

Review

Review of Barriers to Effective Implementation of Waste and Energy Management Policies in Ghana: Implications for the Promotion of Waste-to-Energy Technologies

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Abstract: Issues of rising waste generation are calling for proper management and the sustainable control of waste. This study examines waste- and energy-relevant policies and strategies in Ghana and the stakeholders' perceptions on such policies and strategies. It explores the gaps and challenges in national policy documents to guide the implementation of waste-to-energy projects in Ghana. The approach adopted includes a comprehensive review of relevant policy documents and key informant interviews with selected key stakeholders. Factors such as limited funding, inadequate logistics, expertise and infrastructure, growing population and negative attitudes of general public towards the environment, amongst others, are the concerns identified. Findings from the policy review revealed that capacity to harness energy from waste could be improved through appropriate technologies suitable for Ghana. Adequate institutional framework, stakeholders and mechanisms to explore opportunities to coordinate implementation of various policy strategies and interventions have been established. Streamlining strategies to constitute components to improve governance on waste management, improving financing to ensure sustainable investment in waste-to-energy projects, improving research on waste-to-energy technologies as well as enhancing public interest and education on proper waste management could enhance the implementation of national waste and energy policies for feasible up-scaling of waste-to-energy technologies in Ghana.

Keywords: waste management; renewable energy; waste to energy; policy; Ghana



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1. Introduction

Ghana is faced with sanitation and energy (power) challenges, resulting in calls on the government to implement sustainable solutions and policies to address these challenges. Using the national per capita waste generation of 0.47 kg/day [1] and the current population, it can be estimated that Ghana generates more than 14,000 tons of municipal solid waste (MSW) daily. Even though the waste composition varies geographically, the most comprehensive study carried out to date nationally puts organic components at 61%, 14% plastics and 6% inert. The rest comprises miscellaneous (5%), paper (3%), metals (3%), glass (3%), leather and rubber (1%) and textiles (1%) [1]. Collection efficiency varies between cities; however, nationally, only 20% of the generated waste is collected [2]. The remaining 80% is burned openly, dumped in open fields indiscriminately or buried. The situation is even more precarious in big cities and towns where the population densities are high.

Challenges in solid waste management are multifaceted, involving economic, institutional, social-cultural, environmental and sometimes political and technical factors. Specific challenges highlighted as the problem of waste management in Ghana include growing urban population, changing patterns of production and consumption, poor planning for

waste management programs, inadequate equipment and operational funds to support waste management activities, and inadequate skills and capacity of waste management staff [3–5]. Few treatment options exist mainly for the organic fraction in the cities. Organic waste treatment accounts only for a marginal fraction (7–16%) of the entire waste generated. In the case of plastic, it is estimated that, out of the 2000 tons/day generated, only 2–5% is either reused or recycled or both [6]. Almost all the collected waste is therefore transported to landfills or dumpsites.

On the other hand, the energy sector is experiencing an increasing energy demand as a result of the growing population and urbanization. Between 2015 and 2030, Ghana's energy demand is expected to double with the transportation sector expected to become the highest consumer of energy (50% of demand), followed by the residential sector (23% of demand) [7]. This challenge, together with Ghana's distribution network upgrading, accounts for the recent power fluctuations in the country, which is popularly termed as "dumsor" in the local parlance. Fossil fuel is currently the world's leading energy source, which is non-renewable, contributing significantly to the emission of Green House Gases (GHG), leading to climate change. However, the increasing climate change impact on the global economy is causing the world to gradually shift from non-renewable energy to renewable energy. Governments across the world are implementing policies that promote efficient use of resources through the use of renewable energy technologies such as bioenergy, hydropower, green hydrogen technologies, solar PV technologies and wind technologies. It is becoming increasingly important in Ghana to shift into low-carbon energy sources including nuclear or renewable (such as hydropower, solar and wind) sources of energy supply.

Efforts by the government to sustainably manage Ghana's twin problem of waste and electricity challenges is geared towards the conversion of the waste into a renewable energy. Currently, there are several national policies, regulatory and institutional frameworks relevant to the waste and energy sectors of Ghana. A review of these policies reveals that there are no direct or clear guidelines to guide the implementation of waste-to-energy initiatives in the country although the government's focus is moving towards the influx of renewable energy sources into the country's energy mix as the Renewable Energy Act (2011) stipulates. Ghana's National Energy Policy (2010) [8] identifies high cost, inadequate infrastructure and lack of investment as the challenges to the implementation of waste-to-energy technologies. The policy focuses on increasing the proportion of renewable energy mix and ensuring efficient use, as well as developing strategies to convert waste produced in municipalities and communities into usable energy. However, the choices and operations principles of waste-to-energy technologies in the country are not clearly spelled out in the guidelines. Waste-to-Energy is the process of recovering energy, in the form of electricity and/or heat, from waste [9].

Different waste-to-energy technologies exist on the market, which include anaerobic digestion, pyrolysis, gasification and incineration. Though policies on waste management exist in Ghana, the challenge of waste management still persists and one factor that accounts for that is the inability of Metropolitan, Municipal and District Assemblies (MMDAs) to successfully integrate these policies into their by-laws and activities for effective enforcement/implementation. A review of waste management policies, plans, programs and implementation by Anku (2008) [5] have shown that there has been a general reluctance by District Assemblies and the private sector to invest directly in waste infrastructure. The reasons for this reluctance were due to lack of required investment in waste infrastructure, the inefficiency in enforcement of national policies and district by-laws, and the general flaw of coordination in the implementation of waste management programs. The National Environmental Sanitation Policy Coordinating Council (NESPoCC), with representatives from relevant Government agencies, NGOs and private sector groups, is responsible for coordinating policies and ensuring effective communication and co-operation among ministries and agencies in Ghana. However, clear policies to ensure that waste generated is segregated to enhance effective waste-to-energy process remains a challenge.

This paper presents a review of relevant waste and energy policies in Ghana, key stakeholder perspectives, policy gaps identification and how waste-to-energy initiatives can be integrated into national policies, waste management plans and programs. The policies reviewed include the Ghana Environmental and Sanitation Policy, National Environmental Sanitation Strategy and Action Plan, National Environmental Policy, Ghana National Energy Policy, Sustainable Energy for All (Se4All) Action Agenda, Renewable Energy Master Plan, Ghana Health and Action Plan, and Ghana National Climate Change Policy. Some legislative instruments relevant to Waste-to-Energy were also reviewed.

2. The Policy Review Framework and Approach

The policy review and analysis approach for this study drew on the work of Note (2012) [10] and Bali et al. (2021) [11] in analyzing public policies. In this study, the authors have adopted analytical dimensions of assessing the impacts of policies within the waste and energy sectors of Ghana, as done by [10,11]. These were centered on effectiveness, unintended effects and equity, comprising the effects of the reviewed policies. Adopting Bali et al.'s (2021) policy effectiveness in this case refers to the intrinsic ability of the policy document to address its intended problem at hand or at least substantially mitigate its adverse effects, which overlaps the approach adopted by [10]. The authors further assessed the implementation of the policies reviewed under the cost, feasibility and acceptability dimensions (Figure 1).

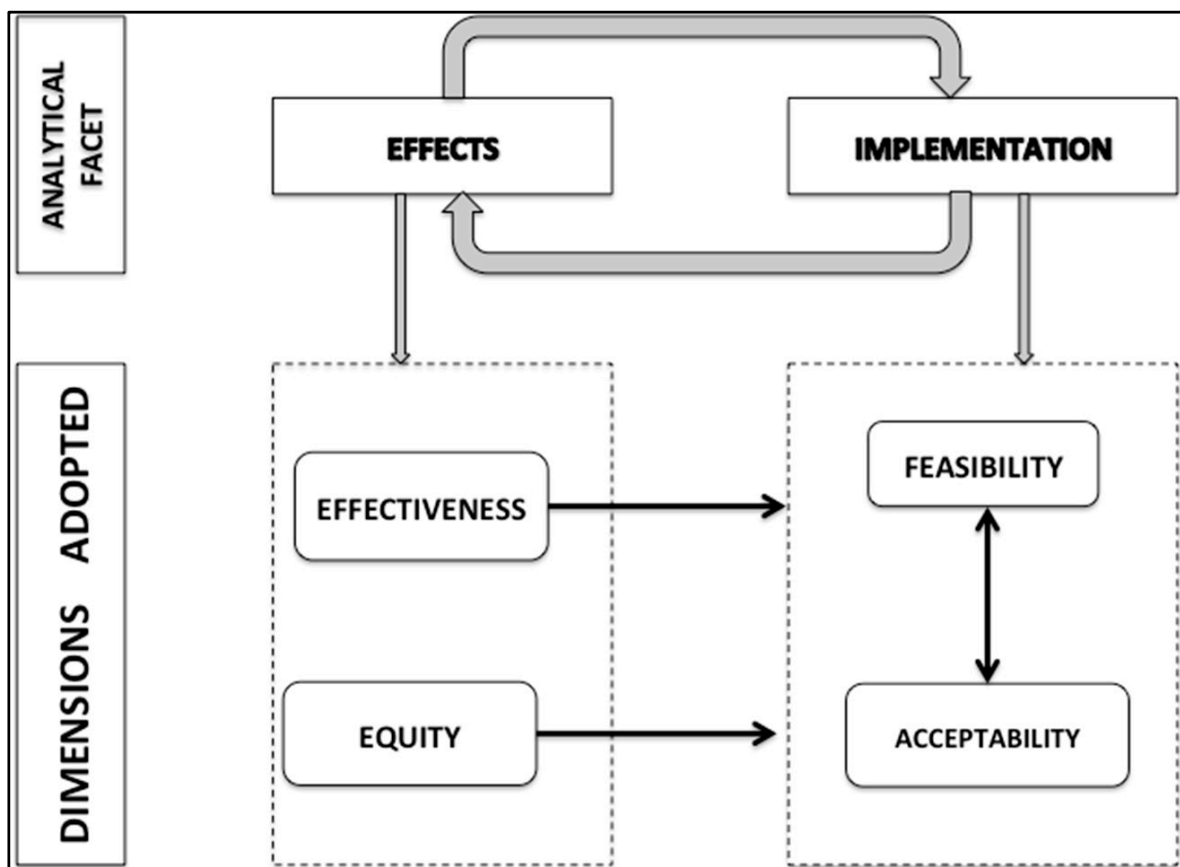


Figure 1. Conceptualization of the policy analysis. Adopted from Note (2012) [10] and Balis et al. (2021) [11].

Six (6) dimensions and eight (8) indicators were explored as an analytical approach to this study, as shown in Table 1.

The review process commenced with a desk study to identify the existing policies related to the waste and energy sectors of Ghana. To assess the 'effect' facet of the identified

policies, the study concentrated on how the policy addresses the overall intended objective of recognizing policies gaps and policy concerns through the policies objectives to explore its effectiveness and equitability. The policy implementation facet of the analysis followed a review of available resources, be it institutional, technological, economical, among others, as well as a stakeholder consultation process to understand stakeholders' acceptability of the policies as shown in the conceptual framework (Table 1). The stakeholder consultations were conducted with key informants from local and national governments, academia and the private sector. They were purposefully selected to provide in-depth insights, discussions and validation of practical implementation of the reviewed policies to ascertain its feasibility. This was done through the completion of open-ended questions.

Table 1. Framework on the dimensions and indicators used in guiding the policy analysis.

Policy Assessment	Dimension	Indicator
Effect	Effectiveness	Effect of policy at addressing targeted objective
	Equity	Differential effects of the policy on various groups such as groups defined by age, gender, socioeconomic status, ethnicity, religion, residence in certain zones, disabilities etc.
Implementation	Feasibility	Availability of resources (human, institutional, technological etc.) including costs and gains related to the implementation of policies by government and various actors. Thus, is the policy operationally feasible?
		Conformity with other relevant legislation including levels of government and mandate of sectors involved
	Acceptability	Existence of pilot programs How stakeholders view the policies under study, influenced by their knowledge, beliefs, values, interests etc. In other words, is the policy socially accepted and politically viable to use?

Stakeholder identification was based on an initial desk review conducted to identify actors, key stakeholders, interest groups and institutions that could aid the successful implementation of the project. A total of eighty-one (81) key stakeholders and actors were identified based on their relevance and connection to waste and energy in Ghana. Stakeholders, as it relates to this study, are persons, groups or institutions with interests in the issue, herein, the waste-to-energy process. These identified stakeholders included a categorization of the public sector, private sector, research institution, civil society organizations and international development partners. The eighty-one stakeholders served as the population for this study, from which 35% were sampled representing about twenty-seven (27) institutions. The study was designed to be as inclusive as possible; hence, the twenty-seven stakeholders sampled had representation from each of the categorized institutions. The responses captured include experience of stakeholders with waste-to-energy projects, their role within the waste and energy sector value chain, knowledge about existing policies within the sector and expected impacts from waste-to-energy projects. Responses from a total of nineteen out of the twenty-seven institutions sampled were obtained, representing a response rate of 70.4%. They provided in-depth insights, discussions and validation of practical use of the reviewed policies and the review findings.

Qualitative (content) analysis was used. Stakeholders' responses were grouped and the groupings were guided by predetermined categorizations of stakeholders according to their role in the waste-to-energy value chain and their relationship and interest with other stakeholders. The breadth of thematic coverage relevant to the purpose of the study was further explored. This included an overview of the stakeholders within the waste and renewable energy sector; stakeholders' impact on the waste and energy sectors; their experiences on waste-to-energy projects; challenges with implementation; policies

and regulations within waste and renewable energy sectors; perception of stakeholders about implementation of waste management legislation, by-laws and acts; as well as the contribution of stakeholders to the sustainability of waste-to-energy projects.

3. Ghana's Renewable Energy and Waste Management Policy Context

National-level policies and action plans related and relevant to the Waste and Energy sectors of the Ghanaian economy that were reviewed include:

- Ghana Environmental and Sanitation Policy [12].
- National Environmental Sanitation Strategy and Action Plan [13].
- National Environmental Policy [14].
- Ghana National Energy Policy [8].
- Sustainable Energy for All (Se4All) Action Agenda [15].
- Renewable Energy Master Plan [16].
- Ghana Health and Action Plan [17].
- Ghana National Climate Change Policy [18].

Furthermore, a number of legislative instruments that relate to the energy sector considered include:

- Local Government Act, 2016 Act 936 [19].
- Environmental Protection Agency Act (1994, Act 490) [20].
- Environmental Assessment Regulations 1999 (LI 1652) [21].

In addition to the above-mentioned policies, other documents were reviewed to ascertain the level of policy coherence to the nation's waste and energy sectors as well as socio-economic development objectives. For policy coherence, there should be a systematic promotion of mutually reinforcing policy actions across government departments and agencies creating synergies towards achieving the agreed national socio-economic objectives. These were:

- Ghana Shared Growth and Development Agenda (II) [22].
- Coordinated Programme of Economic and Social Development Policies (2017–2024) [23].

The National Environmental Sanitation Policy, 2010 [12], which looks at basic principles of environmental sanitation and constraints, was included. Considering the incessant exploitation of natural resources and biodiversity, the National Environmental Policy, developed to look at how to improve the depletion and management of natural resources, was included. Moreover, the National Energy Policy document, 2016 [8], which guides the energy sector, was reviewed. It is important to note that our study only comprehensively considered policies and strategies that guide the energy sector of Ghana sustainably and provide direct relation to the waste-to-energy process and technology. While we acknowledge the existence of other policies and strategies such as National Environmental Policy, National Environmental Sanitation Investment Plan (SESSIP), Strategic National Energy Policy and AU's Agenda 2063, among others, we could not undertake an exhaustive review of all existing policies. For instance, whereas the National Environmental Sanitation Investment Plan (SESIP) exists, the broader National Environmental Sanitation Strategy and Action Plan (NESSAP) [13], which provides an overlap with the SESIP and describes some activities within SESIP, was chosen for review.

4. Overview of Waste and Energy Policies in Ghana

All the twelve (12) policy documents reviewed provide a broad policy framework for the integration of environmental, sanitation as well as energy issues into development planning strategies and actions in Ghana. The Ghana Environmental Sanitation Policy (2010) [12], for instance, promotes resource recovery options, maximizing synergetic benefits at all levels—collection, recycling, treatment and disposal. The Ghana National Energy Policy (2010) is also aimed at creating a conducive environment for increased investment in the energy sector in Ghana and provides a framework for the efficient management of the energy resources. Generally, the policies focus on the following themes:

- Enhancing strategies for improved national sanitation issues.
- Increasing the proportion of renewable energy mix particularly solar, wind, mini-hydro and ensuring efficient energy use.
- Encouraging the use of waste produced from municipalities and communities into usable energy.
- Improving health and quality of life, including social and economic development.

Figure 2 depicts the frequency at which the policies reviewed captured each of the stated purposes. The policies are mainly set to improve sanitation and increase the renewable energy mix. Apart from the Ghana National Energy Policy (2010) [8] that explicitly captures the conversion of waste to energy, policies that encourage the use of waste to produce usable energy were limited.

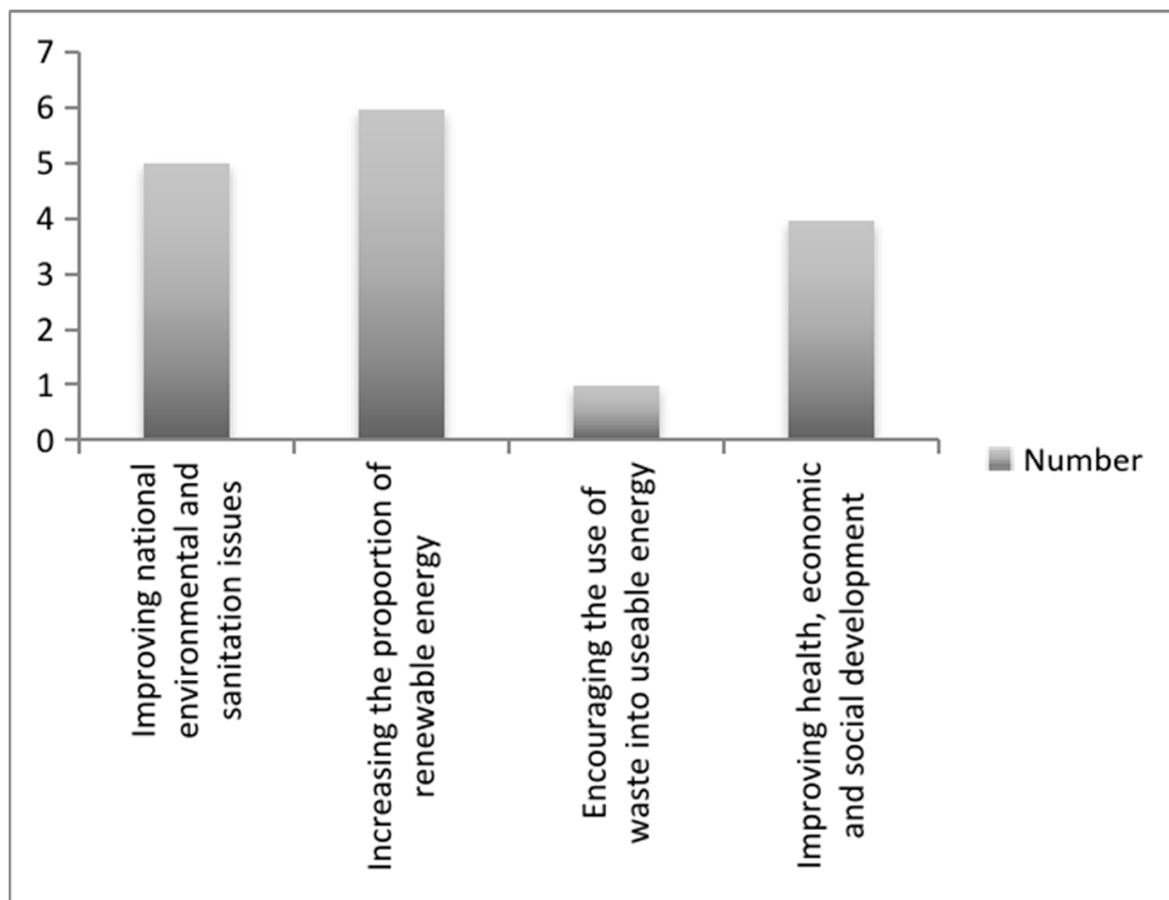


Figure 2. Number of highlighted themes within the reviewed policies.

4.1. The 'Effect' of Waste and Energy Policies in Ghana

The 'effect' facet of the policies reviewed has been summarized in Table 2. Overall, the effectiveness of the reviewed policies centers on the waste and/or energy sectors, except for two of the policies. All but three (3) of the policies also capture the differential effects of the policy on various social groups. Impact in areas other than the targeted objective such as economic, political, environmental, social relations, etc. are included.

4.2. 'Implementation' of Waste and Energy Policies in Ghana

The 'implementation' facet of the policies reviewed encompasses *feasibility* (the availability of resources such as human, institutional, technological and economic resources as well as the policies conformity with other relevant legislation) and level of *acceptability* of the policies (how stakeholders view the policies under study based on their knowledge, beliefs, values and interests).

Table 2. Summary of the ‘effect’ of waste and energy policies in Ghana.

Policy Document	Impact of Policy Objective on Waste and/or Energy (Effectiveness)	Differential Effect (Equity)
National Environmental Sanitation Policy, 2010	<ul style="list-style-type: none"> • Capacity Development • Information, Communication and Education • Sustainable Financing and Cost Recovery • Legislation and Regulations • Research and Development 	Captures levels of service for different population groups, industries, commercial areas at rural, urban and peri-urban
National Environmental Sanitation Strategy and Action Plan (NESSAP)	<ul style="list-style-type: none"> • Awareness creation—change in sanitation behavior and attitudes towards all wastes encompassing advocacy at the highest political levels, effectively implementing policies, and enhancing environmental sanitation education and enforcement management • Phased program for incremental improvements in all aspects of environmental sanitation services targeting the reduction of wastes for final disposal • Creation of green jobs in the environmental sanitation sector • Resource use efficiency and reduction in MMDA’s cost of managing waste. 	Effective coordination of and collaboration among sector stakeholders for country-wide adoption of policies, plans and programs for improved sanitation
National Solid Waste Management (SWM) Strategy for Ghana, 2020	<ul style="list-style-type: none"> • Strengthen sector governance • Create positive social action on SWM • Enable effective waste recovery, reuse and recycling • Establish sustainable sector financing mechanism 	Co-development of comprehensive SWM behavior change
Ghana National Energy Policy, 2010	<ul style="list-style-type: none"> • Maximize energy production from waste • Divert waste from landfills (prohibit burying of waste and landfills) • Facilitate access to the grid for waste-to-energy power plants • Develop infrastructure for waste collection and supply to waste-to-energy facilities. 	Not explicitly captured
Sustainable Energy for All (Se4All) Action (2012)	<ul style="list-style-type: none"> • Doubling the share of renewable energy in the global energy mix • Double the global rate of energy efficiency improvement. 	Achieving universal energy access
Energy sector strategy and development plan (2010)	<ul style="list-style-type: none"> • Maximize energy production from waste • Divert waste from landfills (prohibit burying of waste and landfills) • Facilitate access to the grid for waste-to-energy power plants • Develop infrastructure for waste collection and supply to waste-to-energy facilities 	Not explicitly captured
Renewable Energy Master Plan, 2019–2030	<ul style="list-style-type: none"> • Increase the proportion of renewable energy in the national energy generation mix • Reduce the dependence on biomass as the main fuel for thermal energy applications • Promote local content and local participation in the renewable energy industry 	Provide renewable energy-based decentralized electrification options in 1000 off-grid communities

Table 2. Cont.

Policy Document	Impact of Policy Objective on Waste and/or Energy (Effectiveness)	Differential Effect (Equity)
Ghana Health and Pollution Action Plan (2019)	<ul style="list-style-type: none"> Assist governments to identify, assess and prioritize existing pollution challenges based on health impacts Establish pollution as a priority for action within national agencies and development plans Define and advance concrete interventions to reduce pollution exposures and related illnesses 	Not explicitly captured
Ghana National Climate Change Policy, 2013	<ul style="list-style-type: none"> To adopt effective adaptation strategies which focus on improving energy infrastructure and natural resource management, ensuring agricultural growth and food security and maintain disaster preparedness and response 	To create a more coherent and equal society for women and children, who constitute the majority of the poor, depend more on natural resources and, hence, are more affected
Coordinated Programme of Economic and Social Development Policies, 2017–2024	Not explicitly captured (Focuses on safeguarding the natural environment and ensuring a resilient built environment; maintaining a stable, united and safe country; and building a prosperous country)	Creating opportunities for all Ghanaians
The Medium-Term National Development Policy Framework (MTNDPF), 2018–2021	Not explicitly captured (Focuses on transforming agriculture and industry; revamping economic and social infrastructure; and reforming public service delivery institutions)	Strengthening social protection and inclusion
Ghana Shared Growth and Development Agenda (GSGDA II) 2013–2017	<ul style="list-style-type: none"> Increase the proportion of renewable energy, in the national energy supply mix Promote the use and design of energy-efficient and renewable energy technologies in public and private buildings Create an appropriate fiscal and regulatory framework to encourage renewable energy from mini-hydropower projects 	Support the development of small- and medium-scale hydropower projects
ECOWAS Renewable Energy Policy	<ul style="list-style-type: none"> Ensure energy security and sustainability Normalize gender equality in renewable energy issues. In particular, the productive roles of women Reduce the negative environmental externalities Strengthen synergies with ECOWAS Energy Efficiency Policy at national and regional levels 	<p>Promote universal access to energy services</p> <p>Create a conducive business environment to encourage private sector investment in renewable energy</p>

4.2.1. Legislation and Regulatory Frameworks

There exist policy frameworks guiding the management of hazardous, solid and radioactive waste in Ghana. These include the Criminal Code, 1960 (Act 29); Local Government Act (1994, Act 462); the Environmental Protection Agency Act (1994, Act 490); the Pesticides Control and Management Act (1996, Act 528); Community Water and Sanitation Act, 1998 (Act 564); the Environmental Assessment Regulations 1999, (LI 1652); the Guidelines for the Development and Management of Landfills in Ghana; and the Guidelines for Bio-medical Waste (2000).

Other regulations and guidelines relevant to the waste and energy sectors include:

- MLGRD Environmental Assessment Regulations, LI1652, June 1999.
- MLGRD Management of Environmental Sanitation Services Guidelines, March 2002.
- MLGRD Manual on Prosecution, May 2002, MLGRD Trainers Note for Training on Landfills, June 2002.
- MLGRD/EPA Best Practice Environmental Guidelines Series No.1.
- Community Water and Sanitation Regulation, 2011 (LI 2007).

- EPA/MLGRD Best Practice Environmental Guidelines Series No.3, Manual for the Preparation of District Waste Management Plans in Ghana, July 2002.
- EPA/MLGRD Manual on Environmental Health Inspections, October 2002.
- MLGRD Environmental Sanitation Services Monitoring Guidelines, January 2003.

These acts and regulations emanate from the National Environmental Action Plan (MLGRD, 2004) and serve as guidelines for the various MMDAs to develop by-laws for the enforcement of environmental sanitation at the local level. They show the level at which the policies reviewed conform to other relevant legislation, including levels of governance. With the amendment of the Local Government Act (1994, Act 462) and the enactment of the Local Government Act, 2016 Act 936, currently, the enforcement of environmental sanitation at the local level by the MMDA has been based mainly on by-laws made by the assemblies. Most importantly, the Regional Coordinating Councils (RCCs) must approve the implementation of the by-laws as well as penalty/fines for flouting them, among others.

The Renewable Energy Act, 2011 (Act 832) [24] is also a regulatory framework for the promotion of renewable energy in Ghana. It aims to create an enabling regulatory environment to attract private sector involvement in the development, management and utilization of renewable energy. The Renewable Energy Act provides:

- Feed-in-Tariff Scheme under which electricity generated from renewable energy sources is offered at a guaranteed price;
- Renewable Energy Purchase obligations under which power distribution utilities and bulk electricity consumers must purchase some percentage of their electricity from electricity generated from renewable energy sources;
- Licensing regime for Commercial Renewable Energy Service Providers, among others, to ensure transparency of operations in the renewable energy industry;
- The establishment of the Renewable Energy Fund to provide incentives for the promotion, development and utilization of renewable energy resources;
- Establishment of a Renewable Energy Authority.

Defining policy context is an important step in understanding the effectiveness of a policy. On one hand, the waste sector has key policies and legislative documents. On the other hand, the energy sector also has important reference documents addressing policies and regulations. Other sectors also have relevant policies and legislations which overlap with the waste and energy sectors' activities. The review revealed that, in Ghana, policy, legal and regulatory frameworks specifically focused on the design and approval, operation and monitoring for W2E development are non-existent. The most addressed issues are related to adoption, research and development. Despite Municipal Solid Waste being recognized as a potential renewable energy source, much preference has been given to solar, wind and in some cases small and large hydro. The conversion of waste to energy, however, needs to be covered by effective legal and regulatory frameworks for enforcement before any W2E facility is built and operated on. The policy, legal and regulatory frameworks highlighted above provide legal anchorage and regular control for the enforcement of environmental sanitation.

4.2.2. Actors and Institutional Framework

The government has mechanisms in place that coordinate the implementation of waste management in Ghana. Key institutions, actors and their responsibilities in the waste-to-energy value chain are summarized in Table 3. Actors who have high policy influence and equally have high interest in the waste-to-energy project, as indicated in Table 3, include community leaders and traditional authorities, community-based NGOs and Advocacy groups, MESTI, MLGRD-District Assembly, the Environmental Health Unit, R&D partners and formal private sector players such as Zoom Lion Limited.

Table 3. Key actors and institutional framework with levels of influence and interest within waste and energy sectors of Ghana.

Key Actors	Specific Stakeholders/Institution	Level of Influence & Interest (H = High; L = Low)		Responsibility
		Influence	Interest	
National government (Ministries)	Ministry of Local Government and Rural Development-Environmental Health and Sanitation Directorate; Ministry of Sanitation and Water Resources, Community Water and Sanitation Agency (CWSA); Ministry of Environment, Science, Technology and Innovation, Ministry of Energy; Energy Commission; Public Utilities Regulatory Commission; Environmental Protection Agency; National Development Planning Commission	H	L	MLGRD-EHSD, MESTI, MSWR, NDPC are responsible for policy, establishment of institutional and legal frameworks; EC is Ghana's technical regulator of electricity, natural gas and renewable energy industries, and the advisor to the various ministries on energy planning and policy; EPA is the public body responsible for protecting and improving the environment in Ghana—it is responsible for matters related to regulating the environment and ensuring the implementation of Government environmental policies
	NESPoCC with representatives from relevant government agencies, NGOs and private sector groups	H	L	The NESPoCC is responsible for coordinating policy and ensuring effective communication and co-operation and effective policy coherence
	The Ministry of Finance; Ministry of Trade and Industry	H	L	Responsible for financial sustainability of policy implementation
Local government	Metropolitan, Municipal and District Assemblies (MMDAs), Atwima Nwabiagya Municipal in the Ashanti Region of Ghana	L	H	Solid waste collection and disposal services; enforcement of by-laws; regulating solid waste management activities and mobilizing resources for solid waste management
Research and Academia	CSIR, Universities (IIR/STEPRI), WASCAL, KNUST, KsTU, UNER Teachers in Primary, JHS SHS	L	H	Research in waste management technologies, environmental health and sanitation education
Formal private sector players	Zoomlion Ghana Limited	H	H	Provision of services such as collection, transfer, treatment, recycling and/or disposal of wastes. Services are provided either directly to individuals, community associations and business establishments, or operate under various partnership agreements with the metropolitan or municipal authorities
	Environmental and sanitation providers association (ESPA), waste scavengers association	H	H	Liase with citizens, industries and organizations to control environmental pollution, adopt clean production and technologies; reduce, reuse and recycle materials and natural resources; and minimize waste.

Table 3. Cont.

Key Actors	Specific Stakeholders/Institution	Level of Influence & Interest (H = High; L = Low)		Responsibility
		Influence	Interest	
Informal private sector players	Individuals or small groups	L	H	Individuals or small groups involved in unregistered and unregulated waste management activities.
	Households and Communities	L	H	Households are interested in receiving efficient waste collection services and sometimes waste disposal issues may not be a priority.
Community-based and Non Governmental Organizations	E.g. Coalition of NGOs in water and sanitation (CONIWAS) CEESD	H	H	Assist communities in community mobilization. Assist the District Assemblies, Town Councils, Unit Committees and communities in the planning, funding and development of community sanitation infrastructure for the safe disposal of wastes and the prevention of soil, water and air pollution.
Finance and insurance institutions	Formal commercial banks and Micro-financing institutions	L	L	Financial sustainability
Other Associations	Media	H	L	Awareness creation on source separation, waste-to-energy advocacy, and dissemination of waste-to-energy information.

The government, through institutions such as the Ministry of Environment, Science and Technology and the Environmental Protection Agency, provides leadership and takes charge of policy development in the management of waste in Ghana. Private entities handle the management of waste with decentralized policy implementation and supervision by MMDAs as operated under the Ministry of Local Government and Rural Development. Aside from these institutions, Civil Society Organisations and Non-Governmental Organizations play different roles along the waste management value chain.

The NESPoCC was established in January 2000 to expedite the implementation of the National Sanitation Policy. The council has membership from the Ghana Health Service/Ministry of Health, the Ghana Education Service, the Ministry of Environment and Science, the Environmental Protection Agency, representatives of MMDAs, the Council for Scientific and Industrial Research, and representatives from the private sector and non-governmental organizations.

The Environmental Protection Agency prepares policy documents, which are further developed by the Ministry of Environment, Science and Technology with the government promulgating them. The Environmental Protection Agency, under the supervision of the sectorial ministry, then ensures its implementation. The Ministry of Local Government and Rural Development through the MMDAs supervise the implementation in various MMDAs. The private, civil society organizations and the non-governmental organizations then play their referred roles. In the national energy policy, waste-to-energy is a priority intervention due to the multifaceted benefits such as sanitation, health, energy, organic materials and other recyclable materials that waste-to-energy presents. Moreover, waste management is considered important and key in Ghana's Renewable Energy Master Plan. It was, however, noted by the stakeholders that activities on implementation frameworks for such regulatory documents are very minimal.

Profiling stakeholders and institutions, including their roles and interests, is important in coordinating their participation in the waste-to-energy sector. Relevant stakeholders also need to know exactly what their roles and obligations are regarding the implementation of policies and strategies, and programs for the waste and energy sectors. Qualified public institutions and authorities are responsible for controlling environmental and other emission standards for W2E. The identified institutions are responsible for ensuring that the objectives and fundamental rules of W2E activities are regularly monitored and controlled. Generally, private institutions focus most of their activities on clearing the waste from the environment and processing it into products such as compost, but they are not directly involved in waste-to-energy projects. Although most private sector actors were not directly into waste-to-energy, they expressed interest in waste-to-energy and discussed their plans towards setting up their own waste-to-energy plants, which are yet to materialize due to some institutional and financial challenges.

The main interest of NGOs, CSOs and Media is in bringing communities together and collaborating with them to ensure that they are able to handle their waste properly and collaboratively draw an action plan to address their waste management issues. One key group that was identified by the CSOs and media was the waste pickers (association) who often collect a particular type of waste from waste sites or households and offices and send them for sale or for recycling, unlike waste collectors who collect any type of waste and transport these to their final destination. The role of the media was noted to be awareness creation especially on source separation, waste-to-energy advocacy, and dissemination of waste-to-energy information, bringing out the high influence they have on this project. According to the CSOs, if the implementation of W2E projects is not well coordinated, it could displace some informal workers (waste pickers) from their jobs; hence, there is need for constant communication and engagement with stakeholders. With great influence, the interest of CSOs, NGOs and the media needs to be well managed to enhance W2E activities.

The public sector is committed to policy formulation and implementation, primarily on waste- or energy-related issues. They also coordinate activities by which these policies can be implemented (depicting their influence). For instance, the Metropolitan Municipal and

District Assemblies (MMDAs) are the custodians of waste, so they sign franchise agreements with the environmental service providers. This implies that, before an institution can access waste for other purposes, permission has to be granted by the MMDAs. This strongly emphasizes their influence and also the need for collaboration with various sector to enhance interest in waste-to-energy activities. Additionally, the Government of Ghana has recently announced plans for the establishment of a dedicated National Sanitation Authority (NSA) and Fund to adequately resource activities of the NSA. The Local Government Act also mandates that MMDAs to also have responsibility for the provision of waste management services and this means funds been allocated for SWM from the District Assembly Common Fund (DACF). Thus, financial-level autonomy and responsibilities are not coherently aligned with service-level responsibilities but with inter-ministerial accountabilities, functions and technical expertise.

Institutions under research and academia (Table 3) are primarily responsible for research and development, technology development, training and capacity development as well as knowledge transfer. According to the stakeholders engaged with this, though these different categories appear to be intertwined in their roles, each institution seem to be doing its own thing, which affects their level of influence. Due to this, they are not able to go far or gain much recognition and this calls for strong collaboration among the various institutions so that much can be attained. Researchers who fall within this sector naturally have developed a high research interest in the area and constantly work to make contributions in this area.

The environmental service providers, also known as the upstream waste, supply the waste needed to feed the waste-to-energy plant. As a matter of fact, the private sector is equipped with some resources, expertise and knowledge, and equipment which are relevant to this project. The public institutions are needed to ensure correct procedures within the waste and renewable energy sectors through policy formulation and implementation. Moreover, the project can be sustained when the government agrees to purchase the energy generated from the waste-to-energy plant. The decisions/policies that come out of this project in the long run will have to be used by the related bodies and individuals, and the CSOs, NGOs and Media are a strong advocacy voice in promoting social acceptance, since people's perceptions about the project can indirectly lead to the success or failure of project [25].

The expected impact of the identified stakeholders on the waste-to-energy project include:

- Supply of raw material (waste) to feed the waste-to-energy plant.
- Bringing on board innovative ideas, solutions and waste-to-energy technologies.
- Knowledge sharing and transfer.
- Regulation of waste-to-energy-related activities.
- Implementation of waste-to-energy policies.
- Purchase of the energy generated from the waste-to-energy plant.
- Advocacy and awareness creation to promote social acceptance.
- Mobilization and making efficient use of public, private and household finance to drive improvement in waste and energy sectors management.

4.2.3. Barriers to Effective Implementation of Waste and Energy Policies in Ghana

As part of the policy review process, gaps were identified for interventions to enhance the policy implementation process for the effective waste and energy sectors of Ghana. Waste and energy policies respond to requirements for improving infrastructure and services in the environment to ensure that energy can be produced, transported and used efficiently and supplied in a form that has no adverse health, safety and environmental impact. Some challenges of concern identified in the reviewed policy documents that could serve as implementation barriers to potential waste-to-energy projects are presented in Table 4.

Table 4. Policy gaps relevant as barriers to effective Waste-to-Energy projects.

Policy Document	Identified Gaps
Ghana Environmental Sanitation Policy (2010)	<ul style="list-style-type: none"> • Ineffective cross-sectorial collaborations among ministries and agencies to jointly implement policies and plans. • Difficult management of increasing waste levels associated with growing Ghanaian economy and related lifestyle changes. • Limited technical capacity for final waste treatment and disposal facilities. • Ineffective enforcement and management of by-laws for behavioral change and response to community needs and concerns.
National Environmental Sanitation Strategy Action Plan (NESSAP)	<ul style="list-style-type: none"> • Lack of appropriate technologies for re-use, recycling and recovery of waste from landfills. • Outmoded by-laws and the challenge of MMDAs' inability to enforce laws and regulations could limit investment opportunities and need to be addressed. • Lack of incentive system for waste segregation.
National Solid Waste Management (SWM) Strategy for Ghana, 2020	<ul style="list-style-type: none"> • Ineffective strategies for enforcement and management of by-laws and practices for behavioral change and response to community waste management (generally slow SWM practices).
Ghana National Energy Policy (2010)	<ul style="list-style-type: none"> • Inadequate financing for collection and management of waste-to-energy technologies. • Inefficiency in the management and use of energy. • Lack of gender mainstreaming into development, production and direction of issues within the energy sector.
Renewable Energy Master Plan (2019–2030)	<ul style="list-style-type: none"> • Lack of adequate fiscal and human capital investments in the Renewable Energy sector. • Negative attitudes of the general public towards waste handling. • Non-segregation of waste at the source. • Lack of proper understanding of the composition of waste and hence appropriate technology and cost. • Lack of adequate infrastructures such as waste collection and transfer points. • Inadequate incentives for private sector investment as investors in the RE sector are faced with perceived risk of the Ghanaian financial sector and prevailing macroeconomic conditions. • Lack of coordination between national grid interventions and off-grid interventions.
Energy Sector Strategy and Development Plan (2010)	<ul style="list-style-type: none"> • Inadequate infrastructure for the production and supply of adequate energy services to meet the national requirement and for export. • Lack of requisite infrastructure to ensure universal access as well as efficient and reliable supply of energy services.
Sustainable Energy for All (Se4All) Action (2012)	<ul style="list-style-type: none"> • Poor supply chain infrastructure. • Inadequate access to finance, including investment capital and consumer credit. • Limited public awareness, education and outreach. • Inadequate partnership coordination and knowledge management.
Ghana Health and Pollution Action Plan (2019)	<ul style="list-style-type: none"> • Inadequate number of landfill sites for proper disposal of waste. • Poor sanitation and waste management systems. • Inadequate financial, both government and private, in the waste management sector. • Inadequate policy and institutional coordination particularly in the Health–Sanitation–Energy nexus.
Ghana National Climate Change Policy (2013)	<ul style="list-style-type: none"> • Lack of investment in renewable energy sources such as waste-to-energy, and the lack of a long-term vision and detailed coordination. • Absence of an institutional regulatory framework for effective implementation of policy plans and policies. • Overdependence on natural resources due to insufficient access to alternative sources.

Table 4. Cont.

Policy Document	Identified Gaps
Coordinated Programme of Economic and Social Development Policies (2017–2024)	<ul style="list-style-type: none"> • Inadequate financing of sanitation. • Poor sanitation and waste management systems. • Inadequate policy and institutional coordination. • Limited capacity at MMDA level to address sanitation concerns adequately. • Ineffective environmental health officers.
The Medium-Term National Development Policy Framework (MTNDPF) (2018–2021)	<ul style="list-style-type: none"> • Inadequate capturing of environmental sanitation and waste management plans in Medium Term Development Plans.
ECOWAS Renewable Energy Policy	<ul style="list-style-type: none"> • Limited public awareness of advantages of renewable energy and its potential. • Lack of trust with the international renewable energy business community to be able to attract financing in both the renewable energy and the energy efficiency sector. • Lack of development portfolios of bankable projects at the national level limits attractiveness of private investors and financial institutions.

4.2.4. Level of Acceptability of Waste and Energy Policies in Ghana

Discussions and concerns raised by the stakeholders within the waste and energy sectors of Ghana during stakeholder consultations were around the following areas:

- Challenges affecting the implementation of waste and energy projects and policy gaps.
- Waste-to-energy as a renewable energy source.
- Enablers for sustainable waste-to-energy projects and scale-up.

Challenges Affecting the Implementation of Waste and Energy Projects and Policy Gaps

According to the key informants, Ghana's waste-to-energy plans were noted not to fully have taken off primarily due to the unavailability of funds at appropriate sectoral levels and a general lack of waste-to-energy infrastructure. Initial centralization and public waste management control could not allow private participation until recent public vertical integration and subsequent private participation were implemented. The vertical integration has been hit with a policy directive to put on hold Power Purchasing Agreements (PPAs). The policy directive is to help address gluts in the power sector. Waste-to-energy technologies have also suffered from the low availability of skilled expertise for their implementation. Although there are a good number of experts in waste-to-energy, there has not been a consistent generation of technical people to develop waste-to-energy technologies, especially in the past. The government, on the other side, has not devoted adequate resources to research and development. An additional challenge mentioned was the non-segregation of waste, making it difficult for separation during energy conversion.

Regarding the government's policy on no more PPAs on waste-to-energy projects, the stakeholders explained that such directive from the government asserts an oversubscription of power plants in the power sector. Thus, no more power plants can be rolled out on a power purchasing agreement. This implies that the integration of waste-to-energy projects will be interrupted. Meanwhile, waste-to-energy projects are best designed on commercial scales for good economies of scale. Investors usually bank on PPAs to invest in such commercial projects. Thus, the integration of commercial waste-to-energy plants will be disincentivized. It was made clear that, although new PPAs for Waste-to-Energy are not being signed, the already signed ones are also not being implemented. For instance, although the Ministry of Energy, through the various renewable energy interventions, has facilitated a power purchase agreement for a 50 MWe waste-to-energy plant to be constructed in the Greater Accra region, delay in the approval of the tax waiver from the government of Ghana is serving as a barrier to its implementation. This, by far, would be the largest waste-to-energy project in the country. Obviously, the no-more-PPA rule

is harming the Waste-to-Energy management pathway. It affects investment in waste-to-energy and generally renewable energy development in Ghana. Fiscal incentives to boost investment within the private sector are key.

A general indication of low/no implementation of policies relevant to waste and renewable energy was noted among the stakeholders consulted. While some level of implementation was acknowledged, although at low levels, some stakeholders had not observed any substantive policy implementation. The reasons attributed to these include lack of budgetary allocations, ignorance, low political will and poor governance and planning. It was expressed that, although the Renewable Energy Master Plan and the Sustainable Energy Plans both highlight waste-to-energy, political commitments do not promote such actions. According to the stakeholders, the absence of key waste infrastructures was because of political disregard for the potential of waste-to-energy technologies. Political willingness is key for ensuring investment targeting and priorities.

Waste-to-Energy as a Renewable Energy Source

With a key focus on waste and energy, all stakeholders consulted unequivocally confirmed waste-to-energy as a probable renewable energy source. It was, however, highlighted that 'waste' is technically not a renewable energy resource until conversion into energy for heat generation, electricity or both is done. The conversion methods required for waste-to-energy may be biochemical, thermochemical or mechanical. Presently in Ghana, however, waste-to-energy projects have not commercially taken off. There exist some plants such as a 5000 m³ liquid waste treatment to produce green electricity by Zoomlion Company Limited; a 0.1 MWe waste-to-energy plant at Safisana, Ashiaman, that is connected to a medium voltage network; combined Heat & Power using timber waste at Samartex Ghana, Samreboi; and biogas systems for industrial waste treatment at Ghana Oil Palm Development Company (GOPDC) Limited (palm oil mill effluent), Guinness Ghana (brewery waste water), HPW Fresh and Dry Limited (fruit waste) and a couple of biogas-to-electricity systems in across the country.

The biogas at UENR, for instance, is supplied with solid organic (food waste) from the cafeteria and fecal waste from three different points on the university campus: their auditorium and Information Technology (IT) directorate. The system is a fixed dome Deenbandhu technology composed of an inlet chamber, a pre-treatment chamber, digestion tank and an external plastic biogas storage tank. As waste is continually produced in large quantities with increasing population, the implication is that waste will be readily available for use in energy generation once explored. This is an opportunity to make good use of resources that could potentially reduce environmental pollution. Waste collection in Ghana, nonetheless, has with some challenges [1]. Inadequate financial, technological, infrastructure, human resource and institutional capacities, behavioral changes, and regulatory enforcement have been highlighted. Corruption and nepotism were reported to be hampering waste management even where partnership with private sector operatives is involved at the local government side. The lack of policy on waste segregation and waste disposal has resulted in indiscriminate waste disposal with poorly managed landfills and consequent negative environmental impact. If waste-to-energy projects are to take off commercially, the respondents highlighted the need to improve awareness creation and education on sanitation and the impacts of poor waste management. The government and regulatory authorities need to improve logistical planning and advance provision of better infrastructures and technology for waste management. By-laws enforcement with regulatory punitive measures has to be implemented to ensure better waste disposal and management while governance structures seek better direction for enhanced funding and investment opportunities.

Scaling Up of Sustainable Waste-to-Energy Projects

To make waste-to-energy projects sustainable and to potentially widen and scale up investment within the renewable energy sector of Ghana, the stakeholders consulted pro-

posed improvement in waste collection activities, particularly with segregation practices to extract waste streams that emit high levels of pollutants. Incentive provision for source separation of waste was encouraged. As a result of these, policies that will compel MM-DAs to enforce waste segregation, collection and disposal was advised. This will ensure the required waste for energy production can be easily accessed. Moreover, conversion processes that have the potential of reducing toxic emissions were recommended. Such processes include gasification, plasma gasification and pyrolysis. Boiler exhaust of other thermochemical conversion processes that have higher emission levels requires the use of filters, absorption and scrubbing before being released into the atmosphere.

It was further suggested that waste-to-energy projects should be biomass- or organic-waste-dependent. The centralization of some aspects of waste management (e.g., transportation, which is a significant cost component) was suggested to reduce costs. Community engagement and participation as well as improved education and awareness creation was proposed. This will advance awareness on the benefits of the waste-to-energy concept and provide education on waste sorting at source (household, farm level, etc.). The government has to make such projects part of the energy mix of local government areas. It was suggested that policies targeted at waste management need to be developed with regulations to boost the waste and energy sectors. Finally, political willingness is key in ensuring investment targeting and priorities in any sector of an economy; hence, high political will and political push in decision making, regular monitoring and evaluation, legally bidding commitments and regulatory enforcements were recommended.

5. Promotion of Waste as a Renewable Energy Source in Ghana—Insights from the Policy Review Findings

Energy usage has implications for the environment. Excessive burning of fossil fuels results in the depletion of natural resources as well as a steady increase of carbon dioxide emissions, which is believed to be responsible for increasing average global temperatures [26]. The challenges of growing energy demand and environmental pollution require policies and governance on energy resources that transition towards more efficient energy regimes. This requires a strategically designed sequence of actions that involve multi-scalar policy levels, from local to global. A broad range of policy tools has been introduced such as tradable emission rights, taxes and subsidies, as well as regulation such as feed-in tariffs for renewable energy production [27]. It is essential to understand how to create effective policies that enable conditions for sustainable waste-to-energy technologies.

Most of the policies reviewed were found to be weak in explicitly mainstreaming issues of waste management. Ineffective collaboration among ministries and agencies to jointly implement cross-sectorial policies and plans was identified. The NESPoCC with representatives from relevant Government agencies, NGOs and private sector groups is responsible for coordinating policy and ensuring effective communication and cooperation among ministries and agencies. In a typical waste-to-energy project, several ministries and agencies will be involved; hence, effective coordination is key. For good waste governance, stakeholder consultations, community mobilization and buy-in should be intensified. Stakeholders should be involved in implementing and monitoring waste management activities.

Ghana's capacity to improve and potentially scale up waste and renewable energy sectors and projects rely on informed decision-making processes and the availability of an enabling environment (including resources, standards and regulatory frameworks). The capacity to improve waste management to harness waste-to-energy can be done through effective technologies, for which support is still evolving. According to this review, there are limited and ineffective strategies, systems and programs for the waste and energy sectors of Ghana, particularly on waste management. There also exist inadequate explicit resources and budget allocations to address challenges within the waste and renewable management systems. Nonetheless, adequate institutional framework and mechanisms do exist to explore opportunities to coordinate the implementation of various policy strategies and interventions. For instance, NGOs bring communities together and collaborate with them

to ensure effective handling of waste as well as drawing action plans in their activities to address waste management issues. The private sector also focuses mostly on activities such as waste clearing from the environment and processing with key functions in solid waste collection, transportation, composting and recycling. In addressing the identified gaps related to management of increasing waste levels and limited technical capacity for final waste treatment and disposal facilities, it is important to create an enabling environment to support activities of the private sector and increase private sector participation for effective waste reduction, recovery and recycling.

Additionally, streamlining strategies to constitute components to improve governance on waste management, improve financing to ensure sustainable investment in waste-to-energy projects, improve research on waste-to-energy technologies as well as enhance public interest and education on proper waste management can enhance the policies reviewed.

6. Conclusions and Policy Implication

Waste-to-energy-related policies have been reviewed in this paper with the aim to identify gaps and policy concerns that need to be addressed moving forward. For the policies reviewed, the study concludes that the themes on enhancing strategies for improved national sanitation issues, increasing the proportion of renewable energy mix particularly solar, wind, mini-hydro, and ensuring efficient energy use were given more attention than the promotion of waste into usable energy technologies in Ghana. Equity issues regarding interests of different population groups, industries, commercial areas at rural, urban and peri-urban areas have not been well articulated in the current waste and energy policies.

Stakeholder engagements revealed a low level of implementation of the policies reviewed due to challenges including lack of budgetary allocations, ignorance, low political will, poor waste-to-energy management, weak coordination and policy incoherencies. These findings have implications for the development of policy guidelines for waste-to-energy management and projects implementation in Ghana that integrate stakeholders concerns, particularly that of the private sector players and civil society who have been identified as high influencers. Moreover, for effective an waste-to-energy system in Ghana, future studies could identify an area of public policy where political action has taken place to appropriately provide insights into what needs to be done to develop a political will in the area of waste management.

The following are also policy recommendations drawn from the study findings:

- Awareness creation and education on sanitation and impacts of poor waste management should be improved.
- Institutionalization of the concept of source segregation of waste should form an integral part of the waste management system in Ghana.
- Government and regulatory authorities need to improve logistical planning and advance provision of better infrastructures and technology for waste management.
- By-laws enforcement with regulatory punitive measures has to be implemented to ensure better waste disposal and management.
- Governance structures should be reinforced with better directions for leveraging on both local and foreign funding and investment opportunities for waste-to-energy management.
- To minimize, control or eliminate uncontrolled disposal of waste as well as promote waste segregation, development of a waste management law with policy guidelines for its effective implementation is recommended.
- Develop a strategic financing strategy for mobilizing funds from different sources of funds (such as user fees, public finance, and private sector investment via PPPs), considering options to set up specific funds (e.g., plastic waste recycling fund or national sanitation fund) are sustainable mechanisms for SWM as highlighted in the Solid Waste Management Strategy.

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