AFRICA FOR RESULTS INITIATIVE

UPSCALING THE UPTAKE OF DOMESTIC BIOGAS TECHNOLOGY: LESSONS FROM ZIMBABWE

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Case Study
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SYNOPSIS

Access to modern energy services still remains low in Africa. An estimated 500 million people on the continent have no access to grid electricity. The majority are in the rural areas. In Zimbabwe, energy poverty remains high with about half of the population (6 million) without grid electricity. The energy access disparity between the urban and rural communities is unsustainable with rural communities relying on low intensity, inefficient and often unhealthy energy sources. Using the case of Zimbabwe's pilot National Domestic Biogas Program, the paper draws several lessons and pitfalls for Africa and the developing world on alternative sources of energy.

Key Findings: The main findings include that domestic biogas is difficult to accept in many parts of the world but this paper will demonstrate five success factors identified in the Zimbabwe program that are applicable to any such program. These factors are the following:

- A broad-based partnership between government, private sector and civil society.
- Market based approach to stimulate up-take and support services (with minimum subsidies and incentives for early adopters both end-users and service providers).
- Nesting the program in particular sectors of the economy like dairy
- Formalization of services (for example through curriculum development) and
- Research and development for contextualization (refining the technology to adapt to the local and existing scenario).

Key lessons: Neither a natural resources management crisis nor regulations stimulate increased adoption of biogas technology. A well-developed program integrating the five pillars mentioned above can achieve such results.

Key Recommendations*:* A program to upscale the uptake of domestic bio-gaz technology must be supported by a broad policy framework that should also integrate applied research and development projects to continuously adapt and improve the performance of the bio-digesters while building the capacity of the key players.

Introduction[1]

Pimental et al, (1999) noted that the world population is growing at a rate of 15% (1.13% per year (WORLDOMETERS, 2016) and if all people on earth were to enjoy the same living standards as the average American, then the world's fossil fuels will run out in 15 years. In Africa, access to clean energy is a problem and people spend a-lot-of time and resources trying to access energy. While biogas alone cannot be the panacea to Africa's energy crisis, it can go a long way in alleviating the energy crisis.

Biogas has been used for ages for the purposes of lighting, heating and cooling. Biogas is produced from the anaerobic digestion of organic materials. It can occur naturally or through human controlled production like farm and household wastes in bio digesters (Norin 1998). Biogas has large proportions of methane (60%-70%) and carbon dioxide (30%-40%) (Hagen et al 2001). It has a heating value of $22MJ/m^3$ (Itodo et al 2007). A kilogram of cattle dung produces between $0.09m^3$ to $1.2m^3$[2] of biogas per day (Sasse, 1988) which is enough to cook a meal for an average household of five people. Despite this, the adoption of the technology as a source of energy has not been widespread.

Literature Review

Africa is lagging behind with regards to the use of domestic biogas even when compared to other energy deficient continents such as Asia (Heegde and Sonder 2007). China has an estimated 15 million household using biogas while the whole of Africa only has a few thousands (Mumba 2006). Africa, however, has a large potential for biogas technology. It is estimated that 24% of households in Africa can own a bio-digester (Heegde and Sonder 2007). Figure 1 and Table 1 illustrate the potential for national biogas programs in Africa.

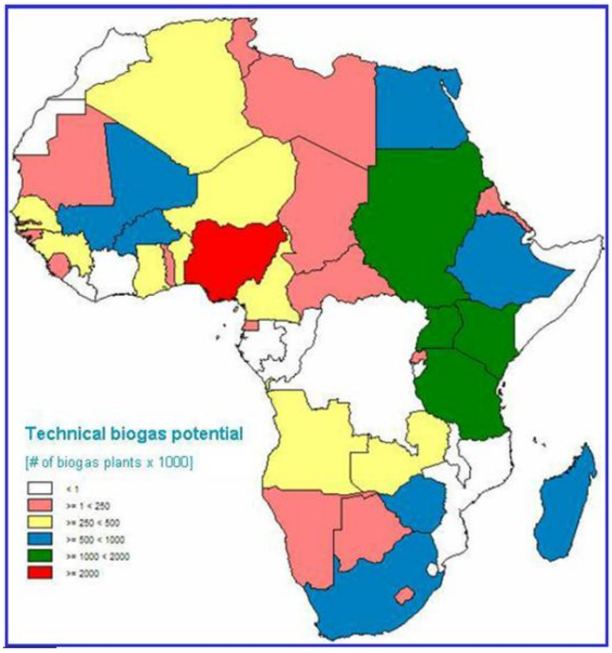

Figure 1 Technical Biogas Potential for Africa (Source: Heegde and Sonder 2007)

Several African countries have a huge national herd including Botswana, Namibia, Tanzania, Kenya Cameroon, Lesotho and Algeria. A prospective household should have at least 6 herds of cattle. Other estimates (Heedge and Sonder 2007) have put it as low as 3 cattle but using the Zimbabwean experience where zero grazing is not very common, six cattle would be able to produce enough dung to feed the digester.

Using biogas as an energy source has several advantages. It is a clean energy sources and thus does not contribute any net greenhouse gasses (SNV 2015, Persson, 2003 and Vagdhal 1999). Biogas adoption encourages a green economy, including the creation of green jobs and greening agricultural activities like livestock production (Abaza, 2012). Biogas is gender friendly, especially for women as they spend less time cooking and looking for firewood (Matsvaire et al 2016).

[1] This study has been prepared by Dowsen Sango (Netherland Development Organization)

[2] http://bisyplan.bioenarea.eu/html-files-en/01-03.pdf

Table 1 National Domestic Biogas programmes in Africa

Country	Programme Duration	Target Number of Digesters	Digesters Built so far	Programme partners	Funding Partners
Zambia	2012-2013	163	17	TDAU/UNZA, DOE, MOA/DLD, SNV	AFDB
Rwanda	2012-2013	90	90	SNV, MININFRA	DGIS
Benin	2011-2012	140	70	Direction Générale de l'Energie, SNV, Direction de l'Elevage, ABERME	DGSI
Ethiopia	2008-2013	8511	8161	SNV, HIVOS, ABPP	DGIS
Uganda	2009-2013	1100	1081	SNV, World Vision, Ministry of Energy and Mineral Development, Ministry of Agriculture, Ministry of Water and Environment	HIVOS
Tanzania	2009-2013	3258	3819	SNV, HIVOS, SIMGAS	DOEN Foundation, DGIS
Kenya	2009-2013	10700	11577	ABPP-Hivos, SNV	

There are several reasons for why Biogas is not being adopted widely in Africa. This include the fact that national governments are not investing time and resources in the promotion of the technology. Governments provide the least information compared to private sector companies and civil society (Ibid). There is a general perception that rural households think that biogas investment is expensive and therefore they are not willing to invest in it. However, Matsvaire et al demonstrated that in Zimbabwe, although a few households (14%) are willing to construct digesters on their own, 92% are willing to adopt the technology if there is some external support.

Methodology and Theoretical Framework

The study design was largely qualitative with the main method being participant observation. The researcher was involved ('participant') in the design and implementation of the project under study as the Monitoring and Evaluation Advisor. In this capacity the researcher was able to systematically describe events, behaviors, artifacts, in the social setting (This sums up participant observation as defined by Marshall and Rossman (1989), Schensul, Schensul, and LeCompte (1999) and Kawulich, (2005).)

The study was grounded in the Technology Acceptance Model (TAM). TAM was proposed by Fred Davis in 1985 to explain how and why new technologies or systems are accepted or rejected by end-users. TAM is considered an extension of the theory of reasoned action (TRA), (Ajzen and Fishbein (1980) and Park (2009)). Davis postulated that technology use is a function of the user's motivation which is directly influenced by an external stimuli consisting of the actual technology's features and capabilities (Chuttur M.Y. 2009). This model is illustrated in Figure 2 below. In this regard household's uptake of biogas technology is a function of how useful biogas is in their livelihood strategies.

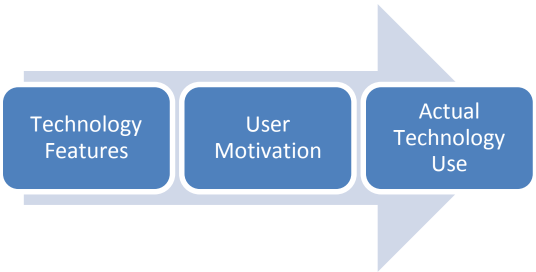

Figure 2 Conceptual Model of Technology Acceptance (Davis 1985, p10)

The Problem

Zimbabwe has a total installed electricity capacity of 1,960MW against a demand of 2,200MW (GoZ 2011). The deficit is compounded by low electricity generation (at 63% of installed capacity) and consumption patterns (Ibid). Domestic demand for electricity has increased, but it is higher in urban compared to rural areas. Rural households predominantly use firewood to meet their energy needs. The Ministry of Energy reckons that 6 million tonnes of wood fuel is consumed every year. This is against a sustainable harvest of 4.6 million tons, thus an estimated 330,000ha of forest are being destroyed every year. At the same time reforestation is outstripped by destruction of 50 million trees every year (Ibid). This points to a fuelwood crisis (Hosier, and Moyo, 2016). While the crisis is not equally spread across the country, most rural areas are the hardest hit.

Thus, the energy deficit in Zimbabwe makes a case for alternative energy sources. Biogas could go a long way in alleviating the energy crisis. In Southern Africa, Heedge and Sonder (2007) noted that Zimbabwe is one of the countries together with Madagascar and South Africa that have the highest potential for large scale biogas dissemination programs of between 500,000 and 1,000,000 digesters respectively.

In Zimbabwe and Africa at large, the adoption of biogas is limited by a number of factors including:

- The lack of experts in the renewable energy sector.
- Lack of appropriate technology. Limited research has been done on suitable biogas technologies for Zimbabwe, therefore there are few or no best cases of biogas.
- Lack of energy finance and in particular renewable energy finance. There is currently no financial institution with an energy finance instrument.

Any successful national biogas program should be able to overcome these barriers (SNV and HIVOS 2012). The next section focuses on the Zimbabwe Domestic biogas Project.

The Zimbabwe Domestic Biogas Project

Biogas is not entirely a new technology in Zimbabwe. Biogas digesters were constructed as early as 1979. From 1979 to 2012, at total of 241 bio-digesters were constructed (210 domestic bio-digesters and 31 institutional) through various public and private initiatives (Ibid).

The Zimbabwe Domestic Biogas Project (ZDBP) is an initiative developed and implemented as a partnership between the Government of Zimbabwe and two international organizations. The partners are:

- Government (Ministry of Energy and Power Development; Ministry of Agriculture, Mechanization and Irrigation Development (MAMID); Rural Electrification Agency (REA))
- Civil society: The Netherlands Development Organization (SNV) and the Humanist Institute for Cooperation with Developing Countries (HIVOS).

The project was funded by the Netherland Directorate for Development Cooperation (DGIS).

The project aims to promote the use of biogas as an alternative energy source for domestic use. The ZDBP was conceived as a five year program but only the first two years (October 2013-October 2015) were funded by external donors and supported through partnering with international organization. Thereafter the government of Zimbabwe would continue the program.

This paper discusses the achievements and lessons from the first two years of implementation. The achievements will be discussed in terms of the performance indicators and targets set for the first two years as well as in relation to the overall project targets. Lessons will be drawn from project implementation that would be applicable to other domestic biogas programs in Zimbabwe and Africa.

Project Goal

The ZDBP aims to improve the livelihoods and quality of life of rural farmers in Zimbabwe through exploiting the market and non-market benefits of domestic biogas. The project target to increase, by 7.400, the number of quality bio-digesters fed by animal manure in 5 years and to develop a commercially viable domestic biogas sector.

In Zimbabwe, biogas digester constructions started as early as 1979. Since then, 241 bio-digesters have been constructed. By 2011, 65 of the constructed digesters were no longer functioning. It was noted that 47 of the digester had ceased working in the 2000s, thirteen had stopped working in the 1990s and five in the 1980s (SNV and HIVOS 2012). There is a huge potential for biogas technology for domestic use with an estimated appetite of close to 65,000 units in the whole country (Ibid). Figure 3 illustrate the potential.

Estimated Potential for biogas (excluding urban households)		
Market segment	Small scale Digesters 4 6 8 10 15 20 cum	Medium / Large Scale Digesters > 20 cum
Domestic		
Subsistence Farmers	63,564	
Piggeries	425	47
Dairy farmers	6	100
Subtotal	*63,995*	*147*
Institutional		
Primary schools (new)	566	
Secondary schools (new)	224	
School other (new)	5	
Abattoirs	16	20
Subtotal	*811*	*20*
Total Estimated Potential	**64,806**	**167**

Figure 3: Potential Biogas Market (SNV and HIVOS 2012, p10)

Project Activities

Under the project the following activities (which will be described in detail later) were conducted:

- Technology promotion and awareness raising
- Capacity building of the biogas value chain players
- Research and development
- Biogas sector coordination and reorientation

Biogas Technology Promotion and Awareness Raising

The implementing partners noted that biogas technology was not well understood in Zimbabwe (SNV and HIVOS 2012). As such, there was need to create awareness among the targeted communities. The project used four models for awareness raising and technology promotion:

1. Promotion officers. These were freelance marketing officers paid on commission for each digesters sized and sited ($15 per digester). They were involved in persuasive promotion which includes door to door marketing. Ward based Agriculture Extension officers from the Ministry of Agriculture were also engaged as promotion officers.
2. Biogas ambassadors. These were early adopters of the technology who were then incentivized through a subsidy on construction materials. Their digesters were used as centers of excellence within their local community where others could come and learn the technology. The assumption was 'seeing is believing' so for others to adopt the technology they needed to see one of their peers benefiting from it.
3. Mass media campaigns. Project partners jointly developed and distributed promotional materials like posters, pamphlets, leaflets, information videos, talk shows, exhibitions and transit mass media highlighting the benefits, cost, services of the biogas technology and project arrangements. Exhibitions proved very effective as they afforded prospective clients to interact with the technology and service providers at the same time.
4. Technology Promotion Investment (TPI): In order to try and address the issue of cost (which was seen as a major barrier to adopting the biogas technology), the ZDBP created an 8 month subsidy on digester construction. The construction cost of a domestic biogas unit of 6 m³ or 9 m³ is between US$700 - $1000.

The TPI was valued at US$250. Initially this fund was given to masons as an incentive to construct more digesters. However, it was soon realized that the mason's motivation did not come from this investment. It was the households that actually needed incentives. Thus the fund was then channeled to subsidize construction costs on cement and dome-pipes.

Early adopters received a voucher to redeem building materials from a participating local hardware shop. The program would then pay directly to the hardware shop owner after the voucher has been redeemed.

The vouchers scheme was designed to be used in a broader supply chain framework with a clear focus on business relationship building for sustainability. The TPI may be an important instrument for first time programs in leveraging the construction materials value chain.

Capacity building of Local Masons

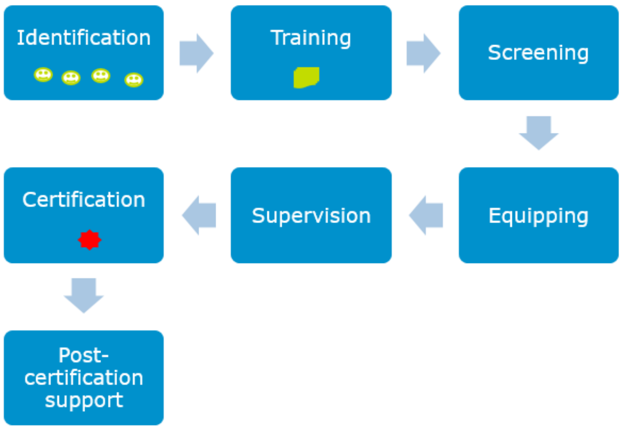

Figure 4 Masons Capacity Building Steps

The project sought to build local capacity to build, maintain and service biogas technologies. This was done through seven steps as illustrated in Figure 4:

Mason Identification: The government through the Ministry of Youths, Indigenization and Economic Empowerment and the Ministry of Small to Medium Enterprises and Co-operative Development (SMEs) identified masons in the targeted local areas. The basic criterion for selecting the masons was their general building experience with various structures like toilets and houses within their communities.

Training: Training was in two stages. The first stage was composed of a 14 days classroom training. In this workshop the masons were taught the theory of the biogas technology. The second stage involved a practical component where the class would build a digester together in partial fulfilment of the course. Government line ministry officials and staff from Technical, Vocational Education & Training Centers were involved in the training workshops of masons to ingrain biogas technology in their curriculum.

Screening: After the training, those who did not show potential and aptitude were dropped from the program.

Equipping: Successful masons were provided with tools and protective clothing.

Supervision: At this stage, masons underwent a kind of apprenticeship/housemanship where they were engaged in supervised construction. Under supervised construction a mason was expected to build at least three digesters under the supervision of a Quality Controller (government official or project staff member). After this the mason was regarded to have obtained relevant and satisfactory experience.

Certification: After the apprenticeship stage, the masons were then certified by the program as a biogas digester mason. Depending on their performance during the training, the masons were certified in four classes Blue, Silver, Gold and Platinum (on an ascending scale with Blue being the basic and Platinum the highest accolade). The masons strove to achieve the highest accolade as this would make them more marketable. Of the 31 masons trained 12 were awarded the Platinum certificate, 6 Gold and 13 Blue. After certification the masons were then deemed ready to go out on their own into the market and begin to construct digesters independently. They assumed the role of biogas entrepreneurs through which they would market the concept of biogas digesters within their communities and sign-up customers in the same way that they would for other building projects.

Post-certification Support: After certifying the mason the project continued to support the masons with trouble shooting, additional training and other needs.

During the training period, masons gained: technical masonry skills, entrepreneurial skills (ability to identify market opportunities and create profitable solutions); skills on how to perform key business operations (ability and desire to organize and manage operations); operational skills (Scheduling, subcontractor/employee management, and materials/supply procurement); accounting (record-keeping) and Finance skills (cash flow management, Sales). This was intended to make the masons self-sufficient beyond the program's life.

Digester construction

Once a household had indicated they wanted to adopt the technology, a trained mason or a government official would visit the household to size and site the digester. This service was offered free. At this stage a 'go' or 'no go' decision was made based on the feasibility (technical or financial capability). If it is a 'go' decision, the household would negotiate labor costs with the mason and sign a 'Sales Agreement' as well as start procuring building materials. Once all the key building materials were on site, the mason would start construction works. At every key stage a government quality controller would come and certify the workmanship. After construction and the initial feeding, the digester would be commissioned. The digester details and geographic location would be logged on a database for post construction support.

To manage the digester construction materials value chain, the project engaged the manufacturer of cement (Lafarge in Harare and PPC Cement in Bulawayo) to ensure distribution channels. For example Local Agrodealers (rural shops) would be stocked with cement and other building materials on consignment. While there is generally no shortage of cement in Zimbabwe, the distribution channels may sometimes be skewed against remote and isolated communities.

Under this activity a total of 122 digesters were constructed. A further 52 digesters were still at the sitting and sizing stage at the time of writing.

Fabrication

The project noted that some components like dome pipes and gas stoves were not readily available on the local and national market. Furthermore there were no local producers for some of these items. Fabricators (existing engineering companies who were interested in broadening their product lines to include biogas components) were engaged and trained on fabricating the components. One very successful fabricators who later become the fabricator of choice for most masons is Milkraft Engineering (Pvt) Limited in Harare. The engineering companies were not only receiving technical drawings of the components and making them, but rather they were actively engaged in research and development of appropriate components. For example, when the project started promoting biogas refrigerators for milk cooling among dairy farmers, the fabricators were involved in a research to develop an appropriate jet diameter size that would allow milk to be cooled in the appropriate time and at the right temperature thus ensuring milk storage quality, microbial standards, maintaining appropriate pH and organoleptic characteristics in an acceptable range.

Research and Development

The programme appreciated the importance of applied research and development (R&D) to continuously improve the performance of the bio-digesters, enhance user experience and to reduce cost. Thus special studies were conducted to test and explore on pertinent issues. For example, studies were conducted on the biogas digester market, appropriateness of the biogas technology for milk cooling, appropriate cook stoves and bioslurry. Households were involved in the studies. For example farmers carried out yield test on fields which had slurry added and those which had no slurry added. A laboratory investigation of the slurry was carried out and traces of Salmonella were detected in the slurry. The results of the studies were immediately incorporated into programming.

Coordination, Monitoring and Evaluation

As a funded public-private partnership program the ZNBP partners realized that the project required a slightly different approach to the regular parastatal or government departmental system of operation (ZDBP 2013). A National Implementing Agency (NIA) was setup with a Secretariat and a Monitoring and Evaluation Unit. The NIA was housed within a government Agency i.e. the Rural Electrification Agency (REA). The NIA Secretariat was headed by an Administrator who reported to the REA Chief Executive Officer. The NIA Secretariat also had a dotted reporting relationship with the National Steering Committee made up of the heads of the partnering organizations. Individual partner organizations would have their roles and activities cut out by the NAI and they reported to the NAI on progress. Implementing these structural issues proved difficult as the institutional formation and transactional costs of setting them up had not been pre-budgeted for. There is need to cost and plan for these institutional capacity building issues.

Project Outcomes

The ZDBP managed to achieve two of its main aims, which were, to develop a commercially viable domestic biogas sector thereby increasing the adoption of biogas and thus improving the livelihoods of rural communities. However, the project had its fair share of challenges and the outcomes are less impressive in light of its theory of change as well as its constituent implementation strategy and set targets (especially number of digesters constructed and people reached). The following subsections discusses the project outcomes in detail.

Awareness raising and promotion of the biogas technology

The project was largely successful in raising awareness about the biogas technology in the country. Three regional full-time promotions officers were hired and more than 60 promoters were trained. A large number of people were reached with biogas technology messages. To illustrate the depth with which the project's promotional activities reached the intended end-users, the project constructed digesters in all the rural provinces of Zimbabwe. Figure 7 illustrate the reach of the ZDBP in the country's ten provinces by year.

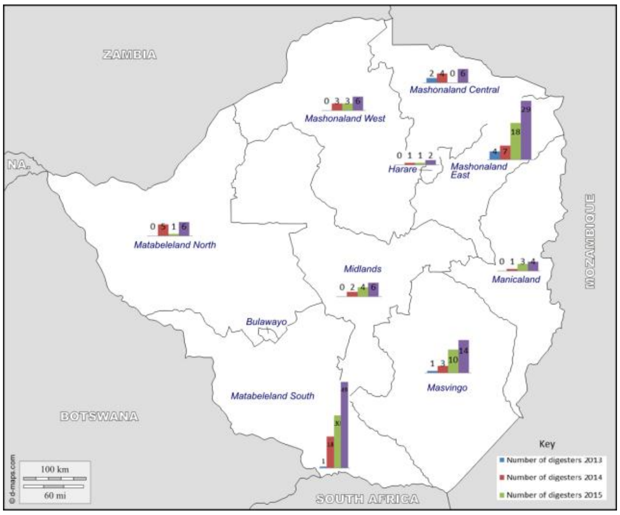

Figure 5 Digesters constructed by Province in Zimbabwe

The use of the TPI was important in stimulating demand but by nature it is not sustainable. Therefore a market-based funding mechanism would be appropriate but it should not be too expensive both for administrators and clients. It may be administered through mobile money systems. Repayments tenures can be aligned to livelihood options of clients.

Capacity building of Local Masons

One of the main outcomes of the ZDBP is that it built local capacity for siting, sizing and construction of domestic-size biogas digesters by individual builders and construction companies in the country. A total of 31 masons were trained and are actively constructing digesters. A couple have metamorphosed into small and medium enterprises for example some two trained masons (Tendenedzai and Pedzisai) have formed a construction company called Masons Partnership. A further 11 quality controllers were also trained and equipped.

Digester construction and Supply of Construction Materials

A total of 122 bio-digesters were constructed and completed in the 24 months under study. A further 27 were still under construction and several more had been sited and sized. An average of 4 digesters per month were built in the first year and this increased to 5 digesters per month in the second year. If this incremental rate is maintained the project might achieve around 70% of the set targets by the fifth year. None of the digesters completed under the project had stopped functioning during the period under study. Figure 8 illustrate biogas digesters constructed by year.

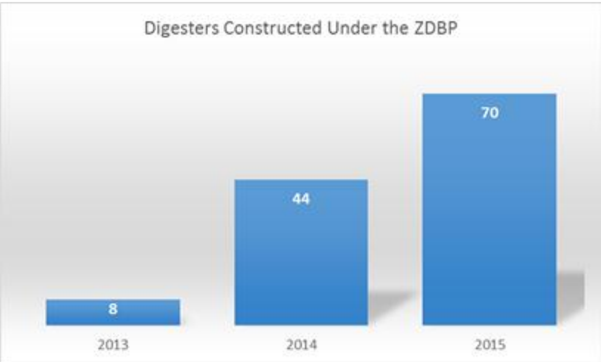

Figure 6 ZDBP Digesters

While the number of digesters constructed may seem impressive for a market-based program, a worrying trend emerges when the achievements are juxta-positioned with set targets. For example the digester target for the first 24 months from November 2013 to November 2015 was 370 but the project only managed to construct 122 digesters. Figure 7 illustrate the yearly achievements against set targets. This lead to the suggestion that target setting was too ambitious and not evidence based. However, a comparative analysis pitting the ZDBP and other national programs like the Ethiopian and Kenyan programs show that the targets were not too ambitious. For example Kenya managed an annual average construction rate of about 2315 digesters while Ethiopia made 1632 digesters (SNV 2013).

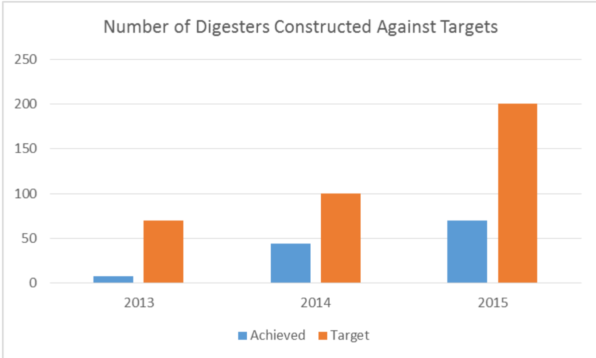

Figure 7 Digesters constructed against targets

Similarly, the target for the number of people using biogas technology outstripped the achievement. Figure 8 illustrate the finding.

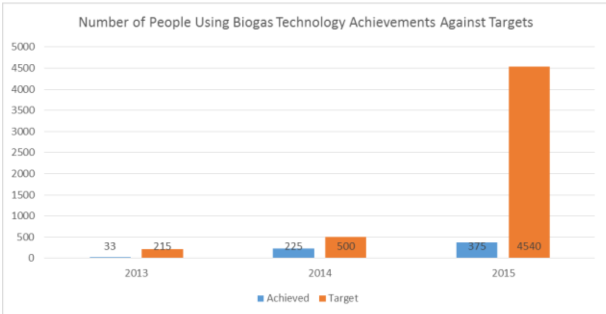

Figure 8 Number of people using digesters constructed under the project

The construction materials value chain has been established in some provinces with local shops stocking building materials especially cement. Two large manufactures of cements acknowledge the program and are willing to continue the supply chain. However, the supply of other digester components is not well developed. The supply of gas stoves, dome pipes and other fabricated parts is still dominated by one major fabricator. This causes a bottleneck in the supply of the items to remote locations. It will be important to have at least two fabricators in each province.

Economic subsectors like piggery, poultry and dairy seized the opportunity and promoted the technology among their own members. A good case in point is the dairy subsector. There are an estimated 1743 smallholder rural dairy farmers in Zimbabwe with cold chain issues (SNV 2012). They provide a ripe market for biogas technology. The biogas value proposition for dairy farmers was impeccable. Most dairy farmers are struggling with the fresh milk cold chain. Forty percent of afternoon milk is not being offered to the formal market due to the poor cold chain (Chinogwenya and Sango 2015). Sixteen percent milk go bad before it reaches the market (Ibid). A rural smallholder dairy farmer losses between 3 liters and 20 liters of milk per day (Ibid). The project introduced biogas fridges. Twelve digesters have been completed for dairy farmers. About 28 dairy farmers had started excavation works and are gathering building materials and a further 30 digesters have been sited and sized. Figure 9 illustrate the situation in the dairy subsector.

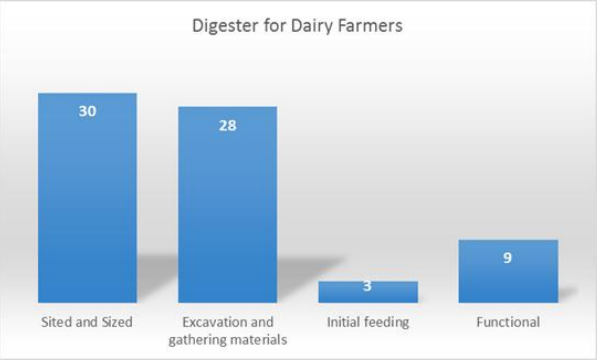

Figure 9 Dairy Digesters

SNV and HIVOS (2012) estimated that the appetite among dairy farmers is 100 household digesters. These have almost been achieved in the twenty-four months of the project (70 digesters including digesters that have been sited and sized)

Research and Development (R&D)

R&D was not well coordinated in the project. This led to piecemeal R&D. There was no dedicated partner to conduct applied research. The project could have benefitted from a dedicated research institute like the Scientific, Research and Development Center (SIRDC) or the University of Zimbabwe. There was little effort to tap into the experience of users in order to refine the technology. A case in point is studied in the dairy sector. The studies could have been done more professionally by a dedicated research institute and not by SNV, a non-research civil society partner.

Sector Coordination, Monitoring and Evaluation

The project profiled the biogas technology well. Several other players in the sector including private sectors companies and civil society organizations saw the project as a reference point. While the renewable energy sector still has a long way in standardizing approaches and technologies, the project has set a good foundation for this. As a funded Public-Private Partnership Program the ZNBP developed a slightly different approach to the regular parastatal or government departmental system of operation. This may not be sustainable in the long run as central government may not allow parallel structure beyond the lifespan of the project. Thus there was need to strengthen existing government structures to perform the functions rather than create parallel institutions like the NIA. Governments should be persuaded as part of their contribution, to fund new and additional functions within their structures.

Overall Assessment

National biogas programmes can be implemented across Africa. Using the Zimbabwean experience, other country programmes would have to consider their varying climatic, economic drivers and cultural conditions. However, the basic building blocks include:

- A relatively sufficient national herd and farmer base.
- Access to water.
- Economic subsectors that can nest the new technology
- A technology adoption funding mechanism like an energy fund.

For the programme to be successful, a broad-based implementation matrix is necessary. No one particular entity can roll-out a national program successfully. However, interest and roles need to be clearly spelt out avoiding duplication of mandates (for example SNV and HIVOS in the ZDBP) as this breeds competition for space which might be detrimental to the overall objective. It is suggested that the consortia be composed of the following:

- A government imperative (to align to the country policy framework and national priorities)
- Technical partners well versed in the technology,
- Funding partners both civil society (to cover transactional costs of the implementation matrix) and private sector
- Research partners.

A market-based approach was used in Zimbabwe, with heavy involvement of the private sector to stimulate up-take and support services. Evidently a market based-approach leads to a slow uptake as households weigh their options and choose where to invest rationally. However, this ensures sustainability and optimal utilization of the technology. While the reporting period is too short to make authoritative assertion about sustainability, inference from other similar programs like the ABPP[3] implemented in Ethiopia, Kenya, Tanzania, Uganda, Senegal and Burkina Faso as well as programs in Vietnam, Cambodia and Bangladesh show that a market based approach, where the end-user commits its own investments is likely to be sustainable.

For success, the program should be nested in particular economic sectors. For example the potential for nesting biogas programs in the dairy subsector is huge in Sudan, Egypt, Kenya, South Africa, Tanzania and Algeria. There are in each country certain subsectors that require the technology more than others. These should be specifically targeted.

The fuelwood crisis may lead to adoption. However, this is not a direct precursor. For example, provinces in Zimbabwe hardest hit by the fuelwood crisis are not adopting the technology as those that can nest the technology in economic activities.

Neither do regulations force households to adopt biogas solutions. For example in the piggery industry, a farmer should have a waste management plan. Biogas digesters as a waste management solution was pitched to pig farmers but this did not translate into a wholesale adoption of the technology. Farmers did not find anything else to do with the digester besides space heating which is not a key production issue in Zimbabwe. Although in dairy, farmers are heavily penalized if they release milking parlor effluents into the environment. They did not adopt biogas for this, but to improve their cold chain. Actually, few dispose their milk parlor effluent into the digesters fearing that the chemicals and detergents they use may affect microbial activity in the digester.

One of the critical success factors of a national program is supported by the policy environment. The ZDBP was nested in a broader policy framework. For example the Zimbabwe energy policy as well as the economic blue print Zimbabwe Agenda for Socio-economic Transformation (ZIMASSET) recognized the importance of biogas (GoZ, 2013). The ZIMASSET for example went as far as imposing national targets (1 250 biogas plants installed by 2018) on the ministry responsible for energy[4]. The biogas technology should also be formalized through being engrained in national education curriculum.

The digester construction materials value chain needs to be managed. In Zimbabwe the project engaged cement and other building material manufactures to link with rural shops on consignment arrangement. Masons were linked to fabricators who could supply them with dome pipes, and biogas stoves. This is important in countries where some commodities may be in short supply like cement, wire mesh and pipping.

A balance has to be struck between support to the biogas demand and supply side. On the supply side

3 https://energypedia.info/wiki/Domestic_Biogas_-_African_Biogas_Partnership_Programme_(ABPP)

4 ZIMASSET Pg 94

of the market, the project partners should ensure that necessary skills are available locally. On the demand side, the program should ensure that households understand the operation and maintenance of their plants sufficiently. There are several cases where bio slurry is not being used and has become a problem for households. While the benefits of bio-slurry are known, farmers find handling bio slurry cumbersome and inconvenient compared to conventional fertilizers.

Households need support when dealing with the private sector including masons to achieve win-win partnerships. The ZDBP conceded that its client support process is not adequate (ZDBP 2013). Some households did not get the technology on time and to their satisfaction. The client-mason relationship was deemed private. This led to a very slow biogas digester construction pace. The client need financial support, negotiation skills and quality control skills. This can be done during the promotion stage. There should be a complaint and feedback mechanism. When, costing complaints started to surface the ZDBP set ceiling for labour costs that masons could charge. This leads to a controlled economy which may deter some experienced masons.

Conclusions and policy implications

Despite The Zimbabwean program, though falling short in some instances on its theory of change and targets, has demonstrated that biogas uptake can be up-scaled in Africa. The study has shown that neither a natural resources crisis nor regulations stimulate a green economy. National governments should forge broad-based partnerships with civil societies, private sector companies and research institutions to promote their ideals.

Nesting new technologies in relevant subsector economies is effective for upscaling uptake. Dairy, piggery and poultry are value chains that have potential in many African countries.

While free inputs are generally discouraged. National governments should craft limited subsidies when introducing new technologies. Equally important are learning sites like early adopters in the ZDBP as well as incorporating the technology in national education curriculum.

Upscaling the uptake of biogas is important for achieving green economies and mitigating climate change problems. This is a shared concern for the Africa for Results Initiative (Afrik4R), the African Community of Practice (AfCoP) on Managing for Development Results (MfDR) who took a lead on discussing how to manage the impacts of Climate change on agriculture and rural development.

References

Abaza Hussein, 2012. GREEN ECONOMY IN ACTION: Articles and Excerpts that Illustrate Green Economy and Sustainable Development Efforts. UNDP August 2012

Ajzen, I., & Fishbein, M. (1980). Understanding attitudes and predicting social behaviour. Englewood Cliffs, NJ: Prentice-Hall.

Chinogwenya Ivy and Dowsen Sango 2015. An assessment of bio-refrigerators as an appropriate technology for improving milk quality in the Zimbabwean small scale dairy sector. An SNV Working Paper.

Chuttur M.Y. (2009). "Overview of the Technology Acceptance Model: Origins, Developments and Future Directions," Indiana University, USA . Sprouts: Working Papers on Information Systems, 9(37). http://sprouts.aisnet.org/9-37

Government of Zimbabwe. 2013. Zimbabwe Agenda for Sustainable Socio-Economic Transformation (ZimAsset) "Towards an Empowered Society and a Growing Economy" OCTOBER 2013- DECEMBER 2018

Government of Zimbabwe. 2011. Zimbabwe Medium Term Plan: Towards Sustainable Inclusive Growth, Human Centred Development, Transformation and Poverty Reduction. Ministry of Economic Planning and Investment Promotion. Republic of Zimbabwe

Hagen M., E. Polman, K. Jensen, K. Jan, M. Asger, J. Owe and D. Anders. 2001. Adding Biogas from Biomass to the Gasgrid. Swedish Gas Centre. Report SGC 118, Malmo

Heegde ter Felix and Kai Sonder 2007.Biogas for Better Life: An African Initiative, SNV, Den Haag

Hosier, Richard. 1986. Zimbabwe: Energy Planning for National Development. Issue 9 of Energy, environment, and development in Africa, Nordic Africa Institute.

Itodo, I. N., G. E. Agyo and P Yusuf. 2007. Performance evaluation of a biogas stove for cooking in Nigeria. Journal of Energy in Southern Africa. Vol 18 No 3

Kawulich, Barbara B. (2005). Participant Observation as a Data Collection Method [81 paragraphs]. Forum Qualitative Sozialforschung / Forum: Qualitative Social Research, 6(2), Art. 43, http://nbn-resolving.de/urn:nbn:de:0114-fqs0502430

Matsvange Diego, Ruvimbo Tecla Sagonda, Patisiwe Zaba and Munyaradzi Kaundikiza. 2016. Biogas Technology Diffusion and Adoption Mechanisms in Zimbabwe. AFRICA INSIGHT Vol 45(4) – March 2016, p148-166

Marshall, Catherine & Rossman, Gretchen B. (1989). Designing qualitative research. Newbury Park, CA: Sage

Moyo, Jeffrey, 2016. Zimbabwe's Famed Forests Could Soon Be Desert. Inter Press Agency. http://www.ipsnews.net/2015/02/zimbabwes-famed-forests-could-soon-be-desert/

Mumba Joseph 2006. Biogas Initiatives Undertaken In Africa So Far: Successes and Failures

Norin Erik. 1998. Biogas – What You Can Do With Rotten Apples. Swedish Biogas Association. Stockholm

Park, S. Y. (2009). An Analysis of the Technology Acceptance Model in Understanding University Students' Behavioral Intention to Use e-Learning. Educational Technology & Society, 12 (3), 150–162.

Persson, Margereta. 2003. Evaluation of Upgrading Techniques for Biogas. Swedish Gas Center AB, Report. SGC 142, Malmö

Pimentel, D. M. Pimentel and O. Karpenstein-Mahan.1999. Energy use in agriculture. Vol. 1, December

Sasse, L. 1988. Biogas Plants. 2nd edition. Vieweg and Sohn, Germany

Schensul, Stephen L.; Schensul, Jean J. & LeCompte, Margaret D. (1999). Essential ethnographic methods: observations, interviews, and questionnaires (Book 2 in Ethnographer's Toolkit). Walnut Creek, CA: AltaMira Press.

SNV 2012. Zimbabwe's Dairy Sub-sector Study. Report coordinated by J. M. Kagoro and K. Chatiza, Harare

SNV 2013. African Biogas Partnership Program. End of Project Report. Nairobi.

SNV 2015. Biodigesters for Clean Healthier Life. The East African, August 29-September 4 2015, p16

SNV and HIVOS 2012, Feasibility on a national domestic biogas programme in Zimbabwe. Report coordinated by Willem Boers, Harare

Vagdahl, Kaj. 1999. Distribution of Biogas in a Biodigester. Swedish Gas Centre AB, Report. SGC 101, Malmo

WORLDOMETERS 2016. http://www.worldometers.info/world-population/

ZDBP 2013. Zimbabwe National Biogas Programme: Monitoring & Evaluation Framework. Working Paper produced by HIVOS.

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