Entrepreneurship Development in the Emergence of Clean and Sustainable Energy in Waste Management

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Abstract- ***There has been an increase in the volume of waste generated and the attendant poor waste management practices as a result of urbanization in Africa. These practices include extensive waste disposal in waterways and unregulated dump sites. These behaviours and patterns have resulted in poor sanitary standards, which has led to disease outbreaks like the plague, cholera, and typhoid fever in some African countries. This paper presented an understanding of waste-to-energy (WtE) technologies that can improve municipal solid waste management and provides an overview of Municipal Solid Waste (MSW) in the context of Africa. The landfill airspace in African major cities is fast diminishing. In addition, youth unemployment is also fast rising in the continent, especially in sub-Saharan Africa (SSA). Investment in WtE technologies could mitigate the challenge of poor environmental waste management and create long-term jobs for many technically trained unemployed youths. In some cities in Africa, municipal authorities have made attempts to start WtE projects. The cities use landfill gas and biogas recovery technologies from waste materials to generate power for use at already operational disposal sites. To generate electricity and generate opportunities for job creation for youths especially those with technical manpower, this paper presents the prospects, opportunities, and challenges of investment in WtE technologies in Africa. It also highlighted the possible roles of the actors in Technical and Vocational Education and Training (TVET) in WtE technologies for sustainable development in Africa.***

Indexed Terms- ***Clean energy, Entrepreneurship development, Waste management, Investment, Africa***

I. INTRODUCTION

Municipal Solid Waste which includes organic waste, is produced in significant quantities in cities around the world. The biogenic component of the waste products can either be put to good use or discarded. Uncontrolled dumping of MSW in developing countries poses significant dangers to the environment and public health. However, the process of collecting, transporting, and disposing of MSW is a major challenge in many communities in developing nations. Experts believe that since urbanization is predicted to continue progressing at a rapid rate, the problems will probably only become worse. In many cities in poor nations, cost recovery is a major problem when it comes to handling MSW but a sustainable investment can be achieved. One method to improve the management of solid waste while promoting clean and healthy urban environments is the recovery of waste and the production of electricity using WtE technologies. With the right investments in technologies and institutional changes, garbage has the potential to become a resource that may promote the socioeconomic growth of cities and rural communities. Globally, over 2 billion tonnes of MSW was produced in 2016 and there was a projection that by 2050, the amount could increase by an additional 1.2 billion tonnes due to the increasing situation of a high degree of urbanization, industrialization and population growth. Traditionally, environmental waste is a mixture of plastic materials, cardboard, plastic materials, metals, glasses, wood, leather, and other biodegradable waste materials. While effective waste management is a common target in developed countries, unfortunately, some percentage of the quantity of waste materials generated in Africa is openly disposed of on the street in a way that is not safe for the environment [1]. It was estimated by Dladla et al. [2] and Idowu et al. [3] that 1.22 kg of MSW is produced per person per day in Sub-Saharan

Africa (SSA) with a total estimation of 62 million tons of waste per annum.

From an environmental emissions and climate change perspective, the common practice of waste disposal in a sanitary landfill in major urban cities can create unhealthy situations. Open landfilling is the favourite and most inexpensive method of waste disposal in many African countries [3]. Waste materials in an open landfill encourage bacterial biochemical actions to produce free methane and some other poisonous gases such as carbon monoxide, ammonia, hydrogen sulphide, nitrogen oxides, benzene and acrylonitrile [4]. The production of these gases in landfills is usually triggered by the process of anaerobic digestion. Methane and oxide of carbons generated from the global MSW landfill sites grossly contribute to the degradation of the air quality and offensive odour [5] due to the unhealthy accumulation of the gases. In the United States, poor handling of waste can result in a case of waste management violations which attract civil penalties. A significant approach toward dealing with the environmental harms orchestrated by MSW is to embrace the technological approaches of waste-to-energy recovery. Many contemporary researchers through case study scenarios have investigated the potential of energy recovery through different technologies [6-7]. Thus, this paper examines the opportunities and challenges for creating employment opportunities in environmental waste management for sustainable energy. In addition, the paper also pinpoints the benefits of TVET stakeholders' inclusion in the training of youths in the business of waste to energy in Africa especially on biogas energy technology.

II. WASTE TO ENERGY TECHNOLOGY: WHAT OPTION FOR AFRICA

One strategy to advance the treatment of MSW while promoting clean and healthy urban environments has been suggested: using WtE technologies to generate electricity. Energy policy initiatives at the national and international levels now place a strong premium on the production of electricity, heat, or biofuels from renewable energy sources. Around 800 thermal WtE installations are reportedly in operation worldwide. According to references [8-9], 11% of processed MSW generates up to 429 TWh of power globally and is handled in about 40 countries. With the right channel of investment in technology and institutional reforms, waste materials have the potential to promote the socio-economic development of cities and rural communities in Africa. There are several kinds of WtE technologies as shown in Figure 1. However, considering the various challenges associated with other WtE technologies, anaerobic digestion can be considered the cheapest option for adoption in Africa. Anaerobic digestion is a coordinated process of microbial activity to convert organic material into biogas, which is primarily made up of methane and carbon dioxide, during the complex process. Figure 2 shows the working systems of anaerobic digestion for energy production. During anaerobic digestion, organic wastes are recycled by anaerobic digestion in biogas systems to create biogas, which contains both energy gas and useful soil products for agricultural production.

The diversity of feedstocks such as wastewater, crop residues, animal dung, slaughter blood, food wastes and others make the process of anaerobic digestion a valuable WtE conversion technology. The anaerobic digestion method can be used in rural communities to generate biogas for cooking as an alternative to the use of firewood with well-pronounced effects on environmental forest degradation. In addition, electrification of off-grid rural communities can be achieved through a biogas power energy system. There are possibilities for the treatment of raw biogas to natural gas quality called biomethane or Renewable Natural Gas (RNG). Biogas that has been processed to remove carbon dioxide, water vapor, and other trace gases to meet natural gas industry standards is known as biomethane. RNG can be utilized interchangeably with conventional natural gas for power generation [10-12]. After being transformed into compressed natural gas (CNG) or liquefied natural gas (LNG), RNG can be utilized as a motor fuel, much like regular natural gas. The benefits of biogas production through anaerobic digestion include the following:

i. Biogas technology has the potential to considerably improve a range of living conditions for the local population in addition to enhancing the nation's economy.
ii. Provision of environmental protection.

iii. The use of biogas systems for waste management offers numerous benefits, including the creation of new revenue sources.

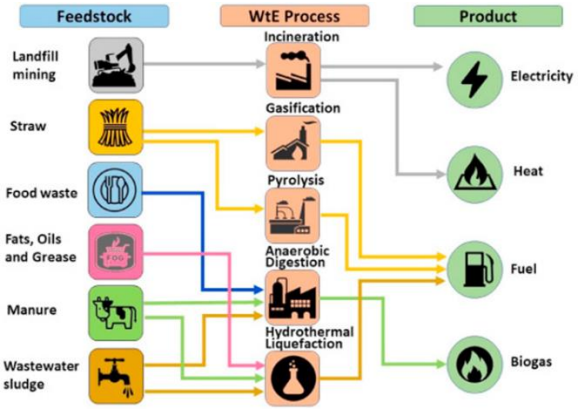

Figure 1: Waste to energy technologies [13]

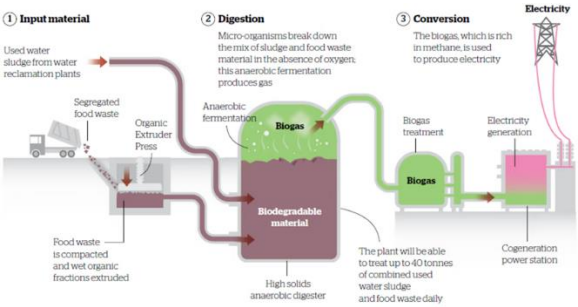

Figure 2: Working systems of anaerobic digestion for energy production [14]

III. OPPORTUNITIES FOR INVESTMENT IN WTE TECHNOLOGIES IN AFRICA

There are several opportunities with the potential to drive investment in WtE technologies in Africa and they include the followings:

A. Dwindling cost of fossil fuels and emerging marketing opportunities

The development of WTE projects, however, has grown significantly over the past 20 to 30 years as a result of diminishing fossil fuel resources, growing attention to energy security, increased awareness of the social and environmental risks associated with poor waste management, and an overwhelming global focus on reducing greenhouse gas emissions. Nevertheless, worries about energy security and a growing understanding of the environmental and social issues connected to current waste management systems (WMS) have increased the potential for developers, financial institutions, and equipment manufacturers in the WtE area, especially in emerging markets.

B. Strategic green economic drivers

Even though the opportunities offered by the WtE technology projects for social and environmental benefits may appear compelling and unquestionable, the same can also be said regarding its economic benefits. A variety of strategies have been used in Europe to advance the development of WtE initiatives from economic perspectives such as feed-in tariffs, renewable heat incentives, green energy tax incentives, imposition of landfill taxes and the availability of green certificates.

C. Emerging deployment of WtE technologies in Africa

The recent deployment of different kinds of WtE technologies in Africa is a great pointer to more investment drive for job creation in the continent. Although, the pace of the deployment of the technologies is quite slow, unlike Europe which is favoured by the existing macroeconomic factors and suitable regulatory regimes. Some of the notable WtE technologies in Africa include the followings:

- Johannesburg, South Africa: 13MW of energy from five landfill gas to energy facilities.
- Ikorodu, Nigeria: 1,500 tonnes of MSW composting project per day.
- Kumasi, Ghana: co-digestion for the production of biogas from the treatment and animal, crop and sewage waste materials.
- Ferlo, Senegal: 40 bio-digesters for the production of biogas from animal wastes.
- Ketu Ikosi, Lagos: biogas project championed by the collaborations between Lagos State Waste Management Authority and Midori Environmental Solution.
- Naivasha, Kenya: treatment of 500,000 tonnes of organic waste per annum for the production of biogas for power generation.
- Addis Ababa, Ethiopia: treatment of 350,000 tonnes of waste materials per annum from the Gorge Farm anaerobic digester 50MW power plant.

D. The persistent shortage of electricity in the majority of the region's nations

The problem of insufficient power generation and the subsequent epileptic power supply make any electricity generation through WtE technology an option in Africa. However, the dearth of modern waste management infrastructure justifies the need for investment opportunities in WtE technologies in Africa. Therefore, such investment initiatives will encourage the development of infrastructure, inclusive growth, environmental awareness, and long-term employment creation.

F. Focus on Africa for WtE treatment markets

The entrance of foreign experienced and recognized companies into the business of WtE in Africa represents increasing the likelihood of better investment opportunities for job creation in the region.

IV. CHALLENGES OF WtE TECHNOLOGIES IN AFRICA

The expense of waste management can be converted into a profit opportunity via the adoption of WtE systems. Unfortunately, the exploitation of WtE technologies in Africa is confronted with different kinds of challenges stated as follows:

- Lack of technically skilled manpower: skilled manpower training is a basic requirement for the design and implementation of WTE projects. In Africa, there is a scarcity of skilled manpower needed for the aggressive deployment of WtE technologies in the continent. From this perspective, there is a crucial need to enhance more training of skilled manpower to rely on indigenous technologies for the development and operation of energy facilities at reasonable costs. To resolve any technical problem, the project developers need to have trained technicians on the ground.
- Absence of sustainable financial support: The size of investment necessary to launch WTE projects is negatively impacted by high interest rates on loans in several African commercial banks. Some local investors in the developing countries of Africa might think the interest rates on loans are too high for their risk tolerance. There are no WtE financial support organizations in Africa at the moment to guarantee the planned local investors that the projects will receive strong financial backing.
- Unavailability of reliable data collection system: waste collection data in many African countries is either non-existent or poorly recorded. This is a major hindrance to investment opportunities since reliable investments rely on realistic facts and figures.
- Limited number of personnel and waste collection vehicles: the number of personnel usually employed by the municipal authority in developing countries to cater for waste collection and processing is not usually enough for the job. This essentially, in most cases affects the efficiency of service delivery and thereby affects the prompt collection time.
- Inaccessible roads especially in rural communities for waste collection: The straggling, poorly built, uncontrolled slums that define the cities of developing nations are frequently characterized by narrow, sloping, unpaved roadways that are impassable to collection trucks.
- High-cost of WtE conversion systems: The systems utilized for managing MSW in industrialized nations need a lot of financial investment and are frequently unsuited for application in poorer nations. Incinerators are one example of a technology that is frequently too expensive for developing nations to use.
- Lack of care for the environment: environmental awareness is sometimes significantly lower in developing countries compared to developed nations. The majority of people are either unaware of or unconcerned about the environment and the need for MSW management because they are focused on more immediate and pressing issues such as poverty, hunger, and disease.
- Public perception and acceptance: for example, in developed countries where incineration plants have been established, there has been a lot of opposition from the people living close to the plants. The main grounds for objection to incineration waste treatment technologies have been the health dangers, emissions of hazardous organic compounds, metals from stacks, and complications associated with flying ashes from the power plant. This thereby brings a sort of stigma around the sector.
- Lack of institutional frameworks: this aspect concerns inadequate political will by the

government authority and institutional weakness based on the underprivileged commitment of waste authorities. In addition, the lack of effective coordination of municipality waste agents is another challenge confronting the development of WtE technologies in Africa.

- Inadequate regulatory framework for investment in WTE technologies: there is an inadequate national and regional plan for the implementation and regulatory framework of WTE projects in Africa. This is orchestrated by a lack of political will by the government.

V. ROLES OF TVET ACTORS IN WtE FOR SUSTAINABLE DEVELOPMENT IN AFRICA

The United Nations Sustainable Development Goal 7 is to ensure that everyone has access to cheap and clean energy. This goal favours renewable energy in general and WTE in suitable contexts. In this regard, going by the clean development and sustainable energy mechanism, some of the countries in Africa are currently striving towards the reduction of greenhouse gas (GHG) emissions from municipal solid waste (MSW) by assessing the potential of WtE technology and supporting a small number of WtE projects that are currently in the early stages. This cannot be achieved in the absence of some desirable support needed to sustain the development. Therefore, TVET actors are expected to make contributions to the struggle for sustainable development of WTE projects in Africa in the following ways:

i. Interaction with government and stakeholders for the development of new policies with a focus on investment in different technologies on waste management systems in Africa.
ii. Introduction of training on different WtE technologies in TVET institutions.
iii. Stimulation of an aggressive campaign for environmental sustainability through programs and initiatives on WtE technological awareness.
iv. Support in regional coordination to facilitate partnerships between government and private investors to promote Renewable Fuel Standards (RFS).
v. Provision of technically skilled manpower for the establishment and operations of WtE projects.
vi. Enrichment of research, training and capacity building in the WtE sector.

CONCLUSION

In comparison to governments in developed nations, African governments have historically placed fewer restrictions on energy projects in the way of permits and licenses. Notwithstanding these efforts, the sufficiency and sustainability of the current waste management systems are being questioned due to changes in demographic and social challenges impacting various African countries. The African continent is now dealing with a number of issues regarding waste generation and management and they include:

i. increasing waste quantities due to growing population, industrialization, and socioeconomic modernization;
ii. shortage of land for the construction of landfill sites due to rapid urban expansion;
iii. and increasing the risk of airborne diseases and other health hazards connected with unsanctioned and unrestricted dumping.

Conclusively, going by the expected adoption of WtE technologies in Africa, waste materials can be turned into heat, power, or fuel for vehicles, providing a renewable energy source that can decrease reliance on imported oil, cut greenhouse gas emissions, enhance environmental quality, and create more local jobs for TVET trainees and a range of other job seekers. Additionally, by recycling waste products through anaerobic digestion, biogas systems might decline the demand for petrochemical and mineral fertilizers required for agricultural production in Africa.

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