3.4 Case Study #3: Waste from agro-business for biogas production from captive and grid – power biogas from vegetable residues and maize stalks in Kenya

Biogas plant in Naivasha, Kenya. (Source: Vegpro)

3.4.1 Project background

This grid-connected biogas-based plant has an installed capacity of 2.4 MW_{el}. It is a good example of agricultural waste turned into electricity to tackle the unreliability of the local grid and the high cost of electricity produced by diesel gensets. The plant supplies power to the host factory for its cold storage and vegetable packing. Excess power is exported to the grid. The feedstock consists of maize stalks and pea waste.

Vegpro (VP) Group is a large vegetable producer and exporter, mainly to the European market. Together with Tropical Power as an operator and Snow Leopard Projects GmbH as an engineering and technology provider, the project was completed within two years. The 2.4 MW biogas plant is located in Naivasha, Kenya[11].

Since the beginning of its operation in 2015, the plant has continuously processed agricultural residues from vegetable production. The main objective of VP was to become independent from the grid's frequent fluctuations, which led to problems and regular repair needs for their electrical motors. The grid is now just providing back-up power.

3.4.2 Technical details

The plant is a two-stage biogas plant with hydrolysis as pre-treatment before the digester. This technology is ideal for fibrous feedstock such as maize straw as it provides higher yields and a better controlled biogas production process, compared with a single biological-stage biogas plant. The plant has two hydrolysis tanks of 759 m³ each, a 5,652 m³ digester and a small digestate storage (759 m³). The digester is equipped with a biogas storage on top. The plant is fully automatic with a state-of-the-art control system, which can be accessed remotely.

The digestate is separated into a liquid and a solid phase. Some of the liquid phase is recycled back to inoculate the new feedstock in the hydrolysis. The remaining digestate is used as bio-fertilizer in the vegetable fields, substituting for the usual chemical fertilizer.

The daily feedstock input is about 150 tonnes. Its amount and composition vary according to the availability of vegetable waste. The daily tonnages may vary depending on the dry matter content of the available feedstock.

3.4.3 Economics & finance

The investment for this plant was USD 6.5 million; 100% equity was provided by the local investors, which sped up the project implementation. The feedstock is provided for free from VP, who get the fertilizer back in return. The payback period is just under six years.

3.4.4 Lessons learned

The renewable electricity produced by the biogas plant replaces an estimated amount of six million liters of diesel fuel previously used by VP to run gensets in the absence of grid electricity. Besides the cost savings, greenhouse gas emissions are saved as no fossil fuel is combusted anymore.

Bio-fertilizer from the biogas plants replaces the chemical fertilizer that was previously used. Although the residues usually stay in the fields, by treating the residues in the biogas plant, the fertilization effect is much higher for the soil than leaving the waste untreated in the field.

One of the main success factors was the commitment of all parties from the conceptualization of the project to its commissioning in spite of numerous challenges, such as a lengthy process to secure a Power Purchase Agreement (PPA) and the construction itself. As the partners were committed to building a plant with high quality and industrial standards, the identification of experienced and qualified contractors and suppliers proved difficult. The project team eventually managed to complete the construction within 12 months, despite the size of the plant and its remote location. It was essential for the local operating personnel to be trained properly in order to ensure a stable performance of the plant after commissioning.

The following conclusions can be drawn from the project:

1. a mixture of agricultural residues and by-products can be good raw material for biogas production;
2. the digestate from a biogas plant is a better ferti lizer than the raw waste;.
3. industrial size and quality biogas plants are viable in Africa;
4. trained and qualified operating personnel is key to the continuous performance of a plant.

3.5 Biogas and the Sustainable Development Goals

The treatment of wastewater or liquid/solid waste from cattle or food industries helps to reduce pollution of lakes, rivers and waterways (SDG 6 & 14). It is a clean and often cheap fuel to produce, making it very affordable (SDG 7). When integrated into agro-industries, biogas plants help solve waste management problems while covering factories' energy needs. This is a good example of inclusive and sustainable industrialization (SDG 9). Biogas production is also applicable to communities, helping manage waste, reduce pollution, build resilience and generate energy and revenues (SDG 11). The use of biogas at industrial or domestic levels and of fertilizers in agriculture are good examples of sustainable circular economy (SDG 12). Biogas production has a strong impact on the mitigation of GHG: it prevents the uncontrolled degradation of wastes and the subsequent release of highly damaging methane into the atmosphere. It also substitutes the use of fossil fuels (SDG 13) and of wood and charcoal, preserving forests and biodiversity (SDG 15).

Biogas projects implemented in off-grid areas bring in energy that can stimulate new income-generating activities (SDG 8), reduce poverty (SDG 1), and improve women's lives (SDG 5). The fertilizer produced from the biogas plant can be used to enhance the soil condition (especially together with biochar). Through this, better crop yields can be achieved (SDG 2). Food security, water sanitation and job creation contribute to better health conditions and well-being (SDG 3). The implementation of the most recent biogas systems in industry and collaboration with academic institutions allow the training of young technicians and engineers who can then participate in the design and in the operation of other plants and stimulate the replication of the technology (SDG 4). It can lead to specialized jobs and enhance economic growth (SDG 8), especially in rural areas, thus helping reduce inequalities between rural and urban areas (SDG 10).

All the above is summed up in Table 3.