Case study:

SUSTAINABLE ENERGY ACCESS IN RWANDA'S RURAL AREAS

Developing a business model for biogas production

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About this publication

This is one of the series of brochures aimed at experience sharing on ARCOS NBCEs Programme. Other case studies produced include:

- ***Community Managed Tree Nursery Centers for Water, Energy and Food Security***
- ***Building Community Ownership and Institutional Development***
- ***Nature Based Village as a model for transformation towards sustainable community development***
- ***Nature Based Community Enterprises as means to create jobs for youth***
- ***Using water hyacinth to improve livelihoods and restore freshwater ecosystems***
- ***The benefits of market-oriented agriculture to women***
- ***Sustainable Energy Access in Rwanda's Rural Areas***
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About ARCOS Network

Established in 1995, the Albertine Rift Conservation Society (ARCOS Network) is an non-governemntal organisation working with NGOs, Governments, Community-Based Organisations and the Private Sector, with the Mission "*To enhance biodiversity conservation and sustainable management of natural resources through the promotion of collaborative conservation action for nature and people***".**

ARCOS has programmes extending in the Albertine Rift region, the Africa Great Lakes and African Mountains.

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1. Introduction: Rwanda's road towards sustainable cooking energy for all

Biomass constitutes the backbone of the energy sector in Rwanda. Specifically in terms of household cooking energy, 97% of all consumption comes from biomass energy resources (firewood 86%; charcoal 11%; crop waste 2%; and other fuels 1%) (MININFRA 2011). Electric stoves and microwaves are used only in urban areas and, to a limited extent, by commercial establishments and wealthy households. In addition, a small increase is currently observed in the use of Liquefied Petroleum Gas (LPG) by middle-class households especially in urban areas.

This high dependency on inefficient and unclean biomass cooking energy sources has resulted in many adverse impacts both on the environment and the health of the population.

As an example, there are an estimated 5,680 deaths a year in Rwanda related to Household Air Pollution (HAP) and over 94% of these are children. This makes HAP deadlier than HIV/AIDS in Rwanda.

In terms of availability of biomass resources, the national Biomass Energy Strategy (MININFRA 2009) notes that the country faces a biomass deficit of over 4 million m^3 per year and this makes it difficult for Rwanda to achieve its Forest Landscape Restoration commitments since more trees are needed to satisfy the cooking stoves than planted.

In order to bring a solution to this challenge, Rwanda subscribed to the Sustainable Energy for All (SE4All) Initiative, a global program that was launched in 2011 with three objectives: increased energy access and efficiency, and a steady move towards renewable energy sources.
Moreover, the country enacted a National Energy Policy and an Energy Sector Strategic Plan which set out a framework for specific actions to achieve, among others, a drop to 50% of the percentage of households using wood energy as a source of energy (Revised Rwanda Vision-2020, MINECOFIN, 2012).

Rwanda, under the SE4ALL action plan (for the horizon 2030) committed, among others, to close the gap between production and consumption of biomass to make it a sustainable source of energy and to provide the growing and urbanizing population with a clean secure supply of cooking biomass energy.

Biogas Infographic by SimGas

1. Manure from livestock
Each day a farmer feeds the digester with manure from livestock and water.

2. Anaerobic digestion
Inside the digester, micro- organisms work symbiotically to convert the manure into biogas and slurry through the process of anaerobic digestion.

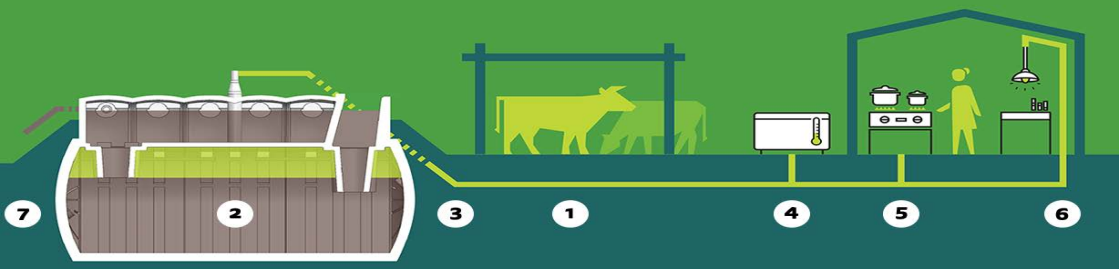
3. Piping
Biogas flows through piping from the digester to the farmer's house, where the pipe is connected to a cookstove and other biogas auxiliaries.

4. Milk chiller
Biogas can be used to power off-grid milk chillers to keep milk fresh.

5. Cook stove
Biogas stoves allow farmers to cook their meals using a clean fuel.

6. Biogas lamp
Biogas can fuel gas lamps used for both task and ambient lighting.

7. Organic fertilizer
Slurry that has been fully digested exits the system onto to the farmer's land where it is used as an organic fertilizer.



This should be achieved through improved cookstoves, more efficient charcoal, biomass pellets, biogas and LPG.
Particularly, pelletized biomass and biogas were identified as the two most promising alternative sources of cooking energy. Among the two, biogas has the biggest potential for growth if hurdles in its supply-chain are well addressed.

In terms of implementation, the government and its partners have since undertaken a number of programs such as the National Biogas Program (NDBP) which targeted to install 12,000 bio-digesters to produce biogas by 2018 and the incorporation of digesters in relevant institutions.
Aggressive incentives were thus put in place including the 50% subsidy for poor households who can operate a biogas digester and all districts were called upon to include biogas promotion in their districts development plans as well as their annual performance contracts also known as “Imihigo”.

Notwithstanding the notable progress that has been made so far, much remains to be achieved on this road towards sustainable cooking energy for all.
A recent study commissioned by IUCN and conducted by ARCOS Network found that the improvement of tree harvesting and carbonization techniques as well as promotion of efficient use of biomass through pyrolysis and full adoption of certified improved cooking stoves have not been fully achieved. Yet, we are at the end of the implementation period for the current Energy Sector Strategic Plan.

Biogas in particular faces a set of unique and different challenges since there exists a variety of constraints to the provision of biogas digesters.
These challenges include the fact that their market absorption capacity is constrained by the low purchasing power of households despite the various financing options and incentives that have been put in place.
Moreover, there is a lack of information and standards to allow better targeting and prevent digesters breaking down and more training is required to increase masons numbers and ensure effective maintenance.

The istallation of biogas plant. The cost is generally beyond the means of many poor. Photo: NewTimes

2. The Challenge: Making biogas a lucrative business

Since 2007 the National Domestic Biogas Program has targeted households with at least two cows to provide enough cow dung.
Digesters have been based on a standard construction design using local materials. The financing mechanism for households incorporated a 50% government subsidy with the remaining cost generally being met through local credit institutions.

Scaling up biogas significantly will require considerable challenges to be overcome.
Firstly, the technology needs to be improved in order to improve reliability. Secondly, affordability of systems needs to be addressed. At around $400 per system, the installation of biogas systems requires a considerable financial outlay which generally is beyond the means of many poor households.

Thirdly, and perhaps most significantly, the potential of biogas depends on the percentage of households that possess or are able to maintain at least two cows in order to generate enough cow dung to feed the digester.
Despite the big number of households which fulfil these criteria and therefore have the potential to benefit from the national biogas program, the uptake is still low.
This is due to the fact that most eligible households cannot afford the initial cost of digesters even after the huge government subsidy. Furthermore, there is limited technical knowhow in remote areas for the maintenance of the biogas systems.

Indeed, the government has done its due share through funding the research on best models of bio-digesters suitable to local conditions.

woman carrying a biogas back from a biogas seller in Ethiopia

It has also thought about the capacity development, training technicians and entrepreneurs, social marketing and subsidizing the construction of biogas systems for households.
However, the realization of the full potential of biogas as a viable cooking energy source for the rural Rwandans requires additional innovative ways for the production and distribution of this fuel.

This innovative re-thinking about biogas systems could borrow a leaf from the notable success story of the adoption of institutional biogas systems where, in schools and prisons, they have reduced firewood consumption by close to 60% and 40% respectively.
As a bonus, the adoption of biogas in these institutions has also significantly improved hygienic conditions of inmates and students and contributed a lot in cost savings.
When this success rate is put in contrast with the painful adoption of biogas by households, it becomes apparent that part of the problem is related to the size and scale of the systems.

In retrospection, the institutional biogas systems have benefited from the fact that their size allows their owning institutions to sink their construction and maintenance costs easily through the economy of scale.
If such a model can be replicated for rural households where large collective digesters are used instead of disparate small household systems, then there is no doubt that a similar success rate can be registered.
This, of course, would require solving the biogas transportation problem and development of adapted cooking stoves. On top of that, a business model has to be developed to facilitate the entrepreneurs to source the funding of the needed investments and recover the costs and make profits through sales to households.

The potential biogas market in Rwanda is estimated at 150,000 households and a client base of this magnitude along with a plethora of different government incentives (financial, fiscal, and technical) around the biogas value chain would combine to ensure the development of a potentially thriving business around biogas in Rwanda's rural areas.

3. ARCOS' Response: Scalable biogas solutions for Rwanda's rural households

One of ARCOS' strategic goals under its current strategic plan for the period 2016-2020 is to promote energy efficiency and access to clean and renewable energy. To achieve this, ARCOS is working with governments, communities and private sector for innovative solutions that promote access to affordable and sustainable energy services.

As embedded in ARCOS' Motto "Collaborative Action for Nature and People", collaboration with stakeholders is a key element of all ARCOS' endeavors. In this context, ARCOS' Community Development Programme, named Nature-Based Community Enterprises (NBCEs), has devised a collaboration framework and programme implementation process called BEST through which all its community work is conducted.

In general terms, ARCOS' BEST Approach comprises of the following four key components:

Components of ARCOS' Approach for Community Development (BEST)

B: Building leadership and sustainable institutions.
At this stage, the community group ARCOS is working with is supported to improve management and governance and to set targets and work plans that are gender and youth-inclusive.

E: Enhancing environmental resilience.
This component consists of assisting the community to integrate good practices in their production systems such as Ecosystem Based Adaptation and promotion of efficiency in the use of water, energy and other natural resources.

S: Sustainable business solutions.
This component includes assisting the community groups to develop and implement sound business plans that include value addition, private sector engagement, market linkages and quality certification.

T: Transforming and inspiring others.
At this stage, the partner community group is supported to undertake initiatives that makes it a beacon of transformation in their area of operation. To achieve this, the concept of Nature Based Village (NBV) has been developed which is a geographically defined village where efforts in the promotion of good environmental practices is concentrated to serve as a model for the integration of environment and sustainable livelihoods. Other initiatives are also conducted under this component such as the establishment of a Nature Based Community Fund (NBCF) to support and sustain sustainable practices in NBV through loans, best performers' awards and common services as well as the organization of community to community exchange visits to allow communities to learn and share practical experiences in the promotion of sustainable livelihoods.

4. Achievements and Impact: *Developing mechanisms for adoption of biogas by poor households through Nature-Based Community Enterprises*

A Total Economic Valuation (TEV) of Mukura forest conducted in 2014 (ARCOS, 2014) and a study termed "Integrated Landscape Assessment and Monitoring – ILAM" conducted by ARCOS in Mukura in 2016 (ARCOS, 2016) both found that firewood extraction was the second biggest threat to the forest after illegal mining.

The respondents in these studies indicated that most households do not have enough trees either as woodlots or planted on their farms.

They therefore use Mukura natural forest as the sole source of firewood. However, the respondents reported that resources has been declining over time and they currently face a serious firewood crisis that makes them use any available alternative source of fuel, including crop residues.

Since 2015, ARCOS has been trying to promote biogas as a viable and green alternative to firewood in this area in order to reduce the threat to the Mukura forest (now gazetted as a national park). T

his effort has benefited from the already on-going national biogas programme which subsidizes biogas digesters installation at 50% of the cost. The remaining upfront costs were financed as loans through the NBCFs that were established in the different NBVs in the area.

So far, 76 households have benefited from the scheme and have digesters installed as well. Having only 76 out of thousands of households that surrounds Mukura forest switch from using firewood to biogas for cooking is not going to have a big impact in terms of reduction of pressure on the forest.

A woman in Bugesera puting firewood from tree stump to dry in sun

A Canvas-type biogas digester under construction in Rutsiro District, Rwanda

However, this has served as a proof of concept which further awareness and sensitization effort on sustainable energy will build on.

Two major challenges hinder the biogas adoption speed in rural areas. The first one is about the initial cost for installation of the digesters and the second one is the lack of local technicians that can carry out the required maintenance works at affordable prices.

To address these two challenges, ARCOS is planning to initiate the installation of big gas production stations which can sell packaged biogas to households who would then only have to install compatible cooking stoves and buy 1 or 2 mobile biogas backpacks.

This would greatly reduce the upfront cost to switching from firewood to biogas and avoid the recurrent maintenance costs required for households-based digesters.

A collective cowshed built for a cooperative as it prepares to develop a biogas production business in Bugesera district, Rwanda;

5. Lessons learned: *Subsidies don't constitute a panacea for biogas but are required to provide proof-of-concept cases*

Currently, much of the progress that has been made in spreading the use of biogas is attributable to the heavy subsidies that the government and other external development partners have put in the sector. This model is unsustainable since it distorts the market prices for the fuel and doesn't encourage the ownership by the end-users. Therefore, the installed systems are left unmaintained which results in inefficiencies and a waste of resources and money. Developing a business model around biogas in a such a way that households can access it without having to incur heavy upfront and recurrent maintenance costs is the way to go. However, the success of such a business model requires a lot of investment to develop the whole biogas value-chain from livestock farming, inspiring potential entrepreneurs, capacity building for technicians and awareness raising for end-users.

6. Challenges ahead: *Awareness and mindset change is key*

Despite this big potential for biomass in rural areas, its wide adoption at household level has been very slow due to different challenges. Among these, the change in the mindset of end-users is the most enduring and would require time to address.

It always takes time to change a tradition that has been in place for generations. Firewood has been the de-facto mode of generation of energy for cooking in Rwandan households especially in rural areas.

Different models are currently used to address the issue of biogas cost and indeed biomass-based fuels (firewood, charcoal, etc) are getting more expensive as we go along.

The main remaining factor of resistance against change towards full adoption of biogas as the main source of energy for cooking in rural areas is that of the mindset.

Intensified education and sensitization programmes are required in order to remove this last barrier on our journey towards a future devoid of polluting and expensive cooking fuels in our households.

7. Conclusion: Together we can achieve sustainable energy for all goals and aspirations

In the past, biomass or wood energy were considered traditional and backwards. Thus, the prevailing wisdom was to phase out their use as quickly as possible.

Since the enactment of the National Biomass Strategy (MININFRA, 2009), a complete U-turn has been made and biomass is now considered a major energy source with a bright future where plans are in place to modernize this type of fuel given its being renewable, its neutrality to climate change, and above all, its cheap price compared to electricity and petroleum-derived fuels. As a result of this modernization of the biomass energy (green charcoal, biomass pellets, etc), its urban consumption is projected to increase and thus the wood scarcity will continue to enlarge if a similar trend is replicated in rural areas as well.

Fortunately, biogas has a niche to be the preferred fuel in the rural areas given the availability of input materials from livestock farming and enough space in households to accomodate its bulky equipment.

ARCOS Network is committed to continue its effort to tap into this potential and it will leverage on its vast network of community partners and international collaborators as well as its long experience to deliver biogas solutions that are tailored to the socio-economic and cultural context of Rwandan households in rural areas. We call upon all development partners to join in this effort to support Rwanda reaching its SE4ALL goals through innovation and scaling up of solutions adapted to local context such as the biogas bags initiative.

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Get involved If you are interested in supporting ARCOS' Community Development Programme. Contact us for any donation, advice or any information.

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