

- i) Methane capture from bio-digesters.
- ii) Waste paper recycling.
- iii) Waste composting.
- iv) Waste plastic recycling.
- v) Methane capture from landfills.
- vi) Waste reuse.

During the stakeholders meeting held at the Ministry of Works Club in Nairobi on 29th November 2012, the information from the private sector was that the waste paper and plastic recycling technologies are fully deployed in Kenya. In fact the main barrier at present is that the quantities of the waste papers and plastics do not meet the demand. For this reason justification of the technology was abandoned.

The technology action plan was therefore developed for the methane capture technology.

2.1.2 General Barriers and Proposed Measures

2.1.2.1 General Barriers

- i) Unregulated private sector participation
- ii) Lack of waste management policy
- iii) Low rate of solid waste recovery
- iv) Weaknesses in municipal councils waste management programmes

2.1.2.2 General Measures

- i) Formulate regulations and guidelines for private sector participation in waste management
- ii) Develop a policy for waste management
- iii) Acquire appropriate technologies for waste management
- iv) Municipal councils to develop effective program for waste management since the largest amount of waste are generated in urban and settlement areas

2.1.2.3 Specific Measures for Diffusion of Methane Capture Technology

a) Economic and Financial Measures

- i) Low construction costs
- ii) Low interest rates
- iii) Low maintenance costs
- iv) Low cost of cooking stoves and light pressure lamps.

b) Non-financial Measures

- i) Skilled technical personnel are available.
- ii) Bio-digesters are modified and improved to meet the emerging needs
- iii) Market links are established

2.2 Technology Action Plan for Methane capture

2.2.1 General description of Methane Capture technology

Methane capture from bio-digesters is done by constructing bio-digester chamber of desired size into which waste materials are deposited and the chamber enclosed to create conditions for anaerobic decomposition of the materials. The decomposition process produces methane gas and small amounts of other gases such as carbon dioxide. The closed chamber prevents oxygen from going in so that almost full anaerobic process is achieved. It also prevents the methane from escaping to the atmosphere. The gas can then be siphoned through pipes to equipment that use it for purposes such as cooking or

lighting. The gas can also be compressed into gas cylinders for storage or transportation to users. The bio-digesters can be constructed in different sizes depending on whether the gas is for single households or for groups of them or commercial purposes.

The technology was selected for the following reasons:

It caters for individual small scale farmers who have access to the required waste materials such as livestock wastes.

- i) It also caters for groups who can combine resources to construct and maintain the bio-digesters.
- ii) It can be commercialized for income generation and poverty reduction.
- iii) It leads to conservation of forests because it reduces demand for biomass energy by communities and hence contributes to climate change mitigation.
- iv) Methane capture reduces emissions of the gas into the atmosphere as is the case where anaerobic decomposition takes place in open places. Global warming potential of methane is 25 times that of carbon dioxide.
- v) The residues from digested wastes are very rich in plant nutrition as compared to ordinary manure. The bio-digesters therefore provide farmers with opportunities to enhance crop production and income generation towards poverty reduction.
- vi) The use of biogas instead of biomass for household energy reduces indoor air pollution and hence reduces incidences of respiratory diseases among residents.
- vii) The bio-digester is sustainable at low cost because once it is constructed the waste materials are obtained from livestock on the farm and other activities that generate wastes.
- viii) The cost of constructing a medium size bio-digester including accessories is about 1,600 US Dollars but the benefits to the communities as shown above are many. With appropriate technical and financial enabling measures it can be diffused widely in the country.

2.2.2 Targets for technology diffusion

For the methane capture technology it is estimated that about 600,000 people will have access to bio-gas for cooking and lighting by the year 2030 which is target of Kenya's Development Vision. Assuming that, on the average, 5 people will be served by 1 biogas unit this target means that about 6,000 households, institutions and commercial enterprises should be able to install bio-digesters per year during the first 5 years increasing to 4000 during the next 5 year, 8000 during the following 5 years and on to 10,000 during the following 5 year. This will result in 120,000 households, institutions and commercial enterprises having access to bio-digesters by the year 2030.

2.2.3 Identification of Barriers to Diffusion of the Methane Capture Technology

Identification of barriers to diffusion of methane capture technology was done through:

- i) Consultation with stakeholders
- ii) Consultant's experience and literature review.
- iii) Logical Problem Analysis (Problem Tree)

2.2.3.1 Economic and Financial Barriers.

a) High cost of construction of bio-digesters.

Most of the construction materials are available locally but are expensive to the small scale farmers who are the largest potential users of the technology. Some of the accessories have to be imported and they are also expensive especially when import duty and value added tax is charged.

- i) **High interest rates on loans.**
The banking institutions in Kenya charge high interest rates which are often the main barriers to potential borrowers leave alone small scale farmers.
- ii) **Lack of financial incentives.**
The Government has zero rated duty and VAT on renewable energy equipment. However for the small scale farmers the cost of a bio-digester including other accessories is still high.
- iii) **High maintenance costs.**
Although a good number of bio-digesters have been constructed by farmers in the country in recent years experience shows that most of them do not operate for long periods mainly because of high cost maintenance including replacement of accessories.

2.2.3.2 Non- financial Barriers

- i) **Lack of skilled technical personnel**
Construction of high quality bio-digesters and their maintenance is essential in order to make them attractive to potential users. Lack of qualified technical people is a barrier to the diffusion of the technology.
- ii) **Low awareness of the benefits of bio-digesters.**
Bio-digesters are sources of clean and reliable sources of household energy. Their use also improves indoor environment and reduces incidents of respiratory diseases. However such information may not be available to potential users.
- iii) **Lack of training for bio-digester users.**
The technology uses animal and other related wastes as raw materials. Handling of these wastes can be a barrier because of cultural beliefs and also general perception that raw animal wastes are dirty. In addition, operation of the equipment for efficient production of methane and its delivery to the point of use will require training of the operators.
- iv) **Lack of space for large bio-digesters**
Most small scale farmers practice mixed farming and hence must utilize the available space as much as they can. They therefore may not have available space for construction of large bio-digesters but can afford adequate space for small ones.

2.2.4 Proposed Action Plan for Methane Capture

2.2.4.1 Proposal for Enabling Framework for methane capture technology

There are a number of legal measures that have been formulated to regulate and give guidance on waste management of various types in the country the main ones being the following:

- i) **Public Health Act (1986):**
The Act requires every local authority to take all lawful, necessary and reasonably practicable measures for maintaining its district at all times in a clean and sanitary condition, and for preventing recurrence therein of or remedying or causing to be remedied any nuisance or condition liable to be injurious or dangerous to health and to take proceedings at law against any person causing or responsible for the continuation of the nuisance.

However, there are now many new issues associated with environment and health in regard to waste management. This Act therefore needs to be amended

to provide regulations for establishing waste disposal site especially with respect to biogas production.

ii) **Local Government Act (1998)**

The Act gives local authorities powers to establish and maintain sanitary services for the removal and destruction of or otherwise dealing with all kinds of refuse and effluent and if any such service is established to compel the use of such service by persons to whom such service is available.

The Act provides mechanisms and procedures for disposal of municipal wastes including their enforcement. This is a crucial act because human activities in urban areas generate large amounts of wastes and urban areas in Kenya are growing rapidly on account of rural to urban migration. The Act should therefore be amended in order to respond to more effectively to the new issues related to waste reuse, recycling and biogas energy production.

iii) **Environment Management and Coordination Act (1999)**

The Act provides legal framework for coordinated management of the environment and natural resources. It gives legal guidelines for waste management including setting of standards, waste disposal sites licences and control of various types of wastes.

The Act requires that any major project in the country must undergo Environmental Impact Assessment (EIA). Wastes generation and management is a key component of EIA.

In 2006, wastes management regulations for various types of wastes were developed. These are comprehensive guidelines since they cover practically all types of waste that are generated through human activities. Activities that may result in environmental degradation are increasing and the Act needs to be revised accordingly.

But these regulations do not address the issues of biogas production. They should therefore be revised to respond to these emerging issues.

iv) **Energy policy (2004)**

The policy promotes renewable energy technologies including energy generation from wastes. The policy led to formulation of Energy Act in 2006.

vi) **Energy Act (2006)**

The Act gives the minister for energy authority to take measures to facilitate environmentally friendly energy generation including generation from wastes.

This Act provides opportunities for the private sector to take advantage of financial incentives it provides to promote development of renewable energy resources. In this regards a number of companies have developed Clean Development Mechanism (CDM) Projects in energy generation from wastes.

The Act needs to be revised to address more comprehensively financial incentives for renewable energy development.

vii) **Kenya Vision 2030 (2007)**

The Vision proposes plan to relocate Nairobi's Dandora landfill to a more suitable location to facilitate more efficient management. The landfill is reputed to be the biggest in Africa. The relocation of the site will enable it to be designed and constructed in a way that will lead to methane capture.

viii) **Kenya Climate Change Response Strategy Action Plan (2012)**

The Action Plan outlines strategies for the wastes management in the country including their reuse, recycling and energy generation. The action plan needs to be implemented as soon as possible in order to support climate change programmes at the county level.

2.2.4.2 Identified Measures for the Diffusion of Methane Capture Technology

a) **Economic and Financial Measures**

i) **Reduce construction costs**

It is proposed that the government gives waiver on import duty and other taxes on all the components that will be imported for the purpose of construction and operation and maintenance of methane bio-digesters. This is consistent with the Energy policy (2004) and Act (2006).

The justification will be based on environmental and health benefits and poverty reduction among the small scale farmers.

ii) **Reduce interest rates**

It is proposed that the financial institutions form partnership with the government to provide low interest loans for development of bio-digesters in order to promote clean energy in rural households towards environmental conservation.

iii) **Reduce maintenance costs**

It is proposed that the government gives tax waiver to components that will be manufactured locally or imported for the purpose of maintenance of bio-digesters.

iv) **Reduce cost of cooking stoves and light pressure lamps.**

It is proposed that the government gives tax waiver on the cooking stoves and pressure lamps that use methane gas.

b) **Non-financial Measures**

i) **Skilled technical personnel are available.**

Technical training institutions in the country will develop customized training courses for technicians who will undertake construction and maintenance of the bio-digesters.

ii) **Bio-digesters are modified and improved to meet the emerging needs**

Research and development institutions will be given funds to conduct research and development of appropriate methane capture bio-digesters that will respond to consumer demands such as those that are portable. The funding will come from a special climate fund which will be created by the government.

iii) **Training and public awareness campaign is implemented**

The responsible institutions within the government in collaboration with research centres and construction companies will conduct training and public awareness campaigns for households on the operation and maintenance of the bio-digesters.

The public awareness campaign will include explaining the benefits of methane energy production on the environment and health and also benefits to the farmers in terms of availability of organic fertilizers which are rich in plant nutrients.

iv) Market links are established

Market links will be developed between the households, potential biogas users, commercial enterprises and the technology suppliers towards increasing the demand for the bio-digesters.

Table 2.3 below shows action plan for methane capture technology.

Table 2.3: Action Plan for Methane Capture Technology

Measure	Why the measure is needed	Responsible institutions	Time frame	Cost of the measure and source of funds in US Dollars	Indicators of success	Risks
Provision of financial grants	The small and medium scale farmers will need to be assisted financially so that they can afford initial construction costs	The Ministry of Finance and international funding institutions and donor countries	1-15 years	15.000,000 USD government allocates 3.000,000 USD international institutions provide 12.000,000 USD	Government allocates at least 3.000,000 US dollars for the project, International institutions and other donors provide at least 12.000,000 USD. At least 4,000 bio-digesters are constructed per year during the first 5 years	Lower prioritisation of rural energy development Weak justification and rationalization of financial assistance.
Low interest loans to farmers	Even with financial grants farmers may need additional financial resources to meet the rest of the costs	Local financial institutions	1-10 years	5.000,000 USD from financial institutions	Even low income farmers have access to financial resources, Bio-digester for commercial purposes are constructed	Interest rates remain high
Maintain duty and VAT exemption for the equipment	This action will help to keep bio-digesters affordable to the small scale farmers	Ministry of Finance	1-18 years	About 500,000 USD loss of revenue by the Government per year	The Government maintains the policy of duty and VAT exception for renewable energy equipment	
Setting of quality standards for construction and equipment for bio-digesters	Low quality construction and equipment lead to frequent breakdown of the system which becomes a barrier to diffusion of the technology	Kenya Bureau of Standards	1-5years	500,000 USD from Government, international institutions and technology suppliers	Bio-digester systems that take at least 1 year without requiring repairs or replacement of equipment	The number of skilled technical personnel remain low

Measure	Why the measure is needed	Responsible institutions	Time frame	Cost of the measure and source of funds in US Dollars	Indicators of success	Risks
Training of technicians for construction and maintenance	If the technicians are well trained there will be less technical problems and the technology will be more attractive to users	Ministries of Energy and Agriculture, technology suppliers, and local training institutions	1-10 years	2,000,000 USD from Government, international institutions and technology suppliers	Progressive availability of well trained personnel in different parts of the country	Institutions put low priority on training programmes for methane capture
Training of technology users	The users of the technology need to be trained in order to enhance efficiency and reduce frequency of system breakdowns	Ministries of Energy and Agriculture, technology suppliers and local training institutions	1-10 years	1,000,000 USD from Government, international institutions and technology suppliers.	Enhanced efficiency of bio-digester use. Increased attractiveness of bio-digester technology	Institutions put low priority on training programmes for methane capture
Conducting public awareness creation campaigns	Lack of awareness of the benefits of biogas use is a major barrier to its wide diffusion within communities across the country and therefore the need to conduct awareness campaigns	Ministries of Energy and Agriculture, technology suppliers and NGOs	1-10 years	1,000,000 USD from Government, international institutions and technology suppliers.	Increasing construction and use of bio-digesters across the country.	Government places low priority on public awareness creation campaigns
Research and Development (R&D)	To modify or improve the technology to respond to the emerging demands from the users	Ministries of Energy and Agriculture, technology suppliers and local research and development institutions	1-10 years	2,000,000 USD	Users expressing their needs for technology modification and getting satisfaction with the modified or new products.	Table 2.2 below shows technology action plan for methane capture technology.