New project lends from nature to power up villages

Ethel Khumalo

Villages in three provinces in South Africa are now benefiting from greener energy technologies thanks to strategic research by the Water Research Commission (WRC). Article by Petro Kotzé.

"My biogas was installed in November last year and when I started to use it I saw a big difference. I was under a lot of pressure when I used wood and electricity because I would pay R750 and that would only last for three months. I once went three days in darkness and I had to use candles until pension day when I could buy more power. Now that I have biogas it has helped me tremendously."

These are the words of Ethel Khumalo, who lives at Obonjaneni in KwaZulu-Natal with her three sons and three grandchildren. Hers is one of the four households across KwaZulu-Natal and the Eastern Cape, as well as community cooperatives in the Limpopo province, who have proven the effectiveness of an alternative, green energy source to improve lives.

Energy is seen as central to improved social and economic well-being, and a key factor for relieving poverty, improving human welfare and raising living standards. For this project, the alternative source of energy is one that has not received as much attention as popular choices like solar, wind and hydro. "There was a need to investigate biogas as part of the renewable energy mix," explains Dr Sylvester Mpandeli, WRC Research Manager for Water Utilisation in Agriculture. As a result, the WRC initiated a project with the University of KwaZulu Natal (KZN), which focuses on the use of biogas at household level, an aspect that is unique in comparison to other similar schemes.

The project aims to introduce biogas production from cattle manure for energy generation into rural households. It goes further to test the effectiveness of bioslurry as liquid fertilizer as well as rainwater harvesting to feed the biogas digester, and for domestic use and crop production. At the same time, while the project enables people to use a readily available energy source, it is a waste management technology that cleans the local environment, and improves the health and quality-of-life of the participants.

Even though the project was awarded to the UKZN, it is a multi-organisational effort. Partners comprise of various organisations, including the universities of Rhodes and Venda and AGAMA Energy. The

researchers themselves come from a variety of backgrounds. "The integration of having a crop scientist, soil scientist, grassland scientist, hydrologist, economist and a social scientist makes it one of the most integrated projects I've worked with," says project leader Dr Terry Everson, a senior research associate at the UKZN.

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For the WRC, this choice was "a strategic intervention," says Dr Mpandeli. While multiple organisations benefit, a number of post-graduate studies have sprouted from it. Strikingly, the project is also building capacity on a community level – educating and uplifting those that could benefit from the results in future.

This was an important element for any realistic success. According to Dr Mpandeli, buy-in from communities was essential. An important initial part of the project entailed educating community members on what the researchers are trying to do. "We prepared videos, brochures and had meetings in all the communities to raise awareness," says Dr Everson. "One of the most effective methods was cross visits, where we took people to existing biogas projects, where they could see how biogas actually works and learn from other community members."

Once they understood how gas for cooking could be generated from manure, the researchers had no lack of volunteers willing to participate in the trial. "We've had so many requests from community members and school feeding schemes," she says "as they see the huge potential of integrated systems such as this".

Participants were selected according to set criteria. They had to, for example, be able to collect a bucket of water and manure a day. "After establishing the minimum criteria we gave community members the task of selecting the most deserving households", says Dr Everson. "This transparent and consultative process was initiated to promote fair selection of biogas digester beneficiaries".

Four biogass digesters were then installed in KwaZulu-Natal and five in the Eastern Cape. Lessons learnt from here were then applied to a different model for implementation in two community cooperatives in Limpopo. Here, one of the biogas digesters was implemented at a school which feeds over 200 pre-school children.

With no electricity village women and children have to walk long distances to collect firewood.

***Above:** The biogas setup in a participant's home.*

***Right:** The biodigesters are coupled to supply one burner in a kitchen about 30 m away.*

A CLOSER LOOK AT THE SYSTEM

A typical system comprises a fixed-dome pre-fabricated AGAMA bio-digester, which is linked to a burner in a kitchen about 30 m away. Each digester container is 2.2 m in diameter and 2.5 m high. It can produce enough gas to provide two hours of burning a day which is equivalent to 0.8 kg LPG or 3.5 kHh continuous electrical output.

Each digester is fed with 20 kg of organic raw material mixed with 20 ℓ of water at a ratio of 1:1 per day. The produced biogas is stored in the dome of the digester and piped directly to the gas burner. While the gas cannot be connected directly to LPG appliances, it is used on a purpose-built biogas appliance. The records kept by community members indicate that there is sufficient biogas for the average household's cooking requirements, if the gas is used in conjunction with efficient cooking methods (e.g. wonderbags).

A second element of the study was the investigation of the use of bioslurry (the decomposed effluent that is a by-product of the anaerobic digestion process) to enhance yield and quality of food crops (e.g. maize) and fodder crops (e.g. Napier grass). The slurry contains 93% water and 7% solids which is a ready-made fertilizer containing key nutrients (N, P, K) needed for plant growth.

It can be applied directly on to fields to grow crops and there is evidence that the productivity of agricultural land can be increased significantly with its use. Further benefits include that it is completely safe in terms of diseases, and doesn't smell or attract flies, says Dr Everson.

Although community members report an increase in the size of crops like cabbages, experimental trials have not shown a huge increase in production. The correct application is recommended as a potential topic for future research.

A critical factor in the operation of a biogas digester, for both biogas and bioslurry fertilizer, is water. The digester has to be fed 20 ℓ a day to maintain biogas production, amounting to 7 200 ℓ per year or 600 ℓ per

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month. However, access to water is a limiting factor for the households in this study. To bridge this gap, the project relies on rainwater harvesting. From 13 techniques recognised for use in South Africa, rooftop water harvesting was selected as the most plausible option. Rainwater is simply collected from rooftops and stored in tanks.

According to Dr Everson, one of the main advantages about the process is that it only entails natural resources, and that there are no chemical or mechanical aspects involved. There are a host of other benefits too, but before mass implementation can take place, a number of hurdles will have to be overcome.

BENEFITS AND CHALLENGES

Perhaps most importantly for the community members, the project has great potential to improve livelihoods through more efficient use of resources. While the benefits are being felt in pockets by money saved on the purchase of wood or electricity, much time is also saved in firewood collection.

"Now women and children do not have to go off for hours to collect wood or pay R300 to R400 per load" says Dr Everson. There are also health benefits to not breathing in the smoke from wood fires anymore. Plus, the biogas projects are often driven by the female head of the household, giving them the opportunity to claim a stake in the green economy.

However, there are also some prohibitive aspects to project implementation, the biggest concern of which is probably the cost of the infrastructure. At a cost of R32 000 per biodigester, the study has shown that it is not a financially feasible investment. Yet, significant economic advantages were identified as well as significant social benefits.

Biogas implementation requires suitable guidance, education and modification to accommodate various situations. The optimal running of a biodigester is important in achieving the identified financial and economic value. This can be challenging, given the novelty of the technology in South Africa, especially in rural communities.

During rooftop water harvesting rainwater is simply collected from rooftops and stored in tanks.

Regardless, while the benefits and costs are highly site specific, it is thought that there are thousands of households technically suitable for biodigester use. While the project is coming to an end in March 2015 (having run since 2010), both the WRC and researchers are looking forward to taking this initial work further, and bigger, in future.

Community members have given positive feedback after the use of bioslurry as fertilizer on their vegetable plots.

Members of the Maila Cooperative in Limpopo who feed pre-school children with its produce.

UKZN post-doctoral student, Yashwant Singh, admires Ethel Khumalo's vegetable garden.

Community members have participated actively in the monitoring of the technology.

INTO THE FUTURE

"Basically our pilot project was small-scale with implementation at household level so, the next step is to up-scale to village level." notes Dr Everson.

In broader terms, a Green Village is envisaged by the WRC where "a knowledgeable rural community in which a healthy ecological infrastructure is maintained, which practises sustainable and productive agriculture, and utilises renewable energy." The current biogas project is one small step in attaining this goal.

To create a Green Village we need to use, the numerous guidelines, methods and procedures on water services enhancement, food security, energy, rehabilitation, and biodiversity protection that have been produced by the WRC and other research organisations. In essence, it will demonstrate that basic services provision can be achieved without compromising ecological infrastructure, through exploring greener alternatives.

"To ensure we sustain this, we need to form partnerships with local government, and perhaps also become involved with public-private partnerships," says Dr Mpandeli. "Our mandate is to generate knowledge and disseminate it but to implement it, we need partners."

Dr Everson confirms that they are already planning to source funding to investigate the feasibility of a Green Village, and to research potential villages as suitable candidates. She adds that the success of such a project would be dependent on government subsidisation.

Dr Mpandeli is positive about the potential for future implementation of the current project, as it adheres to three important characteristics. Firstly, "as the science community we need to highlight the benefits, and show practical examples." Secondly, the technologies promoted by the project are simple and can be used by anyone. Lastly, he says, we have to make sure that whatever we are driving is aligned with government priorities.

An example of the latter is the National Biogas Platform, established as a key resolution of the 2013 National Biogass Conference and created to assist government to unlock the potential of the biogass sector.

As the current project ticks all the right boxes, it is hoped that it will lead to the improvement of livelihoods of thousands of others like Ethal Khumalo in the future. ❑