USAID-DRDF Dairy Project Biogas Plant

Background:

Punjab still has over 7,000 villages that are not connected to the national electricity grid. Traditional fuels like firewood, dung and crop residues currently contribute a major share in meeting the everyday energy requirements of rural and low income urban households in Pakistan. According to the World Energy Outlook 2014, 62% of the population (112 million people) in Pakistan still relies on traditional use of biomass. In Pakistan, 90% of rural population and 50% of urban population uses firewood as their primary energy source. A village woman normally spends two hours a day making dung-cakes or collecting fire-wood.

Young children are often carried by mothers or kept in the kitchen area during cooking exposing them to high levels of smoke. Women do most of the cooking and spend more time in-doors, they are exposed to pollutants and have shown adverse health impacts.

The Challenge and the Opportunity:

Punjab as a province is deficient in energy resources unlike KP, Balochistan and Sindh who have large mineral oil, gas or Hydro resources. Punjab has to explore technology advancements that can use its traditional biomass in more efficient and environmental friendly way for meeting energy needs of its rural population not connected to grid or gas supply network. The level of research on biogas technology in making it affordable and adapt to local conditions is still missing. In sum, knowledge about energy efficient biofuel based plant designs, equipment and technology is missing and not piloted at an adequate scale hence a workable and affordable model is still missing. Most importantly, to scale up investment in clean energy, innovative business models have not been tried nor are right incentives in place for promoting private sector market development.

The biomass based renewable energy potential is estimated as 5,600 MW\(^1\). Punjab has 33 million acre of cultivated land where all type of crops are grown. According to conservative estimates, 43 M tons of agriculture waste from cotton, wheat, rice and corn is produced every year. Excluding local consumption, net available resource potential of these four crops for biomass power generation is about 10.942 million tons.

There are 32 million animals (Buffaloes, Cows Bullocks) in Punjab. Average daily dung of these animals at 15 Kg/animal comes out to be 480 million Kgs. Assuming a 50% collection rate at 0.05 cubic meters per Kg, 24 million cubic meters methane can be produced daily. This will help in providing less costly off grid solution to energy shortages with a potential of meeting domestic energy needs of 60% of the rural population and also to produce huge quantity of bio-fertilizer

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\(^1\) Punjab Investment Opportunities and MIT Technology Review
USAID – DRDF Initiative

USAID through its Dairy Project decided to first pilot the biogas production technology at two different scales with a purpose of creating a commercially viable business model for gas production that can be supplied to nearby community on cost recovery plus profit model. The project helped a small community of dairy farmers in 569 EB, Tehsil Burewala District Vehari to build a 50 cubic meter biogas plant using fixed dome technology. The gas produced from this plant was sufficient to run a 7.5 KVA generator connected to 500 liter chilled milk storage. The model worked well, as this community of farmer managed to save on average Rs.18,000 ($180) on generator’s monthly running cost. The chilled milk also attracted additional Rs.2 (2 cent) per liter in selling price or income. The overall saving and better price fetched additional income of Rs. 29,000 ($290) to the chiller operation without relying on grid electricity up to six hours a day. The bio slurry of the plant was rotated among community farmers and each one of them reported 50% increase in their farm production.

The results of this pilot were very encouraging, and USAID – DRDF Dairy Project in partnership with the Punjab Livestock and Dairy Development Department (L&DD) decided to build the first commercial grade 375 cubic meter biogas plant at Bahadarnagar Farm, Okara. This plant is designed to supply cooking gas to 150 households living on the farm. In preparation for this biogas plant, the project took a group of 18 dairy professionals including three officers from the Dairy and Livestock Department Punjab. They visited during the trip four fixed structure plug-flow digesters built by DVO Inc. USA. The largest of them was producing 1MW methane using dung produced by 750 cows at the farm. The exposure visit created an enthusiasm among the project and dairy department’s staff to pilot one on those lines and workout the economics for wide scale ramping up.

The project started designing a biogas plant and engaged Winrock Inc. USA, who were working in Pakistan at that time. Latching on their deep understanding of biofuel plants construction and USAID grant to Winrock Inc.; technical assistance to local partners free of cost. The project and Winrock Inc. also worked on indigenizing the technology and NESPAK Pakistan engineering reviewed the civil structure and local contractor built the structure, using local materials. All designs and drawings and technical details are available on the project website www.dairyproject.org.pk and can be accessed free of cost.

Partner with the Dairy and Livestock Department Punjab:

In partnership with the Dairy and Livestock Department, the project designed 375 cubic meters Biogas plant on the contemporary plug-flow technology with a target efficiency of 60%. The plant used Winrock Inc. design, and greatly benefited from their experience in Pakistan. In
order to improve technical viability of the plant, four fixed dome digesters are built; 3 digesters of 100 cubic meters each and one digester of 75 cubic meters. The digesters are capable of producing methane content up to 60%, if temperature is maintained around 37 degree Celsius. This design keeps a cushion for future expansion. The expected biogas generation capacity for this plant is 150 cubic meters per day which is enough for generating 242 KWh of electricity per day or can fulfill the needs of 165 households for cooking every day.

**Salient Features**

- Total Cost Rs. 5,170,000 ($49,700)
- Capacity of Plant: 375 Cubic Meters
- Technology Used: Fixed Dome, Plug-flow
- Daily Production of Gas: 150 to 225 Cubic Meter/Day (40 to 60% Efficiency)
- Dung Required Daily= 3.5 Tons
- Slurry Production Daily = 1,500 - 2,000 Liters
- Dung required for Initial Feeding :120 Tons
- Method used for leakage proof: 5 layers treatment of Cement and Acrylic Chemical
- Weather Conditions Control: gas from small dome is used in Geyser to provide warm water in Mixer to maintain digester’s temperature during winter. Insulation by Polymeric Foam.

**Assumption for Calculations in Biogas Plant:**

Dung produced from cattle = 10 -12 kg/day
Generation capacity of a unit size biogas plant = 0.4 m3
Biogas production from 1kg of fresh dung = 0.04 m3
Heating Value of Biogas =20 MJ/ m3.
Conversion Factor 1 KWh = 3.6 MJ

**Input Requirements vs. Output Expectations:**

**Input Requirements:**

Total Manure required for 375 m³ = 1000 x 3 + 750
=3750 Kg /day

**Expected Output:**

Total gas production = 150m³/day
Energy Production from Plant = 64.44 x 3 + 48.33
= 241.65 KWh/day.
Electricity generation potential = 240 unit/day.

**Calculation for general household cooking needs:**

150 m$^3$ of methane has a potential to keep 5cm gas burner burning for 27.5 days continuously. The average household needs 4 hours of gas supply to fulfill its daily cooking needs. The gas produced through this plant will be enough to fulfill the needs of 165 households every day.

**Use of Bio-Surry:**

The percentage of NPK (Nitrogen, Phosphorus, potassium) content of slurry on wet basis is 0.25, 0.13, 0.12, in addition to other nutrients such as Zinc, Iron, Manganese & Copper. The slurry produced has better nutrient value and various case studies have shown that use of bio slurry in vegetable farming increases yield by 20 percent and reduce pest attacks.

**Schedule:**

The biogas construction began on June 22, 2016 with the marking layout process and completed on November 28, 2016. All four domes are producing gas, and 2.5 PSI gas pressure is maintained – demonstrating the success of the design.

**Inauguration of Biogas Plant**

Based on successful completion of left-over work, inauguration ceremony of the biogas plant is planned on December 5, 2016.

**Biogas Video Module:**

The Dairy Project is producing video training documentary, which gives a detailed walkthrough to the audience taking them through each step of the biogas construction and explains its significance. The video will serve as a useful resource for future biogas projects, investors and rural communities seeking to establish similar biogas plants.