

# Report

## Biogas Plant Construction and product Utilisation Manual

**Project Title: Biogas for Sustainable Livelihoods and Green Youth Entrepreneurship (BLESKY).**



**BLESKY Center**

**KAPYANGA – CENTRAL PROVINCE, ZAMBIA**



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## **Executive Summary**

Zambia is one of the recipient countries of Czech Development Aid. In partnership with the UNDP, the Czech Republic has been supporting Zambia in finding solutions to some of its challenges in view of achieving Zambia's sustainable development goals. The objectives of this project, Biogas for Sustainable Livelihoods and Green Youth Entrepreneurship (BLESYG), address Zambia's challenge in Nature Resources Management and Renewable Energy.

Kapyanga is faced with three main issues, deforestation and soil degradation and women and youth unemployment.

BLESYG was incepted to contribute in finding solutions to the above three main issues.

The project intended to construct and install a biodigester, incept sustainable agricultural practices, develop biogas generation by-products and their respective market linkages. It also originally included setting up pig production and the value addition abattoir processing as the employment creation driver and the source of funds for replication in the community. It later evolved that a poultry production and the hammer mill would be better suited to the environment as income generators to support the organic fertilizer production. Reasons being that poultry is easier to manage than the specialised pork production; composted poultry manure will compensate nitrogen deficiency in dried digestate and; there is a high availability of cow dung in the area. The hammer mill will be used to produce ingredients for poultry feed and also generate income through the provision of milling services to the community.

The mission was embarked upon October 2023/October 2023. During this period Nine (9) youths have been trained in the construction of biogas digesters and maintenance of which 33% are female. They constructed a 32m<sup>3</sup> biodigester. One (1) person has been trained in production of organic fertilizer and applications. Six (6) youths have been trained in project management of which 60% are female.

In January 2023, we undertook a verification working tour to Zambia during which the project was launched and had an opportunity to visit the proposed site at Chongwe. It was during the second working tour that Kapyanga site was identified as a suitable location and work started in April 2023. During the same month of April, a project site water source was developed. It is servicing the project site and the neighbouring community.

Works on the biodigester were completed at the end of May 2023.

## 1. Introduction

The proposed solution was through the setting up a biogas production plant. In the BLESYG project, Biogas is considered to be the centre for solving a number of developmental problems. It will bring solutions - clean energy, organic fertilizers, skills acquisition, job creation and income generation.

## 2. Background

Zambian rural communities are practicing nomadic agriculture whereby they deforest farming lands to cultivate crops. They use the land for about 5 years. When it loses nutrients, they leave the area barren and move to other fertile areas where they start deforesting the land in order to start farming again. This is emanating from the high costs of chemical fertilizers, a 50kg bag of fertilizer costs 40USD, as of July 2022.

Hence, the implementation of BLESYG will go a long way in helping save the province from deforestation by introducing farmers to this proposed comprehensive climate friendly package. The project's biogas biodigester will supply affordable organic fertilizers to the local farmers. As a result, they will stay in one place, keep their soil fertile and stop deforesting the land, which is detrimental to the climate.



Figure 1. Charcoal being made on land allocated to the BLESYG project

The produced gas will help spread awareness of this renewable energy, support uptake and utilisation. This will help mitigate against charcoal burning and woodcutting, which are hazards to the environment. Charcoal burning happens to be an income generator in Kapyanga.

### 3. Description of the Kapyanga biodigester

The Kapyanga biodigester is a 32 m<sup>3</sup> fixed-dome type. It has two inlet pipes for feeding. The expansion chamber has a diameter of 2.7 m. The radius (L in the diagram below) is 2 m. This BLESKY Biodigester at Kapyanga cost USD 2500.00. The local partner did not honour its co-financing pledge. The innovator, UCT, had to cover the co-financing.

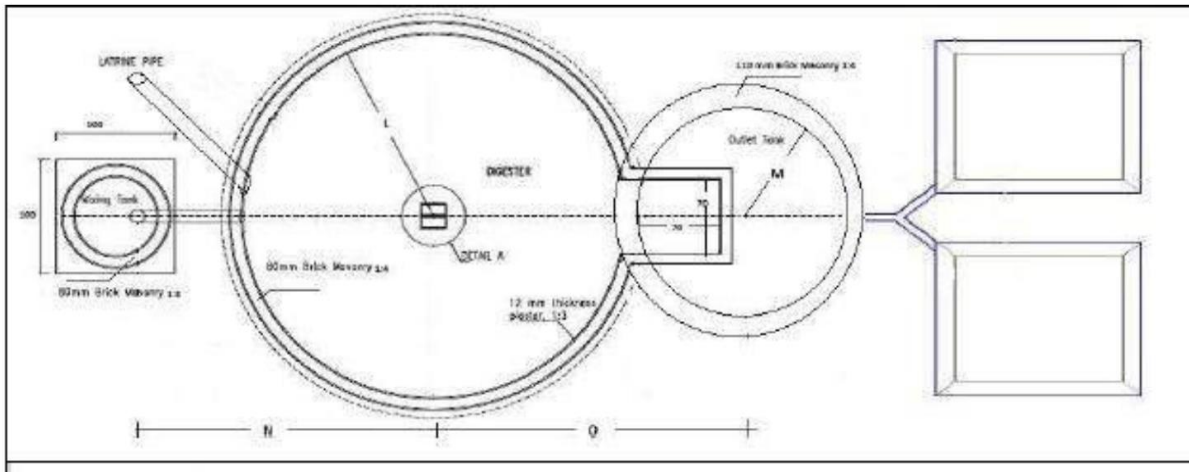


Figure 2. BLESKY biodigester at Kapyanga



### 4. Biogas awareness workshop

A workshop was held at village level. The purpose was to inform the community about the role of biogas in addressing deforestation and land degradation; and about the entrepreneurship opportunities that a biogas plant can create. This workshop was attended by, the Community Development Officer, Agricultural Extension Officers, the Local councillor and community members.



Figure 3. Community workshop for Biogas and organic fertiliser awareness.

## 5. Theoretical training

### 5.1 Selection of trainees

Working with the community, HYSPER came up with a list of NINE (9) people comprising THREE (3) females and SIX (6) males. All were youth.

### 5.2 Theoretical training

Training was conducted at Kapyanga and in Lusaka. The aim was to give the trainees the basic principles of biogas production and procedures for biogas plant construction. Biogas sizing and design were also covered. Trainees were taught how to estimate biogas needs for different family sizes and based on that they were shown how to compute the size of biogas to meet the estimated needs. The cost of practical training for Nine (9) Trainees was USD 1900.00. The local partner did not honour its co-financing pledge. The innovator, UCT, had to cover the co-financing.



Figure 4. Theoretical training.

# 6. Construction and practical training

After siting and setting, a diameter of 4m was excavated to the depth of 6m. Manual excavation was preferred in order to give the local youth a possibility to earn some money.



Figure 5. Pit excavation

The trainees were also involved in the excavation work.



Figure 6. Trainees at work.



Figure 7. Inspecting the dome pit



Figure 8. Setting the expansion chamber      Figure 9. Excavation completed

The center of the base of the dugout pit was located in order to dig out the concave base of the biodigester.

### **Leveling of the Base**

The concave base was levelled. A concrete mixture of strength ratio of 1:2:4 (1 cement, 2 sand and 2 gravel) was used.

Using a radius stick, the slab ring was established. After 36 hours, to allow for the concrete base to cure, brick installation commenced.



Figure 10. Concave base casting

## Brick Work

Good quality locally made bricks were purchased for brick works.



Figure 11. Brick work – trainees working with experienced masons.

## Plastering the Digester Wall

Plastering was done on the inside of digester with a ratio of 1:1/4:4 and a depth of 2cm. The wall was first washed with cement water before being plastered.



Figure 12: Plastering the biodigester

Final works were done on the expansion chamber and gas outlet.



Figure 13. Final works on expansion chamber and gas outlet

After the plastering works, work continued on the production of the cover for the expansion chamber.

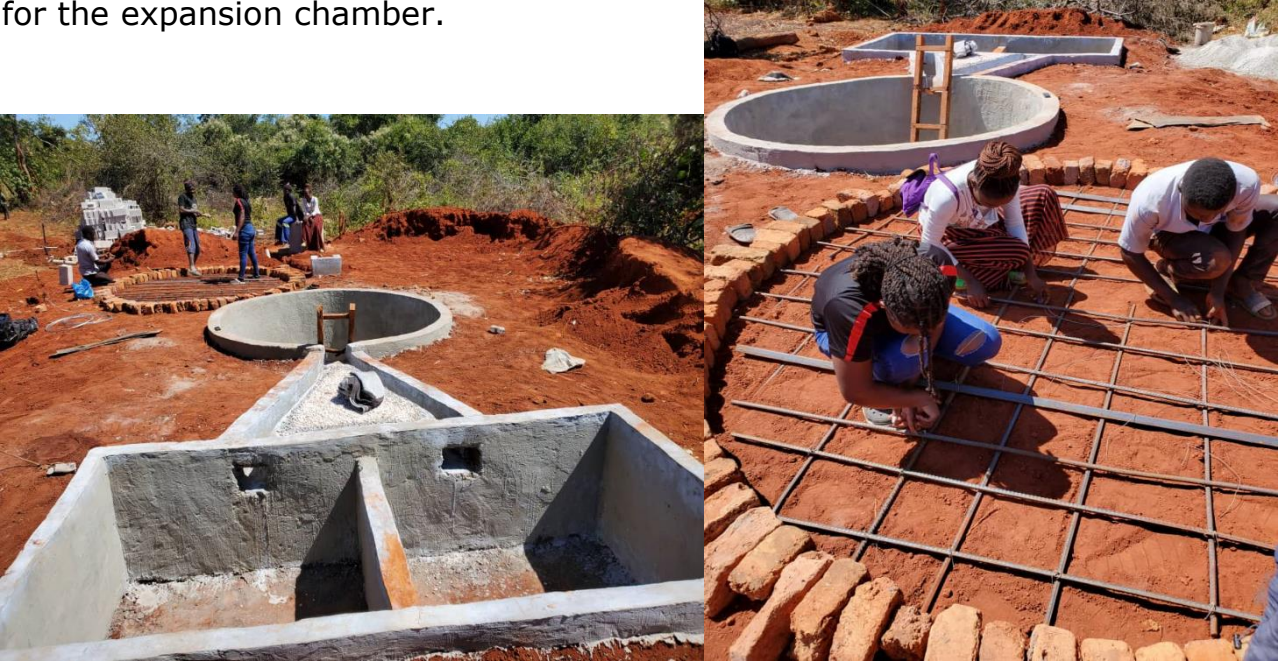


Figure 14. Work on the expansion chamber cover.

## 7. Maintenance training

Upon completion of the construction works the trainees were trained in feeding the biodigester, biogas harvesting and maintenance of the biodigester and general operations.

## 8. Commissioning of the biodigester

On May 12<sup>th</sup> May 2023, the District Commissioner for Shibuyunji commissioned the biogas plant. CAMNET TV and the Zambia National Broadcasting Corporation aired the event on the main evening news.



Figure 15. Mr Alfred Shaputu – District commissioner for Shibuyunji distyrcit commissioned the biodgester.

(<https://www.youtube.com/watch?v=wEyroxuVr7Q>) = **starts at 17:04 min.**

## 9. Feeding of the biodigester

This has been a challenge since the commissioning of the plant. The local partner, HYSER, has turned out to be a small organisation that lacks personnel. In May, HYSER focussed on the harvesting of their agricultural crop Soybeans. Their staff moved to harvesting. Feeding of the biodigester ground to a halt. This situation continued until July. Feeding resumed intermittently at the end of June. It stabilised during the working tour of the UCT team. Unfortunately, the feeding has again become unstable (end of October) despite the fact that the hammer mill and chicken production are generating income, which is supposed to fund the feeding of the biodigester. It could take some settling in time to stabilize biodigester feeding.

## 10. Gas harvesting

A portable gas bag and gas stove have been acquired. The portable biogas bag was sourced from Germany and delivered to Kapyanga by the UCT Team. The gas stove was sourced by HYSER from the local market. It required some modifications since by design it operates on pressurised LPG. The gas stove has not yet been connected despite the fact that the gas is being produced. HYSER has reported logistical problems (personnel issues and yet HYSER staff underwent theoretical and practical training).

## 11. Training for Organic fertiliser production

This training commenced in August. There was only one trainee, Mr. Ashley Gando. Although he lacks educational background, he is very good learner, and he is willing to learn. He is in fact the caretaker of the BLESKY Project Site.

The training comprised composting, Bokashi making using digestate and chicken manure composting.





Figure 16. Chicken manure composting



Figure 17. Making solid organic fertilizer

## 12. Lessons learnt

This part does not only deal with biogas installation. It looks at BLESKY as a whole. The following were the take home lessons:

- BLESKY is a complex system with many intertwined components. Based on the original list of expertise that were sourced from HYSKY, it was thought that they had the required personnel with pre-requisites for such an establishment. Reality is however, different. For instance, there was only one person in the organic fertilizer training.
- The Head of HYSKY, Mr. Gando shows traits of moving BLESKY forward. Given a team of trained followers, he can make the project deliver. He keeps motivating his members.
- The ordinary community members have welcomed the project. They cannot wait to use the organic fertiliser. Some are moving onto the site to start gardening. Some are using water from BLESKY center for home consumption.
- Village dynamics seem to esteem from individual desire for quick gains. BLESKY is a system with processes that are scientific in nature. It is therefore vital that a strong leadership and an environment of building posterity, and togetherness is founded.
- Trained biogas personnel not being available to operate the biogas plant. It later showed that the main driver for participating was the financial incentive in form of trainee allowances.
- The youth members of HYSKY are Lusaka based. Kapyanga is located about 125 km away from Lusaka and it is rural. We have encouraged Hysky to drum up membership from the local youths. The challenge has been high expectations from the local community youths.
- The commitment to the cause of BLESKY by the Mr. Clinton Gando, the head of HYSKY is outstanding. He motivates other members but he seems the drive and vision.

## 13. Conclusion

The BLESGY project in its complexity, under a solid support management structure, it can uplift the Kapyanga community whilst helping to mitigate deforestation and improving agricultural production. The innovator has opened channels with stakeholders namely, Zambia Agricultural Research Institute (ZARI) to support and help the development of the organic fertilizer, the National Technology Business Centre (NTBC) organic fertilizer product development, the Technology Development and Advisory Unit (TDAU) of the University of Zambia (UNZA) for equipment modification and Kasisi Agricultural Training Centre (KATC) for organic fertilizer product development and utilization. HYSER participated in almost all the meetings. They did not participate in the meeting with NTBC, however the contacts were shared with them and during the September training in which the Head of HYSER participated, BLESGY was discussed.

Innovator – Local partner forthcoming collaboration shall be targeted at encouraging the local partner to utilize the expertise that lie in the above-mentioned organisations.

## Annex I

### Plan for future use

The future use of biogas in Kapyanga depends on many factors including affordability, technical support, availability of packaging facilities, availability of affordable appliances; and above all deliberate policies to encourage the use of Green Energy. The affordability question is whilst wood is free in villages, what can make poor buy biogas? The key driver on the horizon are the diminishing nearby forests. This is likely to make biogas the energy of choice in the future in the villages. The immediate need is to find solutions to biogas packaging and affordable appliances to service Lusaka townships where charcoal that is produced in areas like Kapyanga is consumed. This will save the remaining forests of Kapyanga and Shibujunji district. However, when it comes to the organic fertilizers, both liquid form (slurry) and solid form (composted organic fertilizer), the market is readily available.

### ***Ambitious plan***

<b>Biogas uptake plan</b>				
Year 1		Year 2		Year 3
Awareness and Promotion in Kapyanga and beyond (provincial). Build synergies with SNV and People in need (Both are in the promotion of biogas uptake)		Work on packaging (cost effective packaging). Build synergies with NTBC and TDU at UNZA		Biogas as a business for the center – establish market distribution channels
Work with appliance developers and manufactures. (NTBC and TDU are promising stakeholders given their institutional mandates).				

### **Organic fertilizer pellets**

<b>Organic fertiliser pellets uptake plan</b>		
Year 1	First half of Year 2	Second half of Year 2
Free flow product – work on ingredients and testing on the plots at the BLESKY Center (collaboration with ZARI)	Pellet making and product Testing	Product launch
Free flow product – work on ingredients and testing on the willing farmer plots (collaboration with ZARI)		