



**MINISTRY OF ENERGY AND PETROLEUM
RENEWABLE ENERGY DIRECTORATE**

To: Principal, CAVS

From: John K. Maina, Project Manager

Subject: Progress report for the biogas project at CAVS

Date: 23rd June 2015

The above refereed project started in earnest on Friday 13th March, 2015 after a colorful ceremony to hand over the site to the contracting firm, Pharma Consulting Engineers, witnessed by the CAVS and Ministry of Energy and Petroleum officials. The contract was signed between the Ministry and the Contracting firm on 5th March 2015. The contract sum is KES 7.5 million and construction will take 20 weeks and an additional 8 weeks of system testing.

The work has progressed well with the following accomplished to date.

1. Digester and expansion chamber construction completed
2. Gas pipe line of 1.3 km in length excavated, laid and backfilled to the right compaction.
3. Seven water condensation traps put in place to collect vapour that would otherwise impede gas flow to the kitchen.
4. Channel to direct cow dung to mixing chamber for ease of collection and channel to direct bio-slurry to the nearby farm.
5. Biogas bag , compressor, desulfurizer, 4- 50 litre cook stoves and two gas meters procured in readiness for installation once gas build up is witnessed and possible leakages eliminated completely.
6. Biogas bag enclosure completed, though anticipated to provide a shelter

Remaining works

- i). Provision of a shelter at the biogas enclosure to secure the gas bag, desulfurizer and the compressor.
- ii). Fittings from the gas bag to the kitchen and mounting of the cook stoves.
- iii). Checking the system for gas leakages until a steady flow is achieved up to the kitchen.
- iv). Mounting the gas meters to monitor gas production and consumption at the same time.
- v). Testing and maintaining the system up to the end of the contract on 5th August , 2015 and an additional two months thereafter. *The college should take advantage of this period to induct two persons who would be maintaining the system and collection of data after the closure of the project.*

I wish to reiterate the need for the College Management to be at the forefront in ensuring that the project becomes successful by meeting the obligations earlier communicated, with regard to water, dung and the fodder for the livestock.

Attached find the detailed comments during the various supervisory visits.

John K. Maina

Project Manager

A) Inception visit for the proposed biogas project at the College of Agriculture and Veterinary Sciences, Kabete

Participating team

1. Prof. Agnes Mwangombe . Principal CAVS
2. Mr. Chweya . Faculty of Environmental Biosystems Engineering
3. Dr. Richard Nyankanga . Department of Plant Science and Crop Protection/Farm Manager
4. Mr. John K. Maina . Min of Energy & Petroleum (Renewable)
5. Mr. Gitonga J. J. . Min of Energy & Petroleum (Renewable)

Objective of the visit

Visit the proposed site, understand ground situation and discuss as a team on the way forward and possible itinerary for planned activities.

Summary of activities

Office meeting

A brief meeting was held at the Principal's office. Introductions were done and the purpose of the meeting discussed. Out of the discussion the following were agreed upon.

- a. There was need to build a biogas plant for the following reasons:
 - The biogas would provide a teaching and demo unit for green energy to students and the farmers in the surrounding regions of Nairobi and Central
 - To provide cooking gas in the college small kitchen and promote green energy
 - As an avenue of the college taking environmental responsibility to reduce the methane gas (generated by their livestock) emissions to the atmosphere
- b. There was adequate livestock whose dung can be used since the college always have 100 to 160 heads of cattle of which dung from 100 can be collected, 2000 chicken whose dung is available and if need be pigs dung was available from the college piggery.

- c. There is need to develop a design and bill of quantities a task that was to be taken up by the
- d. college and energy technical team.
- e. Tender documents to be prepared by end of June and the Ministry will procure the contractor.
- e. The CAVS and MoEP will supervise the works.



The team at the proposed digester site.

Also noted were the following



One of the college water tanks.

- ✓ The Principal pointed out that use of animal dung was the first step in her plan and in



One of the boreholes that supply water to the institution. Royal satin drinking water bottling plant is in the



CAVs Royal Satin drinking water bottling plant

future hopes to harness biogas from human waste in the college which could result in reduced cost of waste management.

- ✓ The sewer system in the college may need to be redesigned to empty at one place as currently each house is served by a septic tank.
- ✓ In the college's Kanyariri farm, which is 4km away, there is enough livestock to generate biogas possibly for electricity generation



The cattle shed to house 100 heads. A similar one is planned next to it. Insert is the inside of the shed. Note the dung gathered outside the shed.

The team visited the proposed site and two of the four boreholes in



the college. On the proposed bio

digester site is a cow shed estimated to hold a 100 heads of cattle. A similar shed

CAVS BIOGAS CONSTRUCTION

is proposed for construction at the same site and the two could serve the biogas plant. There was adequate space for the biogas plant. Water was readily available at the site and was said to be reliable. Within the college is the college owned Royal Satin drinking water bottling plant.

Conclusion

The college will work out the distance of gas piping to the kitchen along a previously identified route and provide the information in the next meeting. The team agreed on fortnightly meetings to fast track the activities. The next meeting was proposed to be on 16th April 2014.

B) Supervision visit on 10th April 2015

1.0 Background

The Ministry of Energy and Petroleum (MoEP) while in collaboration with Nairobi University College of Agriculture and Veterinary Sciences (CAVS) undertook to construct an institutional biogas plant in the Lower Kabete Campus for the purpose of



training and promotion of the technology to the students, staff and community in the environs of the college as well as others that visit the institutional to seek knowledge. The site was handed over to the contractor on the **13th of March 2015**. The purpose of the visit was to monitor the progress of works and to discuss any arising issues.

2.0 Participants

- | | | |
|---------------------|---|-------------------|
| 1. J. J. Gitonga | - | MOEP headquarters |
| 2. Dr. R. Nyankanga | - | Farm Manager CAVS |
| 3. Maina Kingori | - | Contractor |

The team visited the whole of the project components starting with the digester, the gas line, gas storage area, and the kitchen.

3.0 Observations made were as below.



3.1 Digester construction

Excavation of the digester pit was done and construction of the digester had progressed to the second ring beam. The site had been fenced off to keep the area secured off to control human and livestock entry into the construction site.

3.2 Gas pipeline

The laying of the gas pipeline was in progress concurrent with the construction of the digester. So far one kilometre had been laid with water traps yet to be fitted. The contractor had raised concern the pipeline was more than 1.1km indicated in the tender documents. This was re-measured using a GPS as was previously done and it was confirmed the distance to be **1.3kms**. Areas of concern along the gas line were

- a) A dumpsite that need be relocated to



reduce risk of fire burning the PE pipe.

- b) Sewer & drainage points. In three cases gas line was crossing the sewer and drainage paths which require the contractor to take extra care to protect the gas line by use of sleeves and or concrete.

3.3 Gas bag area

The contractor was shown the proposed location of gas bag.

3.4 Kitchen

The Kitchen officer in-charge had indicated to the contractor there was need to discuss the cookers to be installed. They proposed one conservation jiko and one similar to the conventional gas cookers they were using. It was agreed this concern would be taken up and addressed accordingly.



4.0 Issues of concern

- Water was becoming a challenge as it was not readily available on site. Priority was that the students come first for obvious reasons and therefore in some days water was not available on the construction site as reported by the contractor. While this was not a major challenge during construction it would be during the feeding of the biogas plant when water will be required for cleaning the cattle unit and mixing the substrate. The farm manager was asked to take up the issue with the college administration. The problem could also be addressed through **roof water harvesting** from the large roof area of the cattle shed. This would require guttering and storage tank(s).
- The mix chamber was noted to be small as it was not taken into account that dung would be ferried on trucks in the initial stages before the animal shed is stocked.



5.1 Way forward

- ✓ The college should put plans in place to ensure enough dung will be available at the completion of the digester. This should include stocking the cattle shed, the necessary repairs like the chaff cutter, and how dung will be collected daily from the poultry, piggery and other cattle sheds identified.

- ✓ MoEP to take into account the addition length of the gas pipeline and advise the contractor on the size of the mixing chamber.
- ✓ Contractor to continue the works in consultation with supervision team

6.0 Conclusion

The CAVS biogas plant construction was on course.

C) Supervision visit on 30th April 2015

1.0 Background

The Ministry of Energy and Petroleum (MoEP) while in collaboration with Nairobi University College of Agriculture and Veterinary Sciences (CAVS) undertook to construct an institutional biogas plant in the Lower Kabete Campus for the purpose of training and promotion of the technology to the students, staff and community in the environs of the college as well as others that visit the institutional to seek knowledge. The site was handed over to the contractor on the 13th of March 2015.

2.0 The purpose of the visit

This was routine supervision visit to monitor the progress of works and to ensure design specifications were being followed.

3.0 Participants

1. J. J. Gitonga - MOEP headquarters
2. Maina Kingori - Contractor

The site was visited and observations made as to the progress of works and consistence with the specifications.

4.0 Observations made were as below.



Digester construction at 2nd ring



Digester dome before



Digester dome after



Back filling the plastered digester

4.1 Digester construction

The digester construction had progressed with main stone works complete and walls plastered. The inner of the dome is yet to be plastered. The digester dome has been reinforced and concrete layer applied. Backfilling was in progress. The mixing chamber has been done with the inlet pipe fitted but yet to be plastered.

4.2 Gas pipeline

The laying of the gas pipeline had continued with 1.1km already laid and water traps fitted. The remaining 0.2km was yet to be done.



4.3 Gas bag area

Not started by time of reporting

4.4 Kitchen

Not done at the time of reporting

4.5 Digester feed stock

The college has started accumulation of cow dung near in the cattle shed to ensure enough dung will be available at the completion of the digester. The college has assured there will be enough dung to learn the biogas plant once completed.



5.0 Issues of concern

- Water availability on site continues to be a challenge as it was not readily available on site. Water for cattle in the shed at the biogas construction site has at times to be ferried by wheelbarrows in Jeri cans.

6.1 Way forward

- ✓ Contractor to continue the works in consultation with supervision team

7.0 Conclusion

The CAVS biogas plant construction was on course.

D) SUPERVISORY VISIT ON 16TH MAY, 2015

1.0 PARTICIPANTS

1. John K. Maina - Biogas promotion -Taking notes, MOEP
2. Julius J. Gitonga - Biogas promotion, MOEP
3. Maina Kingøri - Pharma Consulting Engineers

2.0 OBJECTIVES

1. To conduct routine supervision
2. Evaluate validity of omissions of crucial items Project Document

3.0 OBSERVATIONS

3.1 Progress of the work

It was noted that the contractor had moved fast in completing the project and over 60% had been done at the time of the visit.

3.1.1 Digester and expansion chamber

The digester was completed and was curing awaiting internal plastering, whereas the expansion chamber was almost complete.

3.1.2 Gas line

The excavation and laying of the gas pipe had been done up to the 1100 m and an extra 200m had been discovered. Back filling was also completed, but the water traps were yet to be fixed.

3.2 Additional works

The team evaluated the following additional

works: 3.2.1 **Gas line**

It was noted that the length of the gas line indicated on the contract document was 1,100 m but on measuring again it came to 1,300m. The discrepancy was suspected to have emanated from the use of an inaccurate GPS possibly due to a lack of periodic calibration.

3.2.2 Mixing chamber

This component was in the drawing but missed out in the bill of quantities. Further the size in the drawing was found inadequate considering 1,000 kg of cow dung was expected to be mixed daily.

3.2.3 Gas meter shelter

This is necessary for protection from vandalism and adverse weather conditions. **3.2.4 Road crossing**

It was noted that the culvert thought to be the easiest way to cross the road had been blocked and needed to be cleared before further work was done.

3.2.5 Gas storage area

The team noted that the compressor and the desulfurizer needed to be placed in the same storage area to ensure the purification is done before storage so that gas usage can continue even during power outages. The team therefore proposed a 5.5m x 4.5m shelter for the three components.

3.2.6 Earth drain for the bio slurry

This project being more or less a training facility, the team found need to put a 30m earth that will ensure the slurry is directed to the nearby shamba.

3.2.7 Urine/ cow dung channel

Due to the anticipated amount of the cow dung and the need to harness the urine and considering that the college was not modifying the cow shelter as expected, the team decided to have a 15 m concrete channel to drain the wash contents to the mixing chamber.

4.0 CONCLUSION

In view of the need to have the project appear a training facility there is need to consider the above additional works.

5.0 RECOMMENDATION

The project manager was asked to pursue the matter for the appropriate site instructions to be issued.

D) Supervision visit on 11th June 2015

1.0 BACKGROUND

The Ministry of Energy and Petroleum (MoEP) while in collaboration with Nairobi University College of Agriculture and Veterinary Sciences (CAVS) undertook to construct an institutional biogas plant in the Lower Kabete Campus for the purpose of training and promotion of the technology to the students, staff and community in the environs of the college as well as others that visit the institutional to seek knowledge. The site was handed over to the contractor on the **13th of March 2015**.

2.0 OBJECTIVE OF THE VISIT

Routine supervision to monitor the progress of works and to ensure compliance with the design specifications.

3.0 PARTICIPANTS

1. John K. Maina - PREO/ Project Manager - MOEP Headquarter
2. Dickson Kisoa - Snr. Economist - MOEP Headquarter
3. Maina Kingori - Site Engineer, Pharma Consulting Engineers Ltd.
4. Ms Winnie Kinuthia - Assistant Catering Officer

4.0 OBSERVATIONS

The following observations were recorded during the supervisory

visit. 4.1 **Digester construction**

The digester and the expansion chamber construction have been completed to the specification and the contractor was landscaping the site to control erosion and to make it aesthetically appealing.



4.2 **Digester feed stock**

The College had accumulated some cow dung but it was not sufficient for system start up. The livestock housed, which are on semi-zero grazing rearing system, are

fewer than the expected 100 earlier promised. This compromises the expected amount of feed stock as per the project design. The feeding of the digester commenced on Monday 8th June 2015 and by the time of the visit, a depth of one (1) meter had been filled with available cow dung. The only hindrance was availability of approximately 40 tons of cow dung required as seed feedstock. Further the available chaff cutter is defective resulting to wastage of fodder and dung due to being trampled on with waste fodder.



Uncut napier grass resulting to wastage

4.3 Water shortage

In addition water supply is inadequate, making mixing at the ratio of 1:1; water: cow dung quite difficult. About 60,000 litres of water is required to start up and subsequently 1,000 litres to mix approximately one (1) ton of cow dung daily.

The contractor has therefore resorted to direct feeding into the digester, instead of diluting at the mixing chamber for the substrate to flow freely into the digester. The College top management was informed of these challenges and promised to address them as a matter of urgency to fast track start up of the project.



Cowdung fed into the digester

4.4 Gas pipeline

The gas line and all the seven (7) water traps had been done, ready for testing, once gas production commences. It is noted that the contractor has utilized own resources to add an extra 200m of the gas line that exceeded the quoted 1,100 m. The exceeded length will be considered as additional works.



Gas pipe and water trap

4.5 Gas meter

The gas meter has been procured ready for fitting. A decision by supervisory team was made to put up a gas meter housing to secure it from vandalism and poor weather conditions



Gas meter to be

4.6 Road crossing culvert

The visiting team appreciated the fact that the culvert had been blocked and may need remedial measures to safeguard the gas line passing therein. The contractor was urged to provide clips to anchor the gas pipe to the roof of the culvert and also to reinforce the exit and the entrance to the culvert to avoid damage by runoff water.



4.7 Biogas bag

The 20 m³ gas bag has been procured and delivered ready for installation. This will be act as the storage for the biogas before usage in the kitchen.



4.8 Gas bag enclosure and concrete base slab

The 50mm thick 5.5 mx 4.5 m base slab has been put in place as well as fencing of the biogas storage area. The storage area is adjacent to the LPG tanks currently used in the kitchen. It is hoped that use of LPG will considerably reduce once biogas start flowing into the kitchen.



It has also been belatedly proposed that the biogas storage area also house the compressor and the desulphurizer due to insufficient space near the kitchen and also to ensure that the biogas is cleaned before entering the storage bag. In the circumstances, a 5.5 m x 4.5 m x 2.5m shelter has been proposed for the biogas storage area to secure the three components.

4.9 Kitchen

Although the installation of the cook stoves has not been effected, discussions were held with the Assistant Catering Officer, Ms Winnie Kinuthia with regard to the practicability of using 100 litres cook stoves. The catering officer observed that they



do not prepare large meals since students shun their catering services for other cheaper outlets. After lengthy discussion, it was proposed that 50-litre cook stoves would be more appropriate. In the circumstances, the team agreed with the catering department's request and asked the contractor to use the same quoted amount of money to procure the possible number of 50-litre cook stoves. The Assistant Catering Officer was made to understand that the mandate of the ministry is to enhance efficiency thus the need to embrace improved cook stoves as opposed to the open cook frame currently being used in the kitchen.

5.0 Conclusion

The construction work has progressed well since all civil works is almost complete. Procurement of key accessories was also in progress and it is hoped that once the digester is filled with cow dung, there would adequate biogas for testing the system.

6.0 Recommendation

In addition to meeting the obligations discussed above, with regard to fodder, cow dung and water the College has been advised to appoint two hands men to be trained on the operations of the project for future maintenance.

John K. Maina

Project Manager