BIODIGESTER DEMONSTRATION UNITS FOR SMALL ANIMAL FARMS

PROJECT’S AIM: TO INTRODUCE BIOGAS TECHNOLOGY IN DAIRY FARMS FOR IMPROVING WASTE MANAGEMENT AND AS AN ENERGY SOURCE

**Location:**
Mafrag and Zarqa governorates
Jordan

**Technology:**
Biomass Electric Power

**Energy-related need:**
Heating, Electricity

**Costs:**
Total: €42,000
WISIONS financial support: €42,000

**CO₂ Reduction:**
25,000-30,000kg CO₂/year

**Partners Involved:**
National Energy Research Center (NERC)

**Duration:**
04/2008-05/2010

Prior to this project, biological cow manure treatment was not considered as an option by rural farms in Jordan. The majority of organic animal waste is disposed of in municipal landfills or discarded casually in the surrounding communities. Only 14% of the organic waste produced by dairy farms in Jordan is partially composted. This project established Biogas Demonstrations Units (BDUs) in three dairy farms in the Mafrag and Zarqa governorates and has compared the three different designs based on their total cost, durability and overall performance. The specific objective of this project was to achieve a final design for a suitable and reliable digester that was economic and affordable and could be marketed and replicated for use in other projects.

TECHNOLOGY, OPERATIONS AND MAINTENANCE

The three tested BDUs were made of different materials. The first BDU was an 8m³ underground-insulated PVC digester; the second BDU was a 6m³ polyethylene tube digester (PETD) and the third BDU was a 20m³ underground concrete insulated digester. The bottoms and walls of the digesters were primarily thermally insulated with rock wool 3cm in depth. The design purposely enabled the digested slurry to overflow from the underground digester and this could be stored in the upper digestate bond. The biogas generators were imported from China and were slightly modified Natural Gas (NG) generators.

The three BDUs were tested and the underground design was chosen as the most reliable as it provided the most trouble-free operation. This type of design minimizes the pumping system due to the substrate gravity flow. In a first pretreatment stage the manure is mixed manually with water (ratio 1:3) to facilitate the biological treatment. A second advantage of this design is the ease of removing the digested slurry due to the overflow’s design. Furthermore, this trouble-free design enables the mixture of the highly nitrogen-enriched cow manure with vegetable matter in order to achieve a suitable C/N value. Another innovative technical solution was the harnessing of the heat energy from waste hot water from milking machines. The hot water feeds the heating coil inside the digester, contributing to a better energy balance.

FINANCIAL ISSUES AND MANAGEMENT

One main objective of the project was to optimize the overall cost of each BDU in order to make them affordable for the farmers. The use of an underground design also cut the cost (e.g. by eliminating the feeding pump). Reasonable prices were achieved: the cost of a 20 m³ digester for a farm of 20 cows and with a daily output of 500l of biofertilizer is 2000 JOD (around €2,100, including the installer’s fee). A more affordable option for low-income farmers is the PETD, which costs less than...
500 JOD (€530). The biogas generated completely replaces the use of LPG (for heating water for milking machines and households) and kerosene (for heating during the winter) and, therefore, translates into significant cost savings amounting to around 700 JOD (£740) per year. Consequently, the cost for energy on the farms was reduced by about 20%.

ENVIRONMENTAL ISSUES

The harmful environmental pollution produced by organic waste on dairy farms that causes bad odours, infestations of insects and GHG emissions was also reduced due to the biological treatment of cow manure. The biogas meets the energy needs of the dairy farms by providing electricity, hot water and cooking gas. The digested slurry can be used as biofertilizer, which contributes to increased agricultural productivity. The question of resource use in relation to the PET material and its short lifetime has not been tackled, but this is an issue that would need to be considered in a life-cycle analysis.

SOCIAL ISSUES

The project focused on the technical aspects of the biogas digesters and had no specific community-driven approach. However, the project has had social effects; it raised awareness of biogas in the local communities and provided training opportunities for local people. Public health and the standards of living on dairy farms were improved.

RESULTS & IMPACT

The three BDUs were easy to install, operate and adapt to the small dairy farms and remained cost-effective. The PETD was the cheapest and was the easiest and quickest to install. However the lifetime of the PETD is only one year and, therefore, a new one would have to be installed every year. Replacing PET with an alternative material such as leather would increase the lifetime (to around 10 years) but would also double the costs. On balance, the use of leather might be a good long-term alternative for low-income farmers as the initial cost would be higher but the ongoing maintenance costs would be less.

The project has also provided capacity building in the design, installation, operation and maintenance of biogas digesters and has demonstrated biogas thermal applications for small farmers in Jordan. NERC conducted surveys about organic waste production in all the governorates of Jordan and identified the possible BDU beneficiaries for the future. Due to these positive experiences in the applications of biogas, combined with the subsequent enforcement of environmental regulations regarding the biological treatment of organic waste, the MED-EMIP program has sent a biogas expert to Jordan to manage the Jordan Biogas Master Plan.

REPLICABILITY

Based on the experience gained and lessons learned from the project, it is reasonable to conclude that there is good potential for replication in dairy and poultry farms. NERC and the Ministry of Planning and International Cooperation (MoPIC) are committed to establishing a nationwide biogas development plan through a first pilot plant, which could be used for replication in other sites across the country. Since the completion of the project, other activities related to the installation of new biogas plants have been initiated by NERC and other organizations in Jordan, meaning that this project could be regarded as forerunner of biogas development in Jordan. A positive development can also be seen in the introduction of fees in tariffs in Jordan for renewable energy technologies, including electricity from biogas.

LESSONS LEARNED

Some important facts regarding the adaptive application and operation of biogas technologies in dairy farms have been learned. The biogas leakage can be easily checked by distributing liquid soap uniformly on the digester cover and in the pipefittings. If there are leakage points small bubbles will start to appear. The best material found on the market to fix the holes was fiberglass mixed with resin. NERC also discovered that the biogas generators imported from China were simply modified NG generators; to adapt this technology a piece of metal can be added that reduces the cross sectional area of the throat. As NG generators are available on the local market in different sizes this opens up the possibility of installing large biogas plants in Jordan by simply modifying NG generators. When burning the biogas direct (e.g. for cooking) certain small modifications should be made when using equipment designed for use with LPG. Since the air to flow ratio in biogas is much lower than LPG, the nozzle diameter should be increased from 1 mm (for LPG use) to 4 mm (for biogas use).

The main use of the biogas was not to generate electricity. As most farms in Jordan are connected to the grid, they preferred to use the biogas for cooking and for heating water and buildings. It was very important to train the farms properly in the installation of the digester reservoir (e.g. the need to level the ground to maintain level horizontal lines between the input and the output of the digester). However, due to new legislation, in future electricity generated from biogas plants can be fed into the grid.

Source: Final Report submitted to WISIONS by NERC (5/2010)

Picture: NERC