

### 5.2.5 Replication Potential

There exist some 360,000 MW of potentially suitable hydro plants in high-solar insolation regions of developing countries that could benefit from such conjunctive operations with additional PV power plants. In the Philippines alone, there exist close to 3,000 MW of already installed hydro capacity with limited water supplies that could benefit directly from such joint operations.

The size of the potential markets is such that PV manufacturing facilities would have to be increased by several orders of magnitude to serve them. This, in turn, would help to reduce the costs<sup>19</sup> of PV to levels that would make them more cost-competitive with alternative thermal power generation technologies. These cost reductions would also benefit the ongoing, PV-based off-grid electrification programs in the Philippines as well as the many already identified smaller hydro sites that have limited water storage capabilities.

### 5.3 BIOGAS POWER GENERATION<sup>20</sup>

The recovery of methane from industrial waste streams has advanced significantly in the last few years. There is now a better understanding of the parameters that will maintain and propagate the bacteria/micro-organisms that break down organic matter from within these waste streams and transform them into "biogas" suitable for fuel. The Philippine Bio-Sciences and Engineering Co., Ltd. ("PhilBIO") brings new developments in anaerobic digestion ("AD") to the Philippines.

AD is the primary technology used for waste management by PhilBIO. The biological treatment is a three stage bacteria process that converts the harmful bacteria such as e-coli into readily available molecules to convert into methane gas. The primary element in the system is

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<sup>19</sup>The current average cost of a mid-sized PV installation per installed kW<sub>peak</sub> is \$6,900, exclusive of storage or back-up costs. This compares to between \$400 to \$2,000 for alternative, conventional generation sources (thermal or hydro). In terms of average lifetime costs, delivered per kWh costs from conventional sources amount to between \$0.05 and \$0.14, while those from PV range between \$0.30 to \$0.38 in high insolation areas (2,000 to 2,500 kWh/m<sup>2</sup>/year). In addition, solar energy is available only during (sunny) daylight periods, and in variable amounts. If short-term storage has to be added to the PV system to meet system peak load demand, the cost for PV increases to between \$0.42 to \$0.55 per kWh. (Data based on Dennis Anderson, "The Economics of Photo-Voltaic Technologies", draft, October 1998.) Recent projections indicate that PV systems costs may fall within the next few years to around \$3,000/kW<sub>peak</sub> or less. This would reduce per kWh costs in high insolation areas to between \$0.15 to \$0.18, excluding supplemental storage. (According to US DOE's PVMaT program.)

<sup>20</sup>Project information comes directly from West Stewart, PhilBIO's managing director.



hydrogen, combined with nitrogen and carbon. Anaerobic bacteria are those that live in the absence of oxygen.

### 5.3.1 Application in the Livestock Industry

The livestock industry is the first market for PhilBIO's AD technology and services. Other markets include the food and beverage industries and local governments for their solid wastes.

It is well known in the farming community that pig waste is filled with harmful germs that cause infectious disease. The biological oxygen demand ("BOD") and the chemical oxygen demand ("COD") are usually on the order of five or six times that of other livestock operations. In the case of one farm (not Rocky Farms) in the area, the COD level is more than 30,000 ppm.

Anaerobic digestion can be used to support the following environmental benefits:

1. BOD and COD levels can be decreased by 85 percent in the AD vessel. Aeration is still required but only to a limited extent to bring the BOD and COD to the DENR discharge standards.
2. Practically all (99.7 percent) pathogens in the waste stream are destroyed within the vessel. As Luzon has been in quarantine for more than five years, this is an important clean development element.
3. The remaining solids are cleaned and made available for use as compost, organic fertilizer or soil conditioners. If pig manure solids are simply carted off the grounds, they still contain contaminants that can affect the chemical composition of crops and vegetables grown with them. The AD process acts as a pre-treatment for the raw materials used in these nutrient rich slurries.
4. Insect population, especially flies and mosquitoes are greatly reduced in the system. After the disaster in Malaysia (where we are still unsure of what happened on the pig farms, but still more than 1 million pigs were slaughtered), it is important lesson the opportunity for insects with water or air-borne bacteria to contaminate the farms or surroundings.
5. AD controls odors. This is the single most important reason why AD is used on the farm in the US today.
6. AD is a natural biological treatment that is part of nearly every sewage treatment plant. Most wastewater treatment capitalizes off of these naturally occurring



bacteria that are usually found several meters below the surface of ponds, lakes and rivers.

### 5.3.2 Rocky Farms Prototype Project

Rocky Farms is a 14 hectare piggery with about 900 sows, farrow-to-finish. It is located on a creek that leads directly to the Laguna de Bay. The waste product is in the form of a 2 to 3 percent solids slurry. Total waste product per day is about 65 to 70 cubic meters.

The farm currently employs five aerobic lagoons. It uses the sun and elements to destroy harmful bacteria. This passive solar process takes a very long time, and is never complete. During the rainy season, the lagoons are in danger of overflowing. This happens every rainy season. The effluent is then discharged prematurely into the creeks.

The Rocky Farms Biogas Project has recently been agreed upon by Rocky Farms management and Philippine Bio-Sciences and Engineering Co., Ltd. ("PhilBIO"). The project involves: (i) the redesign of an existing wastewater lagoon to improve biogas generation and recovery; and (ii) the installation of suitable power generation equipment to offtake the gas.

The project will address the following key issues.

1. **Compliance with environmental standards.** Rocky Farms faces probable sanction from environmental and local government authorities for discharging its wastewater with high COD and BOD. The project will enable Rocky Farms to meet government standards.
2. **Reduction of energy bills.** PhilBIO guarantees a lower effective power cost than the existing power rate of the Manila Electric Company.
3. **Improvement of productivity.** Since the proposed power system is expected to be more reliable than the grid supply, disruptions in operations are reduced. The lower cost of power will also make it more viable for the farm to use electricity-intensive devices that will directly improve productivity. For example, the use of power-intensive infrared lamps in the piglet nursery significantly improves survival rate.

#### 5.3.2.1 Project Sponsors

PhilBIO is the project initiator/developer and primary contractor. The company will implement the overall biogas production system and power plant. PhilBIO bears all technical risks associated with the project.



PhilBIO is a Philippine corporation with majority equity from Silk Roads Technologies, Ltd. of the United States. PEI is PhilBIO's local partner. The company provides integrated waste-to-energy services to its clients. PhilBIO's typical scope of work includes the following:

1. Help clients access financing, including low-cost funds from various government agencies and programs, and government incentives (e.g. fiscal incentives from the Board of Investments)
2. Design and engineering of the biogas digester, installation of digester equipment and accessories
3. Construction supervision of powerhouse and installation of power plant
4. Commissioning of the digester and power plant
5. Operations and maintenance during early years
6. Training of client staff

Rocky Farms is a Philippine family-owned corporation with the farmsite located close to Laguna de Bay and company head office in Antipolo, four towns away. The company feedmill is located in its Antipolo office. Rocky Farms is an innovator in the local industry. It provides technical services to other farms and is looked upon by others as a source of new technology.

#### *5.3.2.2 Project Costs/Benefits*

The total project cost is about Php 4.2 million. Rocky Farms and PhilBIO will initially share in the capital costs as shown in Table 14. Upon successful completion of commissioning, initial operations and other conditions, Rocky Farms will pay PhilBIO an agreed amount.

The project will use the covered lagoon technology for containing the methane. This involves the installation of a flexible cover over the active lagoon instead of the traditional metal tanks and/or concrete structures implemented in other local biogas projects. PhilBIO will purchase a Ford 40 kVA generator set configured to run on the biogas output. The power plant building sit on a 200 square meter lot, have a square design, concrete pad and perimeter fence.



Table 15 : Rocky Farms Capital Costs

Cost item	Rocky Farms	PhilBIO
Personnel services	70,000	-
Maintenance and other operating expenses	120,000	-
Capital outlay	690,000	2,779,300
Engineering and design	-	550,000
Capital Cost Sharing	880,000	3,329,300
Total Cost	4,209,300	

Source: PhilBIO financial summary

The project cash flow is presented in Table 16. The simple payback period is computed to be 3.5 years. This calculation does not yet account for the significant benefits of increased productivity that comes from the use of more energy-intensive devices such as infrared lamps for the nursery.

Table 16 : Rocky Farms Project Cash Flow

Item	Year 1	Year 2	Year 3	Year 4
Project Pre-operating Costs				
BIORactor	(1,153,800)	-	-	-
Generator set	(745,500)	-	-	-
Engineering & Proj. Mgmt.	(930,000)	-	-	-
Shipping & Contingency	(500,000)	-	-	-
Labor	(70,000)	-	-	-
Equipment Rental	(120,000)	-	-	-
Construction Work	(90,000)	-	-	-
Powerhouse and Lot	(600,000)	-	-	-
Sub-total	(4,209,300)	-	-	-
Maintenance Cost	(100,000)	(150,000)	(150,000)	(150,000)
Project Benefits				
Avoided Electric Power	700,000	1,058,400	1,164,200	1,280,600
Environmental Compliance	182,500	365,000	365,000	365,000
Sub-total	882,500	1,423,400	1,529,200	1,645,600
Annual Cash Flow	(3,426,800)	1,273,400	1,379,200	1,495,600
Cumulative Cash Flow	(2,546,800)	(2,153,400)	(774,200)	721,400

Source: PhilBIO financial summary



### 5.3.2.3 GHG Mitigation

PhilBIO's design engineer estimates a daily methane production of 13,700 cubic feet or over 5 million cubic feet annually. Assuming all methane is captured and burned in the power plant, each pound of methane is equal to 21 pounds of CO<sub>2</sub>. At a density of 23.6 cubic feet per pound of methane, annual methane production is

$$5,000,000 \div 23.6 = 212,000 \text{ pounds or } 106 \text{ tons}$$

$$\text{CO}_2 \text{ equivalent} = 106 \times 21 = 2,226 \text{ tons of CO}_2 \text{ or } 2,018 \text{ MT of CO}_2 \text{ per year}$$

There is a view that anaerobic digestion does not avoid methane because methane is only produced if the process is employed. However, without the AD process, the facility will not be able to meet the government's environmental standards.

Aside from cleaning the waste stream, the power generation from the biogas will effectively displace grid electricity purchases. The estimated annual generation is about 0.25 GWh. Assuming that the avoided generation will come from a gas turbine burning oil distillate, the project will displace 0.23 MT of CO<sub>2</sub>.

### 5.3.3 Other PhilBIO markets

The Philippines food and beverage industries cover a wide range of operations, from sugar manufacturing to meat processing. All of these industries face environmental challenges stemming from their wastewater/effluent discharges. These industries, many of which are located along the Pasig River cutting across Metro Manila, have been alleged to be among the largest polluters of the river.

The conventional method for addressing the need to clean up the wastewater discharge is to use energy-intensive treatment plants. PhilBIO can apply another configuration of its AD technology to address the same need while also providing a fuel source for power generation and/or process heat.

### 5.3.4 Barriers Hurdled

The Rocky Farms project will be the prototype for PhilBIO's operation in the Philippines. It is expected to be the showcase project for medium-size farms. The Philippine market is very conservative market where majority of the participants wait for the application of new systems by the technology leaders. A successful implementation is expected to encourage others to follow suit or else their competitor will gain a substantial cost advantage.



The project will not only showcase technology but also the concept of the energy service company ("ESCO"). The World Bank and other multilateral and bilateral agencies have long championed this mechanism for delivering essential services. ESCOs are not focused on merely delivering kilowatt-hours like electric utilities. They provide the whole gamut of services that address specific client issues. In the case of Rocky Farms, PhilBIO provides a total package (technical and financial) that addresses environmental compliance, energy cost and productivity.

### 5.3.5 Replication Potential

There are hundreds of pig and poultry operations in Rizal province, many of them of the same size or larger than Rocky Farms. The Rizal Hog Farmers Association is a prominent local cooperative with members such as Foremost, Monterey, PureFoods<sup>21</sup> and in the past, Maya Farms<sup>22</sup>. Many influential people and corporations own livestock operations in this province. Therefore, the potential benefits of the Rocky Farms beta project are considerable to the eco-efficiency of the province.

There is even a larger potential in other food and beverage industries. PhilBIO's pipeline includes working with sugar companies, particularly those with alcohol distilleries. Fish canning operations have also gained a reputation for having very high BOD and COD in their waste streams, not to mention the problems with odor and insects.

## 5.4 BIOMASS POWER GENERATION<sup>23</sup>

Corfarm Grains, Inc. ("Corfarm") is a corporation engaged in paddy procurement, rice milling and marketing. Corfarm's existing field operations are located in three sites: paddy buying in Pangasinan and Isabela, milling in Pangasinan and packing and distribution in Bulacan. Its present milling capacity is about 10 metric tons (MT) of rice per hour. Corfarm is the only large rice mill that is registered as a corporate entity and is operated by professional managers. All other large rice mills are family-owned and operated enterprises.

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<sup>21</sup>The largest conglomerates in the country are active in the sector. Business tycoon Lucio Tan owns Foremost Farms, San Miguel Corporation owns Monterey while the Ayala Corporation owns Purefoods.

<sup>22</sup>Maya Farms in the 1980s became self-sufficient in electric power requirement through biogas production from its waste stream.

<sup>23</sup>The information on this project is based on, among others, a feasibility study done by the EDUFI in 1995. EDUFI is a foundation registered as a non-profit, non-stock corporation under Philippine laws. EDUFI specializes in energy policy advocacy.