of GCM farms in Perote are considering heating the contents of the biodigester with the excess heat from a microturbine that would burn methane from the digester [9]. Also, if located in a site with frequent rain, the digester can become too cool as pools of water gather on the surface, deflating the methane bubble and lowering the temperature of the excrement. In Mexico, hog farms in the state of Veracruz often have pooling of water because of the frequent storms during rainy season. If the project has no full time grounds keeper and, like Ag Cert farms, relies on weekly visits from an engineer who lives remotely, then there is sometimes not a pump onsite to move the water off the top of the digester surface. And, even if the local farmer has a pump, he does not always cooperate and use it in a timely fashion [2].

The diet of the pigs can cause fluctuations in the pH, which needs to remain close to 7. Adding ingredients to the excrement to make it more acidic or alkaline can cause large pH swings that over compensate for the problem. However, GCM has found that their excrement is too alkaline at an average of 7.9. They are planning on adding buffer tanks that will neutralize the excrement before it enters the main repository [9].

If the animals suffer from a disease and are prescribed antibiotics or given vaccinations, the medicine can harm the bacteria living in the digester. A close relationship with the farm doctor can help prevent the over-prescription of antibiotics and use of medicine on a rotating group of animals to decrease the impact of the machine on the digester. Likewise, non-biodegradable chemicals used to clean animal stalls can also limit the productivity of the digester by killing the microorganisms that anaerobically decompose the excrement [10]. Empacador Toledo hog farms in Guatemala found that using too much water to clean stalls made the waste too dilute. They cut back on their water use from 20 l per pound of excrement to 5 by manually sweeping waste into pits instead of hosing it and resolved digester problems [11].

The most essential part of the system for carbon credits is the actual burning of methane from a flare after it has been captured. Often the pilot light that lights the methane will get blown out by the wind, rain, or a piece of the flare that falls on top of it. Many flares have begun to install a solar-powered backup pilot light since failure is so common [9]. However, four of the ten digesters the author visited had not properly insulated the cables from the solar pilot light to the flare. The cables were therefore burnt.

If the methane does not burn clearly, there is a problem with the gas content. Often an orange flame is indicative of too much carbon dioxide in the digester. Lime is mixed in to reduce the CO_2 content. If there is too much hydrogen sulfide in the gas, it can damage the flare over time. To reduce the amount of hydrogen sulfide in the gas, it is sometimes passed through a pipe with a piece of iron that attracts the harmful gas. Water is also condensed out of the gas in another filter [2].

4. Communication breakdowns

Communication between the farmer and the engineer is a critical component to the success of digester projects. If the farmer or grounds keeper cannot pass messages directly to the engineer, critical components of the system like fans, pumps, and pipes cannot be repaired in a timely fashion. Often parts for the systems have to be transported from the capital or even ordered from abroad. The Ag Cert model of relying on a remotely located engineer to service a region of farms proves problematic since the company engineer cannot receive phone calls on this cellular telephone from anyone but the Ag Cert office. Farmers who leave messages at the office do not always have success passing it on to the engineer [2].

Contacting a project developer who is located abroad is even more complicated if the company does not have permanent operations and staff in the host country. GCM had the experience of paying high project costs for UEM Group Berhad, a Kuala Lumpur-based company, to develop a project that used sophisticated technology that replicated a design used on dairy cows. The tubes used have a diameter that is larger than needed and better suited for cows instead of pigs. The mechanical devices used to tighten the plastic cover are susceptible to tear. The open flare for the system worked for 24 h before it burnt the pilot light cables and threatened power lines that were sited too close to the flare. Since UEM is based abroad, they did not have an engineer who could frequent the project and offer technical assistance [9]. As a result of this experience, GCM hired the locally-based and more economical Geosistemas to handle the rest of their digester development [12].

There is sometimes a communication failure between the farmer and the consultant with regards to the CDM negotiations. The general director of Socorro Romero Sanchez hog farms, which has 29 projects with Ag Cert, is under the impression that after the first 10 years of the contract, the company will keep the carbon credits [13]. However, if a 10-year crediting period was chosen, then it cannot be renewed for additional carbon credits since a new baseline that includes the functioning digesters would be used in a new PDD an no CERs would be calculated [14].

5. Changing methodology

A change in the UNFCCC methodology for the destruction of methane has changed the economics of methane capture projects significantly. Prior to November 2006, the UNFCCC methodology allowed developers to assume that 100% of the methane was destroyed by these open flares. However, the UNFCCC's new, revised destruction of methane methodology sets a maximum amount of methane destroyed from these open flares of 50%. In order to prove that more than 50% of the methane is destroyed, farm owners have to have a closed flare with a temperature gauge. The heat of the gas flared determines how efficiently the flare is working and the quantity of gas destroyed [15].

The temperature gauge only costs about $1200 USD, but the cost of the flares varies widely. Open flares cost only $27,000–$150,000 while closed flares range between $105,000 and $195,000. The price range reflects the capacity of the flare, and in general, a closed flare costs 1.5–2 times more than its open counterpart [16]. A Mexican company called Geosistemas has created a less expensive closed flare that is comparable in price to the open flare. However, this flare is not yet available for purchase [12].

Projects that started under the assumption that they could buy and use open flares, but did not register the project before the change in methodology have had to revise their budgets to incorporate the cost of the closed flares and in some cases have had to return the open flares already purchased. Fear that the methodology could change again prompts projects in process to finish in a rush and discourages new project development from companies like Ecosecurities who did the CDM negotiations for GCM and had to change 29 digester plans after the methodology was revised [17].

6. Electrical generation

The GCM farms hope to eventually generate electricity from methane and have designed the carbon credit allocations to include the displacement of carbon-intensive fuels from the electrical grid. While the use of methane to produce electricity is a proven technology, several concerns about this aspect of the project operations suggest that the first few years of electrical generation could be a period of trial and error. Too much hydrogen sulfide not only hurts the flare, but can also cause malfunctioning of a generator or microturbine. Doubts about the amount of gas that will be produced and the most appropriate form of equipment make it difficult to size the system precisely [9].

Ag Cert has decided not to incorporate electrical generation in their projects because of the high capital costs of the generator and the uncertainty about how to use some gas in the generator and then switch the stream to the flare. The generators that will serve the farms are not big enough to utilize all of the biogas produced at most digesters owned by Ag Cert. So, the methane would build up in the covered lagoon until the stream was stitched to the flare. At that point, the pilot light must be ready to fire, and the switch must be synchronized well to prevent the release of unburned gas into the atmosphere. According to an Ag Cert engineer, the gas cannot be sent to both the devices simultaneously [2]. Despite these doubts about electrical generation, the farmers at many of the Ag Cert farms are planning on buying generators themselves to make use of the methane and eliminate their electricity bills [18].

Excess electricity that is not used by the farm could theoretically be fed into the grid as is being proposed in Empacador Toledo's hog farms in Guatemala by Ecoinvest. However, the structure of the Mexican market is such that it is complicated to sell excess electricity back to the grid. Generators can sell directly to the state-run company, Comisión Nacional de Electricidad (CFE), and earn 85% of their avoided cost. Or, generators can apply to be a "self-supplier," structure a power purchase agreement with a large customer who is a shareholder of the generator, and sell electricity to this shareholder. Under both schemes, the generator must pay high transmission tariffs. Also, the project owner is responsible for setting up electricity lines from the point of generation to the load [19]. Thus far, no hog farms have chosen to invest in a generator that can produce more electricity and feed it into the grid with the hope of earning money from the excess generation. Therefore, electrical generation only serves the farmer's needs and earns carbon credits equal to the emissions that would have been burnt if the farm was served by energy from the national grid.

7. Regulatory hurdles

Several upcoming regulations will make it more difficult to demonstrate additionality for biodigester projects in Mexico. Additionality is a prerequisite for CDM projects that attempts to ensure that all projects that receive credit would not have occurred in a business-as-usual scenario. If regulations or financial incentives exist that mandate or encourage the creation of the project, then it is more difficult to earn CDM revenues. Even though these regulations could make it more difficult to prove additionality, small-scale projects have the benefit of only having to demonstrate additionality in one of the several additionality categories which include technological, financial, prevailing practice, and other categories. Large projects must show additionality in all of these categories [20].

Prior to the CDM methane capture projects, farmers were in some cases paying fines for the water they emitted as effluent because their wastewater treatment did not eliminate 90% of the solids and qualify as acceptable according to the Secretary of the Environment and Natural Resources 1996 standard [21]. Digesters improve the quality of the water, avoiding the payment of fines, which for some farms amounted to $1000 USD per year. The digester also negates the purchase of expensive equipment like solid separators to improve the quality of water [18].

Hog farms often have strained relationships with neighbors not only because of the poor quality of water emitted from their operations, but also because of the odor of the farms. There is no formal odor ordinance, but these projects could be seen in the future as necessary to maintain cordial relations with those surrounding the project.

A new regulation mandates that new hog farms install biodigesters. This law could limit future development to only those currently-existing farms that do not have digesters and use lagoons to process waste [8].

An incentive for farmers to buy generators and use the methane produced from their hogs to produce electricity exists in the state of Puebla. This incentive supposedly pays half of the first cost of a generator, but there are doubts as to whether there will be enough money in the budget to cover all farmers that may be interested in this incentive. Socorro Romero Sanchez's farmers have begun taking advantage of this law; the government paid for one of the three generators the company bought for methane hog farm capture [8,18].

8. Future development of methane capture projects

Hog farms were the first biodigesters to be developed in Mexico, but opportunities for methane capture exist within several other industries. Ag Cert is currently doing tests on slaughterhouses to see if blood that pools in artificial lagoons before being discharged into waterways is viscous enough to produce significant amounts of methane. High density dairy farms and chicken coops are also being considered [2]. The Japanese bank Sumitomo owns three wastewater treatment plants in Mexico and is looking into the possibility of methane capture [22]. Methane capture from palm oil processing is also beginning to be a large industry in Central America and Colombia. Fedepalma of Colombia has 32 palm producers that have grouped together to take advantage of CDM revenues for methane capture [23].

Already in Mexico, two landfill projects have received registration, two more are in the process, and four additional ones are in the planning stages. All of these landfills plan on having electrical generation that ranges from 1 to 7 MW [24]. The future potential within landfills in Mexico for methane capture is immense, but riddled with challenges.

Landfill methane capture projects have to be implemented quickly since the municipal solid waste produces diminishing amounts of gas over time. A study for a landfill gas capture project operating in Mexico City but coordinating with all of the municipalities, trash collectors, and local stakeholders has delayed the project past the point when large amounts of methane can be extracted [25]. Therefore, these projects are most economical if implemented while trash is still accumulating or soon thereafter. Also, piping can be installed horizontally and vertically to capture the maximum amount of methane if the project is started while the landfill is still in operation. Methane capture works best when the site is a designated landfill and not a dump. Sorting trash before it enters and having a plastic liner beneath the pile help ensure that there will be a certain amount of organic waste content [26]. Also, when the landfill is constructed with a stairstep design that is based on when the trash was dumped, it is easier for engineers to know where most gas can be found based on the age of the trash [27].

Experience from landfill projects in the region points to some of the challenges with these projects. Rio Azul is a dump in San Jose that was retrofit in 2003 for gas capture and electrical production. A technical closure of the plant that coincided with this project led to the crushing of 40% of the landfill wells drilled for methane extraction because of poor communication between the various entities that own the plant. And, tubes used to transport the methane from the field to the site of generation are now frequently stolen since there is less activity and fewer guards on the site. All of these factors have led to the plant producing one quarter of the expected gas and associated emissions reductions [26]. The Zámbiza dump in Quito, Ecuador was also retrofit for flaring and future electrical production and is also under producing gas by 50% because of the inconsistent nature of the trash and a stream that flows through the site and saturates the trash [28].

Another problematic aspect of these projects in Mexico is the question of regulatory additionality. Regulation 083 provides comprehensive guidance for the collection, utilization, and flaring of landfill gas. Given the existence of this regulation, any landfill gas capture project in the country would not be additional. However, this regulation is systematically not followed because it is a part of a Federal Law and municipalities handle local municipal waste. Also, it is routinely not enforced [29]. Social problems can also complicate these projects as bands of people who live in the dumps and gather materials to sell or recycle protest these projects as they would take away their livelihoods.

9. Conclusion

Given the questionable impact of future regulation, technical difficulties, and communication barriers, the future of methane capture for hog farms in Mexico is uncertain. The presence of large hog farms with one owner has contributed to the success of these projects thus far, but Mexico's portfolio of projects may be diversified significantly to include other types of CDM projects in the coming years as the challenges of these projects become better known. Or, the period of digester trial-and-error may be less onerous than expected and push development in new areas of industry like slaughterhouses, dairy farms, coffee farms, palm oil plantations, and landfills. Of these fledging industries, landfills seem to be the most promising in terms of CER generation potential and investor interest. However, experience from landfill gas capture projects throughout the region suggests that these projects may be as different to operate as hog farm gas capture as a different set of technical, regulatory, and social problems plague them.

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