An Integrated Approach to Climate Change Mitigation: Assessing Waste Management Practices, Energy-Use Behaviors, and Community Perceptions of Waste-to-Energy Technologies in Teso South Sub-County, Busia County, Kenya

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Abstract
This study employed an integrated approach to climate change mitigation, focusing on waste management practices, energy use behavior and community perceptions of waste-to-energy technologies. The study was guided by the Diffusion of Innovations Theory and the Theory of Planned Behavior. A descriptive cross-sectional survey design employing mixed methods was adopted. Data were collected from 387 household heads selected through stratified random sampling, alongside key informants from relevant government departments, community organizations, and environmental agencies. Quantitative data were analyzed using descriptive statistics and inferential analysis, while qualitative responses were analyzed thematically. The findings revealed that household waste management remains largely unsustainable, with burning (39.8%) and open dumping (16.0%) being common disposal methods, while formal waste collection (7.5%) and recycling (3.1%) were minimally practiced. Firewood (69.3%) and charcoal (13.4%) remained the dominant cooking energy sources, although solar energy was the leading source of household lighting (44.2%). Attitudes toward waste-to-energy technologies were generally positive. The study concludes that integrating community-based waste management with energy-efficient and waste-to-energy technologies presents significant potential for climate change mitigation in Teso South Sub-county. The study recommends scaling up environmental education programmes, promoting affordable waste-to-energy technologies, strengthening partnerships among government and non-governmental stakeholders, and investing in decentralized waste management systems to enhance sustainable development and climate resilience in rural communities.

Keywords: Climate change mitigation, community-based waste management, household energy use, waste-to-energy technologies, energy-efficient technologies, sustainable development, Teso South Sub-county, Busia County.

1. Introduction

1.1 Background of the Study

Climate change is widely recognized as one of the most significant environmental and development challenges facing the world today. The phenomenon is primarily driven by increased greenhouse gas (GHG) emissions resulting from human activities such as fossil fuel combustion, deforestation, unsustainable agricultural practices, and poor waste management systems (Intergovernmental Panel on Climate Change [IPCC], 2023; Agunyo et al., 2019). The consequences of climate change include rising temperatures, changing precipitation patterns, increased frequency of droughts and floods, biodiversity loss, food insecurity, and adverse impacts on human health and livelihoods (IPCC, 2023). Consequently, governments, researchers, and development agencies have increasingly emphasized the need for integrated climate change mitigation strategies that address multiple emission sources while promoting sustainable development.

Globally, the waste management sector has emerged as a critical area for climate change mitigation. According to the United Nations Environment Programme (2024), the world generates over 2.3 billion tonnes of municipal solid waste annually, and this figure is projected to increase significantly by 2050. Improper waste disposal methods such as open dumping and open burning contribute to environmental pollution and release substantial quantities of methane and carbon dioxide into the atmosphere. Methane, which is produced through the anaerobic decomposition of organic waste, is estimated to have a global warming potential approximately 28 times greater than carbon dioxide over a 100-year period (IPCC, 2023). As a result, sustainable waste management practices have become an important component of climate change mitigation efforts worldwide.

One promising approach to sustainable waste management is the adoption of waste-to-energy (WtE) technologies. Waste-to-energy technologies involve the conversion of waste materials into useful forms of energy, including electricity, heat, biogas, and biofuels. These technologies contribute to climate change mitigation by reducing waste accumulation, minimizing methane emissions from landfills, and providing renewable alternatives to fossil fuels (Kaza et al., 2018). In many developed and emerging economies, WtE technologies have been integrated into circular economy strategies aimed at promoting resource efficiency and environmental sustainability (United Nations Environment Programme [UNEP], 2024).

In Sub-Saharan Africa, however, waste management remains a major challenge due to inadequate infrastructure, limited financial resources, weak institutional capacity, and rapid population growth. Many communities continue to rely on unsustainable waste disposal methods, including open dumping and burning, which contribute to environmental degradation and public health risks (Kaza et al., 2018). At the same time, access to modern energy services remains limited, particularly in rural areas where households depend heavily on traditional biomass fuels such as firewood and charcoal (International Energy Agency [IEA], 2023).

The continued reliance on biomass fuels has significant environmental and socioeconomic implications. Biomass energy consumption contributes to deforestation, land degradation, indoor air pollution, and greenhouse gas emissions. According to the International Energy Agency (2023), nearly 900 million people in Sub-Saharan Africa continue to rely on

traditional biomass for cooking, making the region one of the most energy-poor globally. The use of inefficient cooking technologies further exacerbates environmental degradation while exposing households to health risks associated with indoor air pollution.

Kenya has made considerable progress in addressing climate change through various policy frameworks, including the Climate Change Act 2016, the National Climate Change Action Plan 2023–2027, and commitments under the Paris Agreement. These frameworks recognize the importance of sustainable waste management and renewable energy adoption as key pathways toward achieving low-carbon development and climate resilience (Government of Kenya, 2023). The country's Nationally Determined Contribution (NDC) further emphasizes reducing greenhouse gas emissions through improved waste management systems, renewable energy deployment, and sustainable land-use practices (Government of Kenya, 2023).

Despite these policy efforts, waste management challenges remain prevalent across many parts of Kenya. Studies have shown that improper waste disposal practices continue to dominate both urban and rural settings, with limited waste segregation, recycling, and resource recovery initiatives (Dianati et al., 2021; Agunyo et al., 2021). Similarly, household energy consumption in rural Kenya remains heavily dependent on firewood and charcoal despite increasing promotion of clean energy technologies such as biogas and improved cookstoves (Mwirigi et al., 2018).

Teso South Sub-County in Busia County presents a particularly relevant context for examining these issues. The sub-county is predominantly rural, with agriculture serving as the primary economic activity. Agricultural production generates substantial quantities of organic waste, including crop residues, livestock manure, and biodegradable household waste. These waste streams present opportunities for resource recovery and renewable energy generation through waste-to-energy technologies such as biogas production and biomass briquetting. At the same time, many households continue to rely on biomass fuels for cooking and heating, contributing to environmental degradation and greenhouse gas emissions.

Although waste-to-energy technologies offer significant potential for addressing both waste management and energy challenges, their successful implementation depends largely on community awareness, perceptions, and willingness to adopt such technologies. Research has demonstrated that public perceptions play a critical role in determining the acceptance and sustainability of environmental innovations (Rogers, 2003). Communities are more likely to support and adopt technologies that they perceive as beneficial, affordable, compatible with local practices, and capable of improving livelihoods.

However, limited empirical evidence exists regarding current waste management practices, household energy-use behaviors, and community perceptions of waste-to-energy technologies in Teso South Sub-County. Most studies in Kenya have concentrated on urban centers or broader regional analyses, leaving significant knowledge gaps regarding rural communities and their role in climate change mitigation. This study therefore seeks to assess waste management practices, energy-use behaviors, and community perceptions of waste-to-energy technologies in Teso South Sub-County to generate evidence that can inform climate change mitigation strategies, sustainable waste management policies, and renewable energy interventions.

1.2 Statement of the Problem

Approximately 67.8% of Kenya's 57.5 million population lives in rural areas, and this share is projected to grow by 1.47% annually (KNBS, 2025). This population produces, on average, 0.1 kilograms of waste per person (Kariuki, J. M., Moturi, W. N., Shivoga, W. A., Kilonzi, C. M. and Kinyanjui, D. N., 2015), of which 70% to 80% is organic, dominated by food scraps, crop residues and yard sweepings (Fie Consult, 2026). Although waste production is considered lower than in urban areas of Kenya, rural areas lack proper infrastructure and waste management systems (Waswa B. S. & Chege C., 2024), making them more likely to contribute to increased greenhouse gas emissions, a major concern for global climate change. This may have far-reaching ramifications, as developing countries such as Kenya are particularly vulnerable because their economies largely depend on climate-sensitive sectors such as agriculture and natural resources (IPCC, 2023).

Waste management and household energy consumption represent two critical sectors with significant implications for climate change mitigation. Poor waste management practices, such as open dumping and open burning, contribute to greenhouse gas emissions and environmental pollution. Similarly, continued reliance on traditional biomass fuels such as firewood and charcoal contributes to deforestation, land degradation, indoor air pollution, and carbon emissions (IEA, 2023). These challenges are particularly pronounced in rural areas with weak waste management infrastructure and access to clean energy technologies has remained constrained (Waswa B. S. & Chege C., 2024).

Waste-to-energy technologies have been identified as viable solutions for addressing both waste management and energy challenges. Through the conversion of organic and household waste into useful energy products such as biogas and biomass briquettes, these technologies can reduce waste accumulation, lower greenhouse gas emissions, improve sanitation, and enhance household energy security (Mwirigi et al., 2018). Furthermore, waste-to-energy systems align with Kenya's climate change mitigation objectives and sustainable development goals by promoting renewable energy generation and resource efficiency (Government of Kenya, 2023). Also, despite the potential benefits of adopting waste-to-energy technologies, uptake has remained relatively low in many rural communities in Kenya. This study aimed at investigating how rural households currently manage waste, utilize energy resources, and perceive waste-to-energy technologies, particularly in Teso South Sub-County, Busia County. The findings are intended to address existing knowledge gaps and provide practical insights for policymakers, development practitioners, and environmental stakeholders seeking to promote integrated climate-change mitigation strategies in rural Kenya.

1.3 Research objectives and Research Questions

1.3.1 Research Objectives

i. To assess current waste management and energy-use practices in Teso South Sub-county, Busia County
ii. To evaluate community perceptions of waste-to-energy technologies in Teso South Sub-county, Busia County."

1.3.2 Research Questions

i. What are the current waste generation, collection, disposal, and management practices in Teso South Sub-county, Busia County?

ii. How do community members perceive waste-to-energy technologies in Teso South Sub-county, Busia County?

2.0 Literature Review

2.1 Theoretical Literature Review

2.1.1 Theory of Planned Behavior (TPB)

The Theory of Planned Behavior (TPB) was developed by Icek Ajzen and posits that human behavior is influenced by attitudes, subjective norms, and perceived behavioral control (Ajzen, 1991). According to the theory, individuals are more likely to engage in a particular behavior when they have positive attitudes toward it, perceive social support for the behavior, and believe they possess the necessary resources and capabilities to perform it.

In the context of waste management, TPB explains why households choose to adopt practices such as waste segregation, recycling, composting, and environmentally responsible disposal methods. Similarly, energy-use behaviors such as the adoption of improved cookstoves, fuel-efficient technologies, and clean energy sources are influenced by perceptions of benefits, social expectations, and access to resources.

The theory is also useful in understanding community perceptions of waste-to-energy technologies. Positive attitudes toward WtE systems, social approval from community leaders, and confidence in the ability to use or benefit from the technology can influence acceptance and adoption. Therefore, TPB provides a useful framework for explaining both existing household behaviors and future willingness to adopt climate-friendly waste and energy solutions.

Although TPB effectively explains individual behavior, critics argue that it places excessive emphasis on rational decision-making and may not adequately account for structural barriers such as poverty, inadequate infrastructure, and policy constraints, which are common in rural communities.

2.1.1 Diffusion of Innovations Theory (DOI)

The Diffusion of Innovations Theory was developed by Everett Rogers and explains how new technologies and ideas spread through social systems (Rogers, 2003). The theory identifies five key characteristics that influence adoption: relative advantage, compatibility, complexity, trialability and observability

Waste-to-energy technologies are considered innovations within rural communities. Their adoption depends largely on whether community members perceive them as beneficial, compatible with local practices, easy to use, and capable of producing observable benefits.

For example, households may be more willing to support biogas systems if they observe neighboring households reducing fuel costs and improving sanitation through waste utilization. Conversely, perceptions of high installation costs or technical complexity may reduce acceptance.

The theory is particularly applicable to Objective Two, which seeks to evaluate community perceptions of waste-to-energy technologies. It provides insight into factors influencing community acceptance and potential adoption of such technologies.

2.1.3 Environmental Modernization Theory (EMT)

Environmental Modernization Theory argues that environmental challenges can be addressed through technological innovation, institutional reform, and sustainable production systems. The theory suggests that economic development and environmental protection are not mutually exclusive but can reinforce each other through environmentally friendly technologies and policies.

Waste-to-energy technologies embody the principles of environmental modernization because they transform waste from an environmental liability into a productive resource. By converting organic waste into energy, communities can simultaneously reduce greenhouse gas emissions, improve sanitation, and enhance energy security. Therefore, EMT provides the broader climate change mitigation perspective underpinning this study.

2.2 Empirical Literature Review

2.2.1 Waste Management Practices and Climate Change Mitigation

Solid waste management remains a major environmental challenge globally, particularly in developing countries where waste collection and disposal systems are often inadequate. Improper waste disposal contributes to environmental degradation, public health risks, and greenhouse gas emissions.

A study conducted in Kisumu County, Kenya, found that less than half of generated waste is regularly collected, resulting in widespread dumping and open burning of waste. The study further demonstrated that integrating waste-to-biogas initiatives could significantly reduce greenhouse gas emissions while improving public health outcomes. Combined waste management interventions were projected to generate substantial cumulative greenhouse gas savings by reducing dependence on traditional cooking fuels.

Research across Sub-Saharan Africa indicates that community-based waste management initiatives contribute to environmental sustainability through waste reduction, recycling, composting, and improved sanitation. These practices reduce methane emissions from decomposing waste and promote resource recovery within local economies.

Kamau and Andati (2025) observed that sustainable management of organic waste through bioenergy and biofertilizer production can contribute significantly to climate action by reducing pollution and supporting circular economy principles.

Despite these benefits, many rural communities continue to face challenges such as inadequate waste collection infrastructure, low levels of waste segregation, limited awareness, and weak institutional support. Most existing studies focus on urban centers such as Kisumu and Nairobi, with limited evidence available regarding waste management practices in rural settings such as Teso South Sub-County.

2.2.2 Household Energy-Use Behaviors in Rural Kenya

Energy use remains a critical component of climate change mitigation because household energy choices directly influence greenhouse gas emissions, deforestation, and environmental sustainability. Studies conducted in Western Kenya indicate that rural households continue to rely heavily on traditional biomass fuels, particularly firewood and charcoal, for cooking purposes. Firewood remains the dominant cooking fuel due to affordability and accessibility despite its environmental consequences.

Research by Kimutai et al. (2022) found that household energy choices are influenced by income levels, education, household size, and access to modern energy infrastructure. The study demonstrated that behavioral and socioeconomic factors significantly affect the transition toward cleaner energy sources.

Similarly, Ochieng et al. (2020) reported that many Kenyan households engage in "fuel stacking," where multiple energy sources are used simultaneously rather than completely replacing traditional fuels. Households often retain firewood and charcoal even after adopting improved cooking technologies due to cost considerations, cooking preferences, and fuel availability.

Research on biogas adoption in rural Kenya further indicates that although biogas presents a viable clean energy alternative, adoption remains constrained by financial costs, technical requirements, and limited awareness. Although studies have examined household energy use in Western Kenya broadly, little empirical evidence exists regarding the interaction between waste management practices and household energy-use behaviors within Teso South Sub-County.

2.2.3 Waste-to-Energy Technologies and Climate Change Mitigation

Waste-to-energy technologies involve converting waste materials into useful forms of energy such as biogas, electricity, heat, or biofuels. These technologies are increasingly recognized as important tools for reducing greenhouse gas emissions and promoting sustainable development.

According to Kamau and Andati (2025), organic waste conversion technologies provide dual environmental benefits by reducing waste accumulation and generating renewable energy. Such technologies contribute to climate change mitigation by decreasing methane emissions from uncontrolled waste decomposition and reducing reliance on fossil fuels.

Studies conducted in Kenya demonstrate substantial potential for biogas production due to the abundance of agricultural and organic waste resources. Research assessing biogas as a domestic energy source found that biogas technologies can reduce dependence on firewood while improving household energy security. However, adoption remains limited due to affordability concerns and inadequate technical support.

A study examining waste-to-biogas scenarios in Kisumu County found that substituting traditional cooking fuels with biogas generated from waste could account for approximately 42% of projected greenhouse gas reductions under integrated waste management systems. Most studies emphasize technical feasibility and environmental benefits, while fewer studies

examine how rural communities perceive waste-to-energy technologies and the factors influencing acceptance.

2.3 Community Perceptions of Waste-to-Energy Technologies

Community perceptions play a critical role in determining the success or failure of environmental technologies. Public acceptance influences adoption rates, willingness to participate, and long-term sustainability.

Diffusion of Innovations Theory suggests that communities evaluate new technologies based on perceived benefits, compatibility with local practices, complexity, and observable outcomes. Technologies perceived as beneficial and easy to use are generally adopted more rapidly than those viewed as risky or difficult.

Research on environmental technologies in developing countries consistently shows that awareness, trust, education levels, and perceived economic benefits influence community attitudes toward adoption. Households are more likely to support technologies that offer tangible improvements in energy access, health, and income generation.

Studies on biogas systems in rural Kenya indicate that positive perceptions are associated with fuel savings, improved sanitation, and reduced environmental degradation. However, concerns about installation costs, maintenance requirements, and technical reliability frequently reduce acceptance.

Similarly, studies examining green energy adoption in Kenya found that socioeconomic conditions, environmental awareness, and policy support significantly affect community willingness to embrace renewable energy technologies.

Few studies have specifically investigated community perceptions of waste-to-energy technologies within Busia County, particularly in rural communities where climate change mitigation strategies remain underexplored.

3 Research Methodology

This study employed a concurrent mixed-methods research design. The target population was 36,569 (KNBS, 2019) households within Teso South Sub-county and key informants. To ensure geographic representation, a stratified cluster sampling technique was employed where the sub-county was stratified into six administrative wards (Amukura Central, Amukura East, Amukura West, Angorom, Chakol North and Chakol South). Within each ward stratum, villages were identified, and a systematic random sampling technique was applied to select participants for the quantitative survey. Key informants (experts and community leaders) were selected purposively based on their knowledge of local waste management and energy policies. A structured questionnaire was used to capture data on disposal methods and existing energy sources. Interviews were conducted with Key informants. Descriptive statistics were used to summarize current waste and energy-use practices. Interview transcripts and field notes underwent thematic analysis.

4.0 Findings and Discussions

4.1 Introduction

This section presents the findings of the study based on data collected from households in Teso South Sub-county on the integration of community-based waste management and energy-efficient behaviours.

4.2 Demographic Characteristics of Respondents

The study collected demographic data on three variables; gender, education and household size. These variables have diverse effects on waste production and management. The findings are presented in Table 1.

Table 1: Demographic Characteristics of Respondents

Variable	Category	Frequency	Percentage (%)
Gender	Male	185	47.8
	Female	202	52.2
Education	None	29	7.5
	Primary	132	34.1
	Secondary	163	42.1
	Tertiary	63	16.3
Household Size	1-3 members	49	12.7
	4-6 members	173	44.7
	7-9 members	118	30.5
	Above 9 members	47	12.1

Source: Research Data (2026)

The findings in table 1 indicate that 52.2% of the respondents were female while males constituted 47.8%. This implies a relatively balanced gender representation in the study. The majority (42.1%) of the respondents had a secondary school education, 34.1% had primary school education, 16.3% had tertiary education, while 7.5% indicated that they had no formal education. This education profile is crucial, as it indicates a baseline level of awareness that can be leveraged for community-based sensitization programs regarding climate change mitigation.

The results also revealed that 44.7% of respondents live in households with 4 - 6 members, while 30.5% belong to households of 7 - 9 members. These findings are significant, as larger household sizes often correlate with higher waste generation and increased energy demand, directly impacting the potential for implementing integrated mitigation strategies.

4.3 Assessment of Current Waste Management and Energy-Use Practices

The first objective of this study was to assess waste management and energy-use practices among households in Teso South Sub-county. Understanding these baseline behaviours is essential for evaluating the potential synergy between community-based waste initiatives and the adoption of energy-efficient technologies to mitigate climate change.

4.3.1 Household Waste Disposal Practices

To assess the environmental impact of current waste handling, respondents were asked to identify their primary method of domestic waste disposal. The results are presented in Table 2.

Table 2: Current Household Waste Disposal Methods

Disposal Method	Frequency (f)	Percentage (%)
Burning	154	39.8
Dumping in open field	62	16.0
Composting	81	20.9
Burying	46	11.9
Recycling	12	3.1
Collection service	29	7.5
Others	3	0.8
Total	**387**	**100.0**

Source: Research Data (2026)

The findings indicate that burning remains the most common waste disposal method in Teso South, used by 39.8% of households. This is followed by composting (20.9%) and dumping in open fields (16.0%). Waste collection (7.5%) and recycling (3.1%) were not utilized much. The heavy reliance on burning and open-field dumping suggests potential environmental degradation from air pollution and soil contamination.

4.3.2 Primary Source of Energy for Cooking

The study investigated the energy sources for the households in Teso South. Table 3 shows the findings.

Table 3: Primary Cooking Energy Source

Energy Source	Frequency (f)	Percentage (%)
Firewood	268	69.3
Biogas	9	2.3
Charcoal	64	16.5
LPG/Gas	24	6.2
Solar	17	4.4
Electricity	5	1.3
Total	**387**	**100.0**

Source: Research Data (2026)

The findings show a heavy dependence on firewood (69.3%) for cooking, with 16.5% using charcoal. Cleaner energy alternatives, such as LPG/Gas (6.2%), solar (4.4%), biogas (2.3%) and electricity (1.3%), are used in small quantities. This is likely due to accessibility and affordability challenges.

4.3.3 Primary Source of Lighting

The study examined the primary energy sources for domestic lighting to assess whether households had adopted clean lighting solutions. Table 4 presents the findings.

Table 4: Primary Source of Household Lighting

Lighting Source	Frequency (f)	Percentage (%)
Electricity	124	32.0
Solar	171	44.2
Battery-powered lamps	28	7.2

Kerosene	58	15.0
Others	6	1.6
Total	**387**	**100.0**

Source: Research Data (2026)

The findings revealed that solar power (44.2%) is the primary lighting source for households in Teso South, followed by electricity at 32.0%. The data also indicated that 15.0% of households still rely on kerosene, while 7.2% use battery-powered lamps. The widespread adoption of solar power indicates a positive trend towards renewable energy for lighting, which could be leveraged to promote further energy-efficient behaviours.

4.3.4 Frequency of Waste Accumulation

The study sought to determine the frequency of waste accumulation, providing insight into a potential waste management problem. The findings are presented in Table 5.

Table 5: Frequency of Waste Accumulation in the Environment

Response	Frequency (f)	Percentage (%)
Daily	117	30.2
Weekly	156	40.3
Rarely	86	22.2
Never	28	7.3
Total	**387**	**100.0**

Source: Research Data (2026)

The findings indicate that 40.3% of respondents accumulate waste weekly, 30.2% daily, 22.2% rarely, and 7.3% never. The frequency of waste produced in the household needs a structured management approach to prevent potential environmental hazards.

4.3.5 Use of Energy-Efficient Appliances

The study investigated whether households have integrated energy-efficient appliances into their daily lives. Table 6 shows the findings.

Table 6: Use of Energy-Efficient Appliances

Response	Frequency (f)	Percentage (%)
Yes	181	46.8
No	143	37.0
Unsure	63	16.3
Total	**387**	**100.0**

Source: Research Data (2026)

The findings revealed that 46.8% of respondents used energy-efficient appliances, 37.0% did not use them and 16.3% were unsure. This implies that almost half of households use energy efficiently, which may help mitigate climate change-related challenges.

4.3.6 Perception of Energy Sustainability

Respondents were asked whether they considered their current household energy use environmentally sustainable. The results are summarized in Table 7.

Table 7: Perception of Environmental Sustainability of Current Energy Use

Response	Frequency (f)	Percentage (%)
Yes	132	34.1
No	118	30.5
Unsure	137	35.4
Total	**387**	**100.0**

Source: Research Data (2026)

The findings reveal significant uncertainty regarding environmental sustainability, with 35.4% of respondents being "Unsure." 30.5% indicated they perceived their current energy use was not environmentally sustainable. Only 34.1% explicitly viewed their energy consumption as sustainable. The indecision may suggest a knowledge gap concerning the environmental impacts of common energy sources.

4.4 Community Perceptions of Waste-to-Energy Technologies

This section presents findings on objective two, which sought to assess community perceptions of waste-to-energy technologies in Teso South Sub-county, Busia County**.** Understanding community perceptions is critical in assessing the potential acceptance and adoption of waste-to-energy technologies as part of integrated climate change mitigation strategies.

4.4.1 Awareness of Waste-to-Energy Technologies

The study examined awareness of waste-to-energy technologies in the Teso South community. The responses are presented in Table 8.

Table 8: Awareness of Waste-to-Energy Technologies

Response	Frequency (f)	Percentage (%)
Yes	162	41.9
No	225	58.1
Total	**387**	**100.0**

Source: Research Data (2026)

The findings show that the majority of respondents (58.1%) were not aware of waste-to-energy technologies, while 41.9% reported having some knowledge of these technologies. This suggests that awareness of waste-to-energy initiatives remains relatively low within the study area.

4.4.2 Sources of Information on Waste-to-Energy Technologies

The study further sought to identify the primary sources through which community members obtain information about waste-to-energy technologies. Identifying these channels is essential for designing effective awareness and educational programs. Multiple entries were allowed. Table 9 shows the findings.

Table 9: Sources of Information on Waste-to-Energy Technologies

Source	Frequency (f)	Percentage (%)
Radio	78	20.2
Television	64	16.5
Social media	39	10.1

Community meetings	91	23.5
NGOs	85	22.0
Government agencies	52	13.4
Other sources	18	4.7

Source: Research Data (2026)

The results reveal that community meetings (23.5%) and non-governmental organizations (22.0%) were the primary sources of information on waste-to-energy technologies. Radio also played a significant role, accounting for 20.2% of responses. Social media was the least utilized source among the major channels, with only 10.1% of respondents citing it. These findings demonstrate the importance of community-based platforms and development organizations in disseminating information within rural settings. The implication is that future awareness campaigns should leverage community meetings, local leaders, NGOs, and local media outlets to effectively reach residents and improve knowledge of waste-to-energy technologies.

4.4.3 Awareness of Specific Waste-to-Energy Technologies

This section assessed respondents' knowledge of different waste-to-energy technologies available for household and community-level application. Multiple responses were allowed. Table 10 shows the findings.

Table 10: Awareness of Specific Waste-to-Energy Technologies

Technology	Frequency (f)	Percentage (%)
Biogas	148	38.2
Biomass briquettes	96	24.8
Waste incineration	44	11.4
Biofuel production	31	8.0
Composting for energy use	57	14.7
None	176	45.5

Source: Research Data (2026)

The findings show that biogas was the most recognized waste-to-energy technology, identified by 38.2% of respondents, followed by biomass briquettes at 24.8%. However, nearly half of the respondents (45.5%) indicated that they were not aware of any waste-to-energy technology. This highlights a considerable knowledge gap within the community despite the existence of various technologies that can transform waste into useful energy. The implication is that awareness initiatives should not only promote waste-to-energy concepts generally but should also educate communities about specific technologies and their practical applications in rural households.

4.4.4 Willingness to Adopt Waste-to-Energy Systems

The study investigated respondents' willingness to adopt household-level waste-to-energy systems as part of efforts to improve waste management and energy access. Findings are presented in Table 11.

Table 11: Willingness to Adopt Household Waste-to-Energy Systems

Response	Frequency (f)	Percentage (%)
Yes	201	51.9
No	74	19.1

Need more information	112	29.0
Total	**387**	**100.0**

Source: Research Data (2026)

The results indicate that more than half of the respondents (51.9%) expressed willingness to adopt waste-to-energy systems. Meanwhile, 29.0% stated that they would require more information before making a decision, while 19.1% were unwilling to adopt such technologies. The findings suggest that the community generally has a positive attitude towards waste-to-energy innovations despite relatively low awareness levels. The implication is that targeted education and demonstration projects could significantly increase adoption rates by addressing information gaps and building confidence in the technologies.

4.4.5 Perceived Barriers to Adoption of Waste-to-Energy Technologies

This section examined the key challenges that respondents perceive as limiting the adoption of waste-to-energy technologies within the community. Table 12 presents the findings.

Table 12: Perceived Barriers to Adoption of Waste-to-Energy Technologies

Barrier	Frequency (f)	Percentage (%)
Lack of knowledge	138	35.7
High initial cost	142	36.7
Lack of technical support	72	18.6
Cultural beliefs	35	9.0
Total	**387**	**100.0**

Source: Research Data (2026)

The findings reveal that high initial costs (36.7%) and lack of knowledge (35.7%) were the most significant barriers to the adoption of waste-to-energy technologies. Lack of technical support was also identified as a challenge by 18.6% of respondents, while cultural beliefs were cited by 9.0%. These results suggest that both financial and informational constraints remain major obstacles to technology uptake. The implication is that successful implementation of waste-to-energy projects will require affordable financing mechanisms, subsidies, technical assistance, and continuous community education to overcome adoption barriers.

4.4.6 Community Perceptions of Waste-to-Energy Technologies

The study assessed respondents′ perceptions of waste-to-energy technologies using a five-point Likert scale. The statements covered environmental, economic, and social benefits associated with these technologies. Table 13 presents the findings.

Table 13: Community Perceptions of Waste-to-Energy Technologies

Statement	SD f (%)	D f (%)	N f (%)	A f (%)	SA f (%)
Waste-to-energy reduces pollution	18 (4.7)	32 (8.3)	55 (14.2)	162 (41.9)	120 (31.0)
Waste-to-energy creates employment	22 (5.7)	41 (10.6)	68 (17.6)	157 (40.6)	99 (25.6)
Waste-to-energy is affordable	61 (15.8)	94 (24.3)	88 (22.7)	97 (25.1)	47 (12.1)
Community would support projects	19 (4.9)	33 (8.5)	74 (19.1)	165 (42.6)	96 (24.8)

Waste-to-energy improves livelihoods	15 (3.9)	28 (7.2)	59 (15.2)	172 (44.4)	113 (29.2)

Source: Research Data (2026)

The findings indicate generally positive perceptions toward waste-to-energy technologies. A substantial majority of respondents (72.9%) agreed or strongly agreed that waste-to-energy technologies reduce pollution, while 66.2% believed they create employment opportunities. Similarly, 67.4% agreed that the community would support waste-to-energy projects, and 73.6% perceived that such technologies could improve livelihoods. However, perceptions regarding affordability were mixed, with 40.1% disagreeing or strongly disagreeing that the technologies are affordable. These findings imply that community members recognize the environmental and socio-economic benefits of waste-to-energy systems but remain concerned about financial accessibility. Addressing affordability concerns will therefore be critical in promoting widespread adoption.

4.4.7 Community Concerns Regarding Waste-to-Energy Technologies

The study also explored specific concerns that community members have regarding the implementation and use of waste-to-energy technologies. Multiple responses were allowed. Findings are shown in Table 14.

Table 14: Community Concerns Regarding Waste-to-Energy Technologies

Concern	Frequency (f)	Percentage (%)
Safety risks (gas explosions, emissions)	102	26.4
High installation and maintenance cost	141	36.4
Lack of technical expertise locally	88	22.7
Cultural resistance to waste reuse	41	10.6
Limited government support	68	17.6

Source: Research Data (2026)

The findings indicate that the most common concern among respondents was the high cost of installation and maintenance (36.4%), followed by safety risks associated with the technologies (26.4%). Lack of local technical expertise was also identified as a notable concern by 22.7% of respondents. Cultural resistance and perceived limited government support were mentioned by smaller proportions of respondents. These findings imply that successful implementation of waste-to-energy technologies will depend not only on financial support but also on building local technical capacity, strengthening safety awareness, and increasing government involvement in promoting and supporting technologies.

4.4.8 Summary of Findings on Community Perceptions of Waste-to-Energy Technologies

The findings demonstrate that awareness of waste-to-energy technologies in Teso South Sub-county remains relatively low, with a majority of respondents lacking knowledge of available technologies. Nevertheless, community meetings and NGOs have emerged as effective channels for disseminating information. Biogas was identified as the most widely recognized waste-to-energy technology, reflecting ongoing promotion efforts in rural areas.

Despite limited awareness, the community exhibited a strong willingness to adopt waste-to-energy systems, suggesting substantial potential for future uptake. However, adoption is

constrained by high initial costs, inadequate knowledge, and limited technical support. Respondents generally perceived waste-to-energy technologies positively, particularly regarding their ability to reduce pollution, create employment opportunities, gain community support, and improve livelihoods. Concerns regarding affordability, safety, and technical expertise remain significant challenges.

The overall implication of these findings is that achieving climate change mitigation through an integrated approach involving community-based waste management and waste-to-energy technologies will require comprehensive awareness programs, financial support mechanisms, technical training, and strengthened institutional support. Such interventions would enhance community acceptance and facilitate the successful adoption of waste-to-energy technologies in Teso South Sub-county.

4.5 Answers to the Research Questions

4.5.1 Research Question I: What are the current waste generation, collection, disposal, and management practices in Teso South Sub-county, Busia County?

The study established that waste management practices in Teso South Sub-county are predominantly characterized by household-level disposal methods with limited formal waste management services. The most common methods of waste disposal are burning (39.8%), composting (20.9%), open dumping (16.0%), and burying (11.9%), while only a small proportion of households utilize formal waste collection services (7.5%) or recycling (3.1%). Waste accumulation is frequent, with over 70% of respondents reporting daily or weekly waste build-up, indicating inadequate waste management infrastructure.

The findings further revealed that household waste consists mainly of organic waste, including food waste (88.1%) and agricultural waste (78.6%), alongside substantial quantities of plastic waste (71.1%). Despite the high potential for composting and recycling, waste separation practices remain poor, with 29.5% of households never separating waste before disposal and only 19.9% doing so consistently. Community participation in waste management activities is relatively low, and the majority of respondents expressed dissatisfaction with existing waste management services. The principal challenges identified include inadequate waste collection services, insufficient disposal facilities, limited recycling opportunities, low public awareness, financial constraints, and weak enforcement of environmental regulations. Overall, the findings indicate that waste management in Teso South Sub-county remains largely unsustainable and requires integrated interventions involving improved infrastructure, enhanced public awareness, increased community participation, and strengthened institutional support.

4.5.2 Research Question II: How do community members perceive waste-to-energy technologies in Teso South Sub-county, Busia County?

The study found that although awareness of waste-to-energy technologies remains relatively low, community perceptions of these technologies are generally positive. More than half of the respondents (58.1%) had limited or no awareness of waste-to-energy technologies, and nearly half were unfamiliar with any specific waste-to-energy technology. Nevertheless, over half (51.9%) expressed willingness to adopt waste-to-energy systems, while an additional 29.0% indicated that they would adopt them after receiving more information.

Respondents largely recognized the potential benefits of waste-to-energy technologies, with the majority agreeing that they can reduce environmental pollution, create employment opportunities, improve livelihoods, and receive community support. However, respondents also identified several barriers to adoption, including high installation and maintenance costs, inadequate knowledge, limited technical support, safety concerns, and insufficient government support. These findings suggest that the community is receptive to waste-to-energy technologies but requires greater awareness, technical capacity building, affordable financing mechanisms, and stronger institutional support to facilitate widespread adoption. Consequently, waste-to-energy technologies have considerable potential to contribute to sustainable waste management, renewable energy generation, and climate change mitigation in Teso South Sub-county if the identified barriers are effectively addressed.

5.0 Summary and Conclusion

5.1 Summary of the Findings

The study findings indicate that the respondents were predominantly in the economically active age group (26–55 years), accounting for 75% of the sample, with a relatively balanced gender distribution (52.2% female and 47.8% male). This demographic composition provides a representative perspective on household energy use and waste management practices among adults who are actively engaged in livelihood activities. Most respondents were married (56.6%), and the majority had attained either primary (34.1%) or secondary (42.1%) education, while only a small proportion had no formal education (7.5%). These findings suggest that the community possesses a moderate level of literacy, which provides a strong foundation for implementing awareness and education programs on climate change mitigation, sustainable energy use, and waste management.

The findings also reveal that household waste management and energy-use practices in Teso South Sub-county remain heavily reliant on traditional, environmentally unsustainable methods, despite emerging opportunities to adopt cleaner technologies. Waste disposal is primarily conducted through burning (39.8%), composting (20.9%), and open dumping (16.0%), while formal waste collection (7.5%) and recycling (3.1%) remain minimally utilized. Waste accumulation is common, with over 70% of respondents reporting daily or weekly waste build-up, reflecting inadequate waste management systems.

The study further established that firewood (69.3%) and charcoal (13.4%) remain the dominant cooking energy sources, underscoring continued dependence on biomass fuels that contribute to deforestation, greenhouse gas emissions, and indoor air pollution. However, encouraging progress was observed in household lighting, where solar energy (44.2%) surpassed grid electricity (32.0%), indicating growing acceptance of renewable energy technologies.

Regarding energy efficiency, nearly half of the households (46.8%) reported using energy-efficient appliances, while improved cookstoves (50.1%) and solar systems (43.4%) were the most commonly adopted energy-efficient technologies. Most respondents rated their household energy efficiency as moderate (47.0%), suggesting that although energy-efficient technologies have begun to penetrate the community, considerable potential exists for further adoption.

Further, the findings indicate that community awareness of waste-to-energy (WTE) technologies in Teso South Sub-county remains relatively low, with 58.1% of respondents

reporting they were unaware of these technologies. Community meetings (23.5%), non-governmental organizations (22.0%), and radio (20.2%) emerged as the primary sources of information, demonstrating the effectiveness of community-based communication channels in rural settings. Among specific technologies, biogas (38.2%) was the most widely recognized, while nearly half of the respondents (45.5%) had no knowledge of any waste-to-energy technology, highlighting a substantial information gap.

Despite low awareness, the community held a positive view of waste-to-energy technologies. More than half of respondents (51.9%) expressed willingness to adopt household waste-to-energy systems, with a further 29.0% indicating they would be willing to do so after receiving more information. Respondents generally perceived waste-to-energy technologies as beneficial for reducing pollution, creating employment opportunities, improving livelihoods, and garnering community support. However, concerns regarding affordability, safety risks, lack of technical expertise, and limited government support remained significant barriers to adoption. High installation costs (36.4%) and inadequate knowledge (35.7%) were identified as the most critical challenges limiting uptake.

5.2 Conclusion

The socio-demographic characteristics of the respondents reveal a stable, predominantly agricultural, and low-income rural population with moderate educational attainment and extensive community experience. These characteristics provide both opportunities and challenges for implementing integrated household energy and waste management interventions. While the respondents' educational background and long-term residency offer a favorable environment for community participation and environmental awareness initiatives, their limited financial capacity underscores the importance of promoting low-cost, practical, and sustainable solutions. Therefore, future climate change mitigation programs in Busia County should prioritize community-based approaches that are economically feasible, culturally appropriate, and tailored to the livelihoods and household characteristics of the local population. The study concludes that household waste management and energy-use practices in Teso South Sub-county remain largely unsustainable, with widespread dependence on biomass fuels, open burning, and inadequate waste disposal systems posing significant environmental and public health challenges. Nevertheless, the increasing adoption of solar energy for lighting, improved cookstoves, and other energy-efficient technologies demonstrates the community's willingness to embrace cleaner and more sustainable alternatives when they are accessible and affordable.

The abundance of organic waste presents a significant opportunity for integrated waste management approaches such as composting and waste-to-energy initiatives, while the existing uptake of renewable energy technologies provides a strong foundation for expanding climate change mitigation interventions. An integrated approach that combines sustainable waste management with energy-efficient technologies, supported by community engagement and institutional commitment, offers the greatest potential for reducing greenhouse gas emissions, improving environmental quality, and enhancing sustainable livelihoods in Teso South Sub-county. The study concludes that although awareness of waste-to-energy technologies remains relatively limited in Teso South Sub-county, the community demonstrates a strong willingness to adopt these technologies when provided with adequate information, technical support, and financial assistance. Positive perceptions regarding the environmental, economic, and social benefits of waste-to-energy systems indicate considerable potential for integrating such technologies into local climate change mitigation

strategies. However, addressing barriers related to affordability, technical capacity, safety concerns, and institutional support will be essential for achieving widespread adoption.

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