AFRICAN CIRCULAR BUSINESS ALLIANCE

UNLOCKING THE PROMISE OF WASTE TO ENERGY

ARTICLE

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Unlocking the Promise of Waste to Energy: Overcoming Challenges for Widespread Adoption in Africa

Across Africa, agricultural waste burning, household burning and forest fires make significant contributions to the problem of open burning in Africa. However, open waste burning at dumpsites is the main contributor to noxious pollutants that are harmful to both the environment and human health.

Uncontrolled landfills and open burning remain the primary waste management methods for most African cities. A report estimated that up to 90% of waste is openly dumped, and often burned. This not only creates hazardous air quality for nearby residents but also releases potent greenhouse gases. Decomposing organic waste in landfills becomes the world's third-largest anthropogenic source of methane emissions, after fossil fuels and livestock, accounting for 22% globally and a staggering 34% in Africa, according to a high-level assessment of anthropogenic methane emissions in Africa with case studies on potential evolution and abatement.

Prompting zero waste initiatives to advance UN 2030 agenda:

Many countries and organisations are currently exploring waste management solutions that align with the United Nations 2030 Agenda following the invitation in 2022 from the United Nations to implement zero-waste initiatives at all levels, to promote environmentally sound management of waste and sustainable development.

Behind zero waste systems lies the promotion of sustainable consumption and production approaches, including resource efficiency and life-cycle approaches, in which products and materials are designed in such a way that they can be reused, remanufactured, or recycled and therefore retained in the economy for as long as possible, along with the resources of which they are made, and the generation of waste is avoided, or at least minimized.

Waste-to-Energy (WtE) Technologies: An opportunity for energy recovery and climate change mitigation

While the circular economy prompts the extension of the life of products and materials, it is more realistic to acknowledge the incapacity to reinject some products and materials into the economy. This includes toxified components of products that have been dumped for years in landfills, old plastic packaging containing hazardous substances, and organic materials from food waste. As such, many innovative technologies emerge to recover the energy and molecules from these municipal and industrial waste streams.

From turning plastic to fuel using pyrolysis, generating electricity using combustion, to producing biofuels from organic materials, Waste-to-Energy (WtE) technologies have been presented as circular and green solutions for waste management and energy recovery. Nevertheless, it is paramount to study their applications judiciously, especially on a large scale.

- **Incineration:** A waste-to-energy technology which has been widely used since the 1990s for waste management in developed countries produces energy from waste through combustion. However, this WtE technology has been reported as being linked with health effects on neighbouring inhabitants and being strongly polluting. In point of facts, burning trash in incineration reduces its volume by 95% into ash and generates emissions including lead, mercury, dioxins and furans, particulate matter, carbon monoxide, nitrogen oxides, acidic gasses (i.e., SOx, HCl), metals (cadmium, lead, mercury, chromium, arsenic, and beryllium), polychlorinated biphenyls (PCBs), and brominated polyaromatic hydrocarbons (PAHS). Furthermore, even with the addition of air quality control systems, these pollutants remain in the process's byproducts such as ash and wastewater causing harm to groundwater and arable lands.
- **Gasification:** Another waste-to-energy technology that has been developed in Japan, boasts low-emissions, high-efficiency, high-energy generation, fewer residues, and lower air pollution than conventional incinerators. The development of this technology has been mainly caused by regulatory restrictions from Japan on landfilling in 2000 but its adoption in other countries remains humble- reported as highly expensive, especially in the context of developing countries.

- **Anaerobic digestion:** A circular champion used to produce biogas and biomethane from the decomposition of organic materials, remains the most interesting WtE technology from a circular economy and net-zero targets perspective. This technology concerns only the organic fraction of municipal waste that could be mixed with other organic materials such as wastewater sludge, manure, and crop residues. While the energy recovery from organic waste is less effective than conventional incineration, it produces an environmentally friendly residue: digestate, as well as economically viable byproducts.
- **Biomass Gasifier:** A WtE technology that converts biomass materials, such as wood, agricultural residues, or organic waste, into a combustible gas known as "syngas" or "producer gas." This process involves partial combustion of the biomass in a controlled environment, usually with limited oxygen, to produce a mixture of carbon monoxide, hydrogen, methane, and other gases. The produced syngas can be used as a fuel for various applications, including generating electricity, heating, or as a precursor for the production of chemicals. Biomass gasification is considered a renewable energy technology, as it utilises organic materials that can be replenished through natural processes. It offers an alternative to traditional combustion methods and provides a means of harnessing energy from biomass resources in an environmentally sustainable way. Another reported advantage of waste gasification is that the process provides much better electrical efficiency compared with the direct combustion of waste materials.

Image: WtE - Anaerobic Digestion Plant

BioEnergy: Turning the organic fraction of Municipal Solid Waste (MSW) into an additional renewable energy source

Wind and solar are two sources of renewable energy that have been used widely to increase the share of renewable energy in the energy mix of many countries. However, an energy revolution requires additional renewable resources. Besides, as countries attempt to achieve zero waste systems and net zero greenhouse gas emissions, waste-to-energy technologies are prompted to serve both purposes. Additionally, many developed countries have already established incineration plants, and despite the enthusiasm toward increased products and materials recycling, combustion-based waste-to-energy facilities such as incinerators, are more likely to remain functional with upgrades such as the addition of Carbon Capture and Storage, according to the "Material and Energy Valorisation of Waste in a Circular Economy" report from the International Energy Agency (IEA).

Nevertheless, in African Countries, these waste-to-energy Plants are few. Thus, questions should arise as to whether to choose the usage of combustion-based facilities for waste management or directly move forward to advanced waste-to-energy technologies in terms of circularity.

In the majority of African Cities, the organic fraction of Municipal Solid Waste is higher than 70% compared to 50–60% in developed countries. Additionally, low-income countries rely on agriculture for their economies, reflecting why a large part of their GHG emissions are coming from the Agriculture, Forestry and Other Land Use (AFOLU) sectors. Consequently, exploring the possibilities of combining organic waste materials generated by agriculture with the organic fraction of Municipal Solid Waste to generate bioenergy seems mostly adequate in an African context where the options of an Anaerobic Digestion or Biomass Gasification plants come into action.

Also, according to this publication, when comparing the primary sectors that produce waste streams suitable for bioenergy production – wastewater treatment plants (both primary and secondary sludge), municipal and industrial organic solid waste, liquid and solid manure, crop residues, surplus grass, and wastewater sludge. Those with significant methane potential and large quantities are organic solid waste and crop residues.

Bioenergy in Africa: barriers and learned lessons

The enthusiasm toward Anaerobic Digestion technology exists in African countries, mainly due to its potential to solve several issues, such as methane and carbon dioxide emissions mitigation, production of biogas- a renewable energy source used in cooking, lighting, or even electricity generation, local economic development, and waste management. Nonetheless, widespread adoption is lacking, except in South Africa. However, in other countries, such as Ghana, small-scale digesters have been developed for household cooking, direct lighting, small-scale power generation, and bio-sanitation. Unfortunately, many of these systems are now non-functional. In Kenya, the first anaerobic digestion plant in Africa, the “Farm Energy Park,” is grid-connected. It utilises local crop waste to produce biogas for electricity generation and serves as a research facility to explore advancements in this technology.

Therefore, key barriers to the adoption of Waste-to-Energy (WtE) technology in Africa include challenges related to small-scale development, poor business models, and complex logistics for waste collection and storage. To overcome these obstacles, there is a pressing need for the implementation of an integrated business model that effectively tackles these challenges, ensuring the economic value of WtE technology. This highlights the significance of taking a holistic approach, addressing not only the technical aspects of waste-to-energy technologies but also emphasizing the economic viability of both primary products and any secondary materials or by-products generated in the process. In conclusion, successfully overcoming these challenges is crucial for the widespread implementation and adoption of waste-to-energy technologies in the African context.