

REMOVING BARRIERS TO GREENHOUSE GAS MITIGATION IN MEDIUM-SCALE AGRICULTURAL LIVESTOCK ACTIVITIES IN MEXICO

PROJECT'S AIM: TO DEMONSTRATE THE USE OF CONVERTED GASOLINE MOTORS FOR GENERATING MECHANICAL AND ELECTRICAL ENERGY FROM BIOGAS IN ORDER TO IMPROVE THE PRODUCTIVITY OF MEDIUM-SCALE LIVESTOCK FARMS

Location:

States of Puebla, Tlaxcala,
Estado de Mexico and Morelos
Mexico

Technology:

Biogas
Biomass electric power

Costs:

Total: € 65,500
WISIONS financial support: € 45,000

Partners Involved:

IRRI Mexico
(www.irrimexico.org)

Duration:

06/2014 – 01/2016



Picture: IRRI Mexico

This project aimed to improve the productive use of biogas from livestock waste in small and medium farms in central Mexico by demonstrating various applications of biogas and adapting off-the-shelf electric motors to run on biogas. It was implemented by IRRI Mexico (Instituto Internacional de Recursos Renovables AC), with support from technicians from IRRI's spinoff organisation, Sistema Biobolsa. The Biobolsa (Biobag, in Spanish) is a modular biodigester system designed to be affordable, durable and easy to install and operate.

The industrial-scale and domestic biogas sectors are currently growing in Mexico; however, the use of biogas by small farmers in the agricultural sector is still limited. One key barrier to the use of biogas for productive activities is the lack of suitable small biogas motors on the Latin American market. To address this, the Sistema Biobolsa team developed and tested a range of small-scale gasoline motors

capable of running on biogas, which this project demonstrated in the field.

TECHNOLOGY, OPERATIONS & MAINTENANCE

The project comprised two main phases. In the first phase, four Biobolsa biodigesters, waste treatment systems and biogas use systems were installed at four medium-scale livestock farms (two pig farms and two dairy farms). During the design phase, baseline data was collected on the volumes of livestock and waste production at each farm, as well as on energy use and opportunities for reusing nutrients as fertiliser. The biogas now being produced on these farms is used for space heating for pig maternity areas, for heating water for cleaning purposes, and as gas for cooking.

In the second phase, the project adapted 20 small (5-10 kW) commercial gasoline motors available on the Mexican market so the small and medium farmers could

produce mechanical and/or electric power from biogas. Of these motors, 16 were installed in existing small biogas plants and 4 in new medium-sized demonstration plants, totalling 152 kW of new capacity. In this phase, there were five significant areas of R&D: biogas filtration, matching energy production and use, motor sizing and design, grid interconnection, and training and maintenance.

The motors are used for powering milking parlour pumps, pumping water and fertiliser, powering small grain and animal feed mills and for meeting other electricity needs on the farm premises. One of the participating farms received approval from the grid authority to connect its 13.5 kW biogas motor to the grid. This allows for the maximisation of the production of biogas-generated electricity as the farm is not limited to using the motor to power the farm's loads.

The installed motors are currently being monitored for a period of 12 months



following the end of the project implementation, with the aim of collecting data for further technical improvements to the components; for example, increasing the methane concentration in the biodigesters through improved filters. Moreover, the monitoring regime aims to build clear projections for the costs and benefits of the system under a range of different conditions and uses.

The overall potential of the biogas motors to provide renewable electricity based on the biogas production capacity of the farms in the project is 675 kWh per day and 246 MWh per year.

DELIVERY MODEL & FINANCIAL MANAGEMENT

WISONS funding provided an economic incentive to the farmers at demonstration sites, while co-funding came from the crowd-sourcing KIVA loan platform. The farmers must pay back the loans provided via the KIVA platform.

Operating data from the systems installed as part of the project show a high level of energy recovery and technical viability. It is estimated that the return on investment period for these systems is less than three years, based on the value of the energy and fertiliser produced per year. Preliminary analysis showed that the farmers are motivated by the financial savings made from biogas use in different ways, depending on what the biogas replaces. Those with access to grid electricity prefer to use their biogas for thermal uses. Farmers who run gasoline powered motors for their productive uses see a higher value in replacing the gasoline with biogas.

ENVIRONMENTAL ISSUES

The main benefit of the project arose from replacing fossil fuel generated power (LPG, grid electricity and gasoline motors) by biogas generated electricity. However, there was also an emphasis on the pollution mitigation aspects of the technology. Some of the systems installed included water treatment systems for demonstrating the options available for treating the effluents from the biodigesters. A three-part model

was tested, with a sedimentation phase, subsurface wetland phase and a surface lagoon with aquatic plants. Tests showed that this system enabled farms to meet national water quality discharge standards.

SOCIAL ISSUES

During the project it was observed that although the farm managers appreciate the economic benefits arising from the fuel savings, the staff in charge of operating the motors do not always perceive this benefit. Comprehensive training and the implementation of procedures are required to better integrate the use of the motors into the daily farm routines.

In addition to demonstrating the technology to farmers, this project sought to develop technical capacity with local motor distributors to convert, install, service and maintain these small biogas motors. The project used a variety of motor brands, including those that guaranteed the best quality and service in Mexico.

RESULTS & IMPACT

The project led to significant advances in the application of biogas for small-scale electric power generation (between 5 and 10 kW) and has opened the door to the further development of the technology. In particular, developing a low-cost, simple filter for the biogas proved to be a central challenge. In order to produce electricity from biogas, proper filtration of the gas before it enters the motor is critical. Based on previous research by Biobolsa, the design of the filter was optimised in a number of ways, including the biogas flow through the filter, pressure losses, operational life and increased energy density of the biogas. The research also considered the economics and practicalities of different filter materials in the disposal, recycling and regeneration phases. In addition to investigating currently available filter materials, the study investigated an innovative iron oxide-based product with promising characteristics as a potential alternative.

A further key innovation was the development of low-cost adaptors for

receiving low-pressure gas from Sistema Biobolsa digesters and drawing the gas into the motor at the required rate.

REPLICABILITY

This project is part of a wider effort by IRRI to increase biogas use in rural communities and in small and medium-scale farms in Mexico. Awareness-raising activities and practical demonstrations run by IRRI are coordinated in order to maximise the impact, and IRRI participates in knowledge exchange networks in the region and abroad. This particular business model, where access to credit is available and economic benefits are achieved in a relatively short time frame, has a high potential for replication in the region.

LESSONS LEARNED

A number of barriers to the adoption of the adapted motors were observed. For example, some farmers saw the biogas generator as a back up option for times without grid electricity. In some cases, it was found that farmers who were already using biodigesters prior to the installation of the biogas electric motors were accustomed to having access to the thermal energy and did not always administer the gas properly in order to have some excess for producing electricity. Matching energy production and energy demand was a further challenge. Improved load profiles for the farms are needed in order to identify the peak periods when power is required for milking, pumping and other uses.

Source: Final Report submitted to WISONS by IRRI Mexico in January 2016

