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Biogas and Solar Energy Use in Rural Institutions in Southern Province, Rwanda

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Abstract

In Rwanda, 85% of primary energy comes from biomass. To alleviate this huge dependence, the Government banks on use of alternative sources of energy prioritising solar energy and biogas in rural areas. This paper

analyses the use of the two sources in 45 rural institutions in Southern Province, using data collected through desk study and survey. The research reveals that these sources of energy are known in Rwanda, but very few rural institutions are equipped with such systems. Solar energy and biogas are used for lighting and cooking respectively. Their adoption is still government and NGOs driven. Institutions equipped with such systems experience lack of skilled technicians resulting in poor maintenance and malfunctioning. Lack of funds, little insight on the advantages of using the two sources of energy, and existing financial facilities set up by the government to promote their dissemination are major obstacles to their adoption. Therefore, departments in charge of energy should organise awareness campaign for heads of institutions to inform them on the advantages of using these energy sources. They should also set up and run specific training programmes to avail technicians capable of installing, operating and maintaining solar or biogas power systems.

Key words: Rwanda, Southern province, biogas, solar energy, uses, constraints.

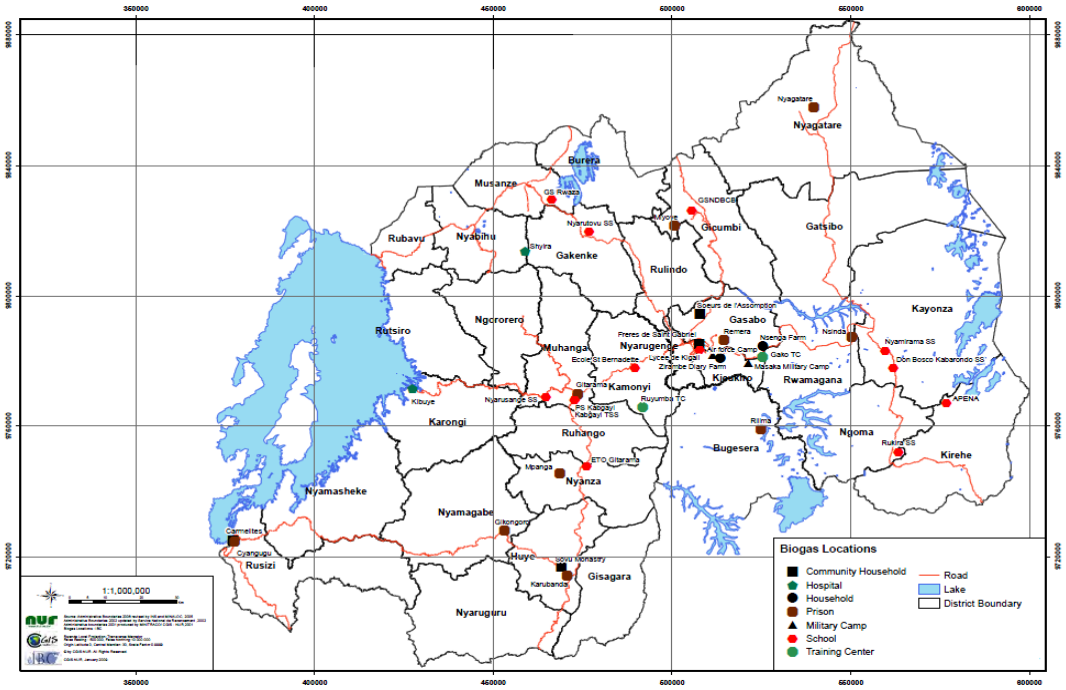
Introduction

Approximately 85% of primary energy in Rwanda comes from biomass, 11% from petroleum products and 4% from electricity (MININFRA, 2011). The large use of wood leads to both social and environmental negative effects such as time consuming for wood collection, deforestation, erosion, soil fertility and water resources depletion, climate change and so on (Muhizi, et al., 2013; REMA, 2011; Nkwatoh et al., 2009; Strassburg et al., 2009; Bajgain et al., 2005). To alleviate the great dependence on biomass, the Government of Rwanda (GoR) targets to have at least 35% of the population connected to electricity and to reduce wood use in national energy consumption to 50% by the year 2020 (Republic of Rwanda, n.d.). One of the strategies to achieve this consists in promoting solar energy for rural electrification and biogas for cooking and lighting (MININFRA, 2011). To that end, the Ministry of Infrastructure has set up the National Domestic Biogas Programme (NDBP) and Rwanda Solar Program 2012-2015. These programmes are meant to be implemented in collaboration with the GoR development partners. These include among others the European Union, the World Bank, the African Development Bank, the Dutch Government, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), the Nordic

Development, etc. (EWSA, n.d.; Nkurikiyinka, 2008) that are ready to put money in such initiatives.

In Africa, biogas system is not a new technique as the first biogas plants were installed in 1950s in South Africa and Kenya (Amigun, et al., 2012). In Rwanda, the National Domestic Biogas Programme provides clear guidelines and funding scheme for the construction of biogas digesters in households and institutions (MININFRA, 2011). Following the political commitment and financial facilities put in place, biogas systems were installed in many places of the country. A survey conducted in 2008 revealed that 28 biogas systems were installed in community households, secondary schools, prisons, military camps, training centres and in one hospital since 2001 while other 8 were under construction (Figure 1). However, some of the installed biogas systems were not functional (Munyehirwe and Kabanda, 2008). With dissemination of biogas, the GoR expected to reduce considerably the huge quantity of biomass used in cooking in households and institutions.

Figure 1: Institutional biogas installations, Rwanda



Source: Munyehirwe and Kabanda (2008).

As of the solar energy, the main objectives and targets of SolaRwanda Program are to promote the widespread use of solar water heaters in residential sectors thanks to financial incentives, and other incentive measures. The use of solar photovoltaic systems and solar heaters would assist in reducing the load of pressure on the national electricity grid while improving the country energy supply mix as a renewable source of energy (EWSA, n.d.). Indeed in the country, the potential of solar energy is significant: average solar radiation is 4-6 kWh/square meter/day (MININFRA, 2011).

Despite the existence of the policy and national programmes aiming at the development of use of solar energy and biogas systems, several studies (MININFRA, 2011; SNV, 2010; Nkulikiyinka, 2008; REMA, 2009; Munyehirwe and Kabanda, 2008, etc.) reveal that the use of the two sources is still very low in general, and within institutional communities in particular. This inspired us to undertake the current study on the use of solar energy and biogas systems in some institutions found in the Southern Province, Rwanda. Thus, this paper analyses the constraints associated with the installation and the use of solar energy and biogas systems in that province.

Materials and methods

Both desk study and survey were used to understand the general context of the use of solar energy and biogas systems within rural institutions in the Southern Province. These include schools, health centres, religious communities, industries, administrative offices, cooperatives and so on. A survey questionnaire was developed. It focused on identification of sources of energy used, their uses, constraints and challenges associated with their installation, operation and maintenance with particular attention to solar energy and biogas. The survey questionnaire was administered to heads of institutions or their representatives. The survey was conducted in 45 rural institutions, with emphasis put on those equipped with solar energy and biogas systems. As showed in figure 2, surveyed institutions are located in the following sectors: Gikonko and Kibilizi (Gisagara District), Karama and Mbazi (Huye District), Rukoma, Kayumbu, Ngamba and Mugina (Kamonyi District), Cyeza, Kabacuzi, Nyamabuye and Kiyumba (Muhanga District), Kitabi and Tare (Nyamagabe District), Mukingo and Busoro (Nyanza District), Cyahinda and Kibeho (Nyaruguru District), Bweramana, Kinazi, Ntongwe and Ruhango (Ruhango District). The survey was conducted in May-June 2012. Collected data were processed and analysed with SPSS 17.0.

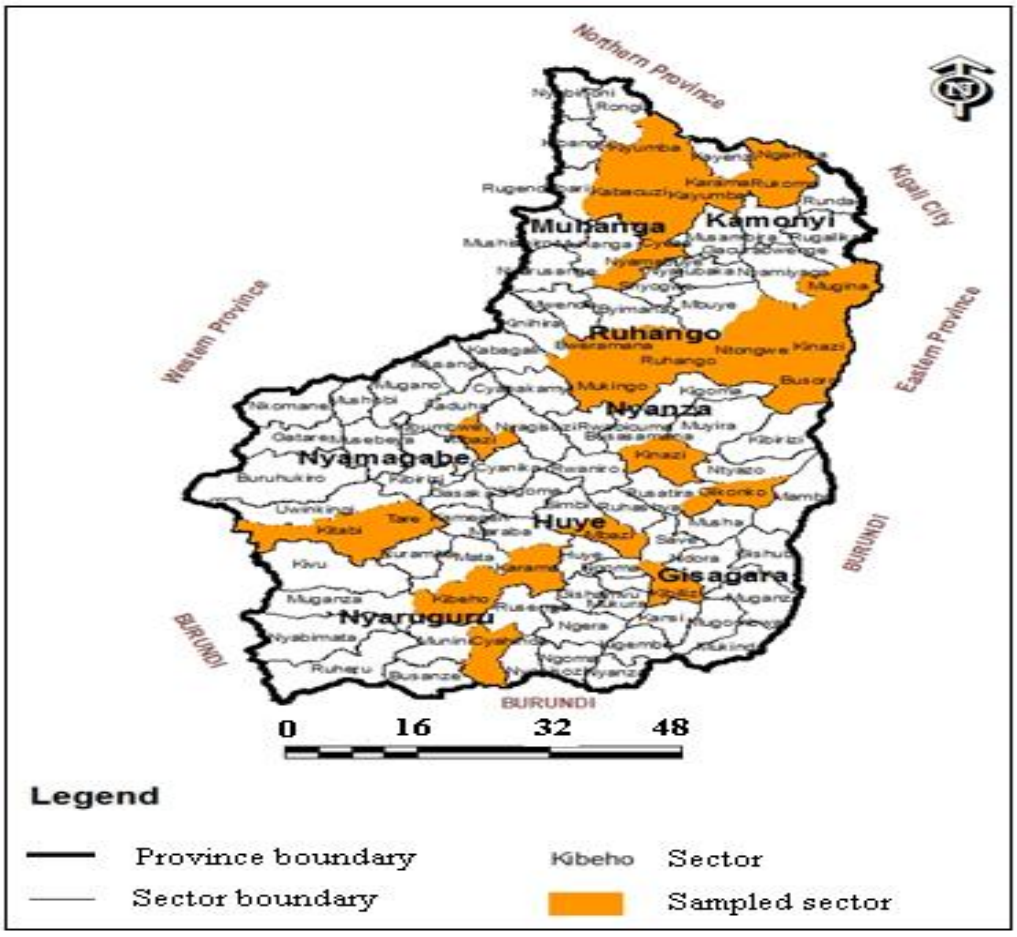


Figure 2: Southern Province, Rwanda

Results

Sources of energy used in institutions

The survey reveals that 56, 53, 51 and 42 percent of the 45 institutions surveyed use solar energy, electricity from the grid, wood and generator, respectively. Use of other sources of energy (charcoal, biogas, gas, peat, battery, dry cell) is limited as shown in figure 3. Solar energy, energy from the grid and generator are used primarily for lighting while wood is used for cooking. The relative low use of wood compared to solar and electricity from

the grid is related to the types of surveyed institutions which do not need wood as source of energy, especially administrative offices.

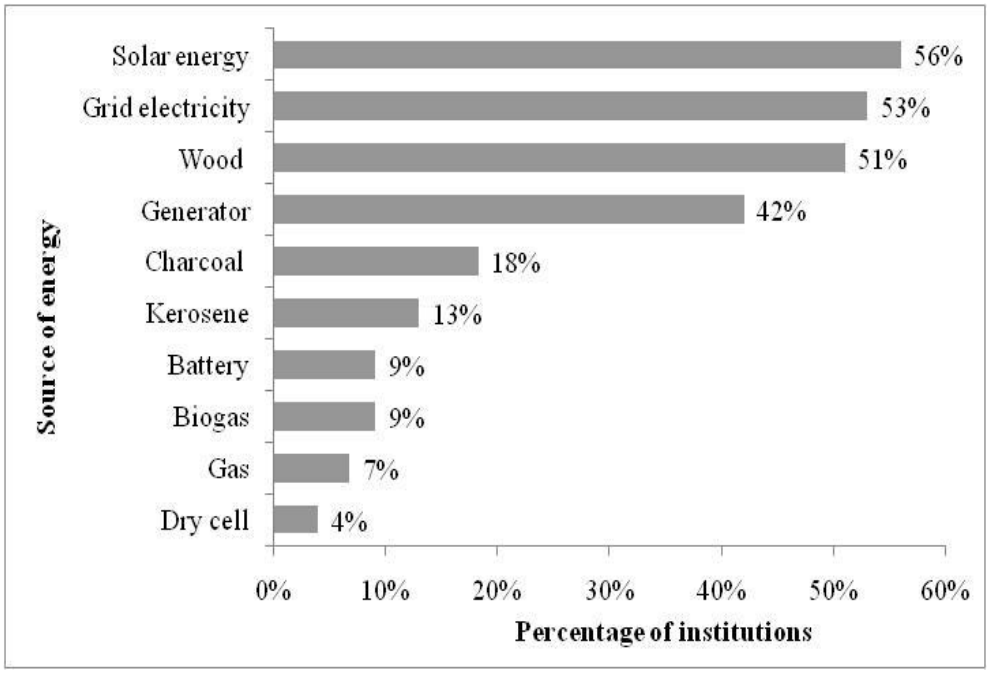


Figure 3: Source of energy used in rural institutions

Solar energy

Among the 45 surveyed institutions, 25 have solar energy system. Among them, 13 heads or their representatives (53 percent) declared that the major reason of using solar energy is that there are not connected to the electricity grid, 10 (40 percent) use it as back up, and 1 (4 percent) for other reasons. Other heads or their representatives reported to use solar energy because it is a clean and cheaper source of energy once installed. Furthermore, 19 heads or representatives of surveyed institutions (76 percent) announced that they use solar energy only for lighting. Other uses reported include operating radio, charging mobile phones and water heating. No one has reported to use solar energy for cooking.

Among the heads or representatives of institutions which do not own solar energy, 6 (30 percent) pointed up the financial incapacity (or high initial investment capital) as an obstacle to acquire such system, 4 (20 percent) mentioned the lack of awareness. Sharing the use of one solar power plant between institutions located in the same neighbourhood can help meet the high cost of investment capital. However 2 heads of institutions (10 percent) reported low collaboration between their institutions. The 8 remaining (40 percent) declared not to own solar energy system because for them, solar system has no advantages compared to electricity from the grid, or they have little or no insight of the solar energy system's potential.

Except in Nyamagabe district where none institution equipped with solar energy was surveyed, 17 institutions over the 25 institutions (68 percent) that own solar energy system complained about very little maintenance because of lack of skilled technicians.

Biogas

Among the dozen of institutions that own biogas systems in the Southern province, only four were surveyed. Biogas plants were functioning in all visited sites. All were built thanks to government' or donor's funds. Biogas systems are mainly used for cooking in the four institutions, and are also used for lighting as back up. Heads or representatives of surveyed institutions reported that their institutions have no skilled people to maintain the installed system.

Financial incapacity to install biogas system was stated by 31 heads or representatives of surveyed institutions over 41 which do not own biogas (this is 76 percent) as the major reason for not owning the system. Furthermore, little awareness and ignorance of biogas system's potential were mentioned respectively by 13 and 5 over 41 surveyed institutions (32 percent and 12 percent respectively) as other reasons for not installing biogas system.

Discussion

Solar energy, electricity from the grid, wood and generator are the main sources of energy used in institutions. Solar energy and electricity from the grid are mostly used for lighting. Generator is used in institutions which are not connected to the electricity grid or which are not equipped with solar energy. Use of electricity from the grid is most common in institutions as it has been given priority. Indeed the electricity from the grid was considered as

the only source of energy until 2000s (Kigabo and Gatarayiha, 2005). But after 2005, because of frequent power cuts, some institutions acquired generators to serve as back up. The installation of solar energy plant in institutions is recent as it dates back late 2000s with installation of photovoltaic systems in public health centres, schools and some administrative offices in some remote rural areas (Hankins et al., 2009). With this initiative, the solar energy was then considered as source of energy that could be used in provision of electricity (MININFRA, 2009).

As observed in the current study, low adoption and use of solar energy within institutions which have large population is surprising as the Government promotes the use of solar energy as one alternative way to solve the electricity problem and to lower the use of biomass (MININFRA, 2011; Hankins et al., 2009). Solar energy is promoted because of its renowned advantages. These include very long lifetime (20-30 years), low maintenance cost, high reliability, environmental friendliness and small loads (USAID, n.d.). For Rwanda specifically, the use of photovoltaic systems would reduce considerably emission of CO_2, contributing therefore to the reduction of greenhouse effect (UNFCC, ACP, UNEP and RISØ, n.d). Heads or representatives of surveyed institutions agree that solar energy is a friendly and cheaper source of energy once installed as there is no monthly bill to pay.

As of obstacles to adoption of solar energy system, it is strange to note that institutions face the same problems as individual households. These include financial limitations, little sensitisation and little insight of solar systems' potential and lack of technicians (Muhizi, et al., 2013). Heads or representatives of institutions which do not own solar system mentioned that they cannot afford the cost of installation. For those who have solar system in place, the lack of technicians is considered insuperable obstacle for their effective use as it takes long delay to get technicians to fix damaged components. These concerns are the same as the ones reported by the USAID (n.d.) which states that installation of solar system is highly costly especially if a high performance (power) is needed and lack of technicians as obstacle to adoption of solar system. Risks of theft of batteries and panels, vandalism mentioned in USAID document have not been reported by the heads or representatives of institutions. Indeed these risks can be easily overcome as all institutions have permanent guards.

However it is not understandable how the lack of financial resources can be an obstacle to the installation of photovoltaic system in institutions. Though the initial cost is high, it is assumed that private institutions (religious communities, coffee washing stations, rice processing factories, business trade, etc.) and public institutions (schools, health centres, administrative offices, etc.) should have enough means to acquire such systems. Such institutions could also benefit from the financial facilities put in place to allow the use of solar energy (Hankins et al., 2009). Indeed the cost of installation is still high compared to other sources of energy and to the region as reported (Hankins et al., 2009; Timilsina et al., 2011). However at least, State-owned institutions would benefit from government budget to boost the use of solar energy. The role of heads of public institutions is capital in addressing the issue, especially in planning. The little importance given by institutions to adopt solar energy system also broadly appears in their respective annual performance contracts. For instance in the 2011/2012 Prime Minister's Performance contract, 17 health centres and 7 schools were to be provided with solar energy systems countrywide over the whole year (Repubulika y'u Rwanda, 2012). In 2012/2013 performance contracts, none of all districts of the Southern province had included solar energy provision in its targets. Moreover State-owned institutions should also collaborate with national agency (FONERWA) and international agencies to promote the development of solar energy. These international agencies include GIZ, JICA, SNV, DFID, etc. and other donor agencies. However, the problem of training technicians also has to be addressed. Specific training should be offered to a critical mass to make available technicians able to bridge the gap.

The survey revealed that there is a low use of biogas system in institutions, though the first biogas system was installed in 1982 at Kabuye near Kigali in a public poultry project farm called *Project de développement du petit élevage* then operated by the Ministry of Agriculture and Animal Resources (Dekelver et al., 2005). The low use of biogas within institutions in the Southern province indicates that the National Energy Strategy and Policy passed in 2011 that encourages the use of biogas system especially in cooking to reduce deforestation (MININFRA, 2011) has not been implemented yet. Biogas is promoted as alternative source of energy because of its multiple advantages. Biogas technology is mastered in Africa since 1950s (Amigun, et al., 2012) and therefore its use should not pose technical problem. It is not only a cheap source of energy and cheap way of handling waste products but

also a clean and renewable source of energy. Furthermore, this source of energy has great heat efficiency and is clean cooking fuel as it does not emit smoke (Wargent, 2009). The use of biogas contributes to the increasing of agricultural production (Renwick et al., 2007) and the development of biogas industry leads to the creation of new employment opportunities (Rio and Burguillo, 2008; Vasudeo, 2005 quoted in Tumwesige, et. al., 2011).

Despite these multiple advantages, the research reveals that adoption of biogas system in the Southern province is hampered by several factors. Obstacles reported by institutions which do not own biogas plant include limited financial resources, and little insight and ignorance of biogas system's potential. These problems are similar to the ones reported by rural households in the Southern province (Muhizi, et al., 2013) and the country (Munyehirwe and Kabanda, 2008). The reported issue of limited financial means is also arguable. According to Munyehirwe and Kabanda (2008), the cost of a biogas system of 30-60 m^3 for a community is comprised between 3,000,000 and 8,000,000 Rwf, this roughly between 4,300 and 12,450 US dollars. This is not a large amount for a community especially when institutions State-owned (like secondary schools, prisons and health centres) are considered and with regards to the advantages of using biogas system. Once installed and functioning, the cost could cover all costs paid for buying wood for cooking, and such institution could reduce their CO_2 emission. In case the State cannot fund such equipment due to budget constraints, such institutions should be authorised to access to bank loan facilities set in place by the government (in line with the National Domestic Biogas Programme, NDBP) to promote the use of biogas and from which households already benefit from (Owekisa, 2008). Moreover, State-owned institutions can apply for financial support from various development partners interested in the promotion of the use of biogas like GIZ, Dutch Government, AfDB, etc. (Nkurikiyinka, 2008). In this process, farmers pay only 68 percent of the total cost while the government pays 32 percent (Okewisa, 2008 and Renwick et al, 2007).

As for solar energy, the non adoption of biogas is also related to little priority given to such development by institutions. Though it was not possible to analyse the budget of public-owned and private institutions, little importance is mirrored in district performance contract. As for the financial year 2011-2012, only two districts, Nyanza and Huye, had included the installation of biogas systems in two schools each in their performance contracts.

The lack of technicians and the poor maintenance mentioned by all the 4 heads of institutions with biogas digester are common in Rwanda. Munyehirwe and Kabanda (2008) stated that there were a very limited number of skilled technicians. In prisons that pioneered the installation of biogas digesters, one prisoner is in charge of routine operating the digester. When serious technical problems arise, all prisons request the assistance of the technician from Mpanga prison (Nyanza district) who was trained in spot by the German Cooperation in 1980s in Burundi. The two authors ascertain that in other communities, biogas is maintained by companies that constructed the plants. Yet by 2008, only 6 building biogas contractors were registered countrywide. In this context, it is understandable that getting a technician in right time is near impossible. There is therefore a big need for training in that domain.

Among other reasons mentioned by heads or representative of institutions which do not own biogas plants are little awareness and ignorance of biogas system's potential. The two reasons are frequently mentioned in Rwanda and other countries as well. This constitutes a serious drawback to the development of biogas as noted by Amigun et al. (2012) since people cannot adopt techniques unknown to them. In this context, lack of reliable information on the benefits of biogas and uninformed or poorly informed authorities mean that there is little dissemination about biogas by departments in charge of renewable energy, especially EWSA.

To promote knowledge and potential use of biogas, department in charge of biogas development should organise frequent field visits for heads of institutions to places where biogas plants are well functioning especially the prisons (Munyehirwe and Kabanda, 2008). Heads of institutions would be presented the technical aspects of the system by the technical manager as advised by Amigum et al (2012). The management of prisons would present long run financial and environmental advantages of the use of biogas.

Conclusion

To solve energy problem, Rwanda is promoting the use of alternative sources of energy. In this context, the country has embarked on the use of solar energy and biogas in all sectors especially in rural communities. The study revealed that the use of both energy system technologies is known in Rwanda since 1980s. Some institutions have pioneered in the adoption of these technologies. The research reveals that these two technologies have not

yet been fully integrated in rural institutions. Limited financial capacity, little knowledge on solar energy and biogas' potential, lack and insufficiency of skilled technicians, little dissemination of the technology among the management of rural institutions are the main barriers to the adoption of energy from biogas and solar energy. These obstacles are not specific to the Southern province, they have been also observed in other countries. As these obstacles remain while the Government of Rwanda has set financial mechanisms to overcome them, it is urgent to put more emphasis on dissemination of these measures, showing how people can benefit from them.

Recommendations

To promote the use of solar energy and biogas systems,

The Government should:

1. Extend to State-owned institutions such as schools, health centre, administrative offices the access to financial facilities put in place to promote the use of biogas and solar energy. These financing schemes are currently restricted for rural households.
2. Promote training of technicians in the installation, management and maintenance of solar and biogas systems.

Departments in charge of promoting renewable energy should:

1. Organise awareness campaign for heads of rural institutions on the potential of solar energy system and biogas system, financial and environmental advantages of using those systems and inform them on potential sources of funding, and
2. Increase the capacity of rural institutions to work with national and international funding organizations.

Rural institutions should:

1. Include the use of solar energy and biogas systems in their annual performance contract, and
2. Approach potential development partners to finance the installation of solar and biogas systems.

We think the above mentioned measures, once implemented, can contribute to the adoption of the use of solar and biogas in Rwanda.

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