Attaining a Clean and Healthy Urban Environment: Utilising Waste-to-Energy Technology to Power Cities

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Abstract

This paper critically examines how waste-to-energy technology can foster clean and healthy urban environments for Sustainable Development. The paper argues that cities and urban areas globally are facing mounting environmental and social challenges key among them being the problem of municipal waste. It notes that cities and urban areas globally are facing waste management challenges due to rapid urbanization, poor waste management practices, lack of technical and financial capacity, and low policy priority among other factors. The paper argues that the challenge of municipal waste is putting the lives and health of city residents at risk while also fueling environmental challenges including pollution and climate change. In light of the challenge of municipal waste, the paper advocates the adoption of waste-to-energy technology in order to power cities while also fostering clean and healthy urban environments.

1.0 Introduction

Cities and urban areas are hubs of economic growth and development. It has been observed that cities and urban areas are the centres where most countries generate their Gross Domestic Product (GDP)[1]. Further, most private sector jobs are created in cities and urban areas[2]. According to the United Nations Human Settlements Programme (UN Habitat), cities and urban areas act as engines of national economic development[3]. Strong urban economies are necessary in poverty reduction and the provision of vital services

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[1] World Bank Group., 'Urban Development' Available at https://www.worldbank.org/en/topic/urbandevelopment/overview (Accessed on 01/07/2025)

[2] Ibid

[3] United Nations-Habitat., 'The Economic Role of Cities' Available at https://unhabitat.org/sites/default/files/download-manager-files/Economic%20Role%20of%20Cities.pdf (Accessed on 01/07/2025)

including adequate housing, transport and infrastructure, water and sanitation, health, education and safety[4]. Cities and urban areas are therefore engines of economic growth. It has been argued that the rapid economic growth usually associated with urbanisation can be attributed to structural transformation, as labour moves from the agricultural sector in rural areas to industry and services in cities and urban areas[5].

The world is witnessing a rapid pace of urbanization. It is estimated that currently, nearly half of the world's population live in cities and urban areas[6]. Further, it has been pointed out that by 2050, nearly 7 in 10 people globally will live in cities[7]. The world is therefore becoming increasingly urbanized with this trend expected to accelerate in the coming years. Much of this urbanization is expected to unfold in Africa and Asia ushering in huge social, economic and environmental transformations[8]. The rapid growth of cities and urban areas globally has the potential to drive human development and progress[9]. It has been argued that urbanization has the potential to usher in a new era of human well-being and prosperity, resource efficiency and economic growth[10]. As cities and urban areas grow, they help entire regions and even countries to become more prosperous and productive[11].

Despite having the potential to drive economic growth and prosperity, the rapid growth of cities and urban areas is also associated with several challenges. For instance, due to the high concentration of people, infrastructure, housing and economic activities, cities

[4] Ibid
[5] Colenbrander. S., 'Cities as engines of economic growth: The case for providing basic infrastructure and services in urban areas' Available at https://www.iied.org/sites/default/files/pdfs/migrate/10801IIED.pdf (Accessed on 01/07/2025)
[6] World Bank Group., 'Urban Development' Op Cit
[7] Ibid
[8] United Nations Population Fund., 'Urbanization' Available at https://www.unfpa.org/urbanization (Accessed on 01/07/2025)
[9] Kuddus. M.A., Tynan. E., & McBryde. E., 'Urbanization: a problem for the rich and the poor?' *Public Health Reviews*., Volume 41., No. 1 (2020)
[10] United Nations Population Fund., 'Urbanization' Op Cit
[11] World Bank Group., 'Urban Development' Op Cit

and urban areas are particularly vulnerable to climate change and natural disasters[12]. Further, urbanization has been identified as a major source of greenhouse gases contributing to the climate crisis[13]. Cities and urban areas are also facing challenges in meeting the growing demand for better jobs, transport, infrastructure, healthcare, education, housing and energy among other basic urban services[14]. In light of these challenges, it has been argued that Sustainable development depends on the successful management of urban growth to create sustainable cities and urban centres in both developed and developing countries[15]. Achieving sustainability in cities is therefore vital in enhancing the quality of life for people residing in cities and protecting urban environments for posterity.

This paper critically examines how waste-to-energy technology can foster clean and healthy urban environments for Sustainable Development. The paper argues that cities and urban areas globally are facing mounting environmental and social challenges key among them being the problem of municipal waste. It notes that cities and urban areas globally are facing waste management challenges due to rapid urbanization, poor waste management practices, lack of technical and financial capacity, and low policy priority among other factors. The paper argues that the challenge of municipal waste is putting the lives and health of city residents at risk while also fueling environmental challenges including pollution and climate change. In light of the challenge of municipal waste, the paper advocates the adoption of waste-to-energy technology in order to power cities while also fostering clean and healthy urban environments.

[12] United Nations Environment Programme., 'Goal 11: Sustainable Cities and Communities' Available at https://www.unep.org/explore-topics/sustainable-development-goals/why-do-sustainable-development-goals-matter/goal-11 (Accessed on 01/07/2025)
[13] United Nations-Habitat., 'World Cities Report 2024: Cities and Climate Action' Available at https://unhabitat.org/wcr/ (Accessed on 01/07/2025)
[14] World Bank Group., 'Urban Development' Op Cit
[15] United Nations., 'Urbanization' Available at https://www.un.org/development/desa/pd/content/urbanization-0 (Accessed on 01/07/2025)

2.0 The Problem of Municipal Waste in Cities

Municipal waste has been identified as the most significant contributor to the problem of waste. Municipal waste refers to the waste generated by individuals and households in their day-to-day activities[16]. Municipal waste has also been defined as waste collected and treated by, or for municipalities[17]. It covers waste from households, commerce and trade, office buildings, yard and garden waste, street sweepings among other kinds of waste[18]. It has been pointed out that municipal waste consists of waste collected by or on behalf of municipal authorities and disposed of through waste management systems[19]. It mainly consists of waste generated by households, although it also includes similar waste from other sources including shops, offices and public institutions[20].

Municipal waste generation is a global problem. It is estimated that more than 2 billion tonnes of municipal waste is generated globally every year with this figure expected to rise to over 3.8 billion tonnes by 2050 if no urgent action is taken[21]. It has been pointed out that food, green waste and plastics among other sources are the major contributor to municipal waste[22]. Rapid urbanization, population growth, poor waste management practices, and the expansion of industries contribute to the global problem of municipal waste[23]. With rising urbanization, rapid industrialization, and ever-increasing consumption, the generation of municipal waste is expected to increase in the coming

[16] JeyaSundar. P.G et al., 'Waste treatment approaches for environmental sustainability' *Microorganisms for Sustainable Environment and Health.*, 2020 pp 119-135

[17] Organisation for Economic Co-operation and Development., 'Municipal Waste' Available at https://www.oecd.org/en/data/indicators/municipal-waste.html (Accessed on 01/07/2025)

[18] Ibid

[19] European Commission., 'Glossary: Municipal waste' Available at https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Municipal_waste (Accessed on 01/07/2025)

[20] Ibid

[21] United Nations Environment Programme., 'Global Waste Management Outlook 2024' Available at https://www.unep.org/resources/global-waste-management-outlook-2024 (Accessed on 01/07/2025)

[22] Yatoo. A.M., 'Global perspective of municipal solid waste and landfill leachate: generation, composition, eco-toxicity, and sustainable management strategies' Available at https://pubmed.ncbi.nlm.nih.gov/38443532/ (Accessed on 01/07/2025)

[23] Ibid

years[24]. Increase in generation of municipal waste is expected to be more in developing countries, where the challenge of municipal waste is worsened by the lack of reliable waste collection services, limited source separation of waste types, inadequate financial and technical capacity to foster sound waste management and reliance on unmanaged landfills and open dumps for disposal of municipal waste[25].

The problem of municipal waste is more severe in cities and urban areas. It has been observed that urban households and businesses produce substantial amounts of solid waste that must be collected regularly, recycled or treated and disposed properly in order to maintain clean, healthy and sustainable urban environments[26]. However, due to rapid urbanization, population growth, poor waste collection and management practices, and inadequate investments, many cities are facing municipal solid waste management challenges[27]. In addition, it has been argued that the higher the income level of a city, the greater the amount of municipal waste produced[28]. Therefore, the economic growth expected in developing countries is likely to pose greater challenges in solid waste management in cities and urban areas[29]. For example, it has been observed that due to the fast rate of population growth and rapid urbanization in Africa, the amount of municipal solid waste in the continent is increasing drastically[30].

Lack of effective management of municipal waste in cities affects both people and planet. For example, poor management and disposal of municipal waste in cities creates vast,

[24] International Finance Corporation., 'The World has a Waste Problem. Here's How to Fix It' Available at https://www.ifc.org/en/blogs/2024/the-world-has-a-waste-problem (Accessed on 01/07/2025)
[25] Ibid
[26] United Nations-Habitat., 'Solid Waste Management in Cities' Available at https://unhabitat.org/sites/default/files/2019/02/Indicator-11.6.1-Training-Module_Solid-waste-in-cities_23-03-2018.pdf (Accessed on 01/07/2025)
[27] Ibid
[28] Ibid
[29] Ibid
[30] African Clean Cities Platform., 'Situation of Municipal Solid Waste Management in African Cities - An Interpretation of the Information provided by the First ACCP Meeting' Available at https://www.africancleancities.org/sites/default/files/2023-06/8_Discussion_Paper_2.pdf (Accessed on 01/07/2025)

toxic mountains that pollute the air, contaminate sources of water and endanger public health[31]. Further, the disposal and treatment of waste produces greenhouse gases including methane thus contributing to climate change[32]. The financial costs of waste management are also huge taking a toll on economies especially in developing countries[33]. In light of these challenges, effective municipal waste management strategies are necessary in order ensure clean and healthy urban environments.

3.0 Utilising Waste-to-Energy Technology to Power Cities

Waste-to-energy refers to various technologies that convert non-recyclable waste into usable forms of energy including electricity, heat and fuels[34]. It has been pointed out that waste-to-energy plants and technologies burn energy-rich materials including plastics, paper and products made from wood to generate various forms of energy including electricity[35]. Waste-to-energy therefore refers to waste treatment technologies that convert municipal waste among other forms of waste into energy[36]. Waste-to-energy technologies use several processes including incineration, pyrolysis, gasification, anaerobic digestion and landfill gas recovery in order to convert waste into usable forms of energy[37]. For example, incineration involves burning combusted waste at ultra-high temperatures in order to produce energy[38]. Anaerobic digestions entails the use of technologies that biologically convert organic material into compost as well as biogas for energy[39]. Further, the process of pyrolysis involves the use of technologies that thermo-

[31] International Finance Corporation., 'The World has a Waste Problem. Here's How to Fix It' Op Cit
[32] Contribution from waste to climate change., Available at https://www.grida.no/resources/5665 (Accessed on 01/07/2025)
[33] United Nations Environment Programme., 'Global Waste Management Outlook 2024' Op Cit
[34] Waste to Energy., Available at https://studentenergy.org/conversion/waste-to-energy/#:~:text=Waste%20to%20Energy%20(WTE)%2C,%2C%20heat%2C%20fuels%20and%20electricity (Accessed on 02/07/2025)
[35] Biomass Explained: Waste-to-Energy (Municipal Solid Waste)., Available at https://www.eia.gov/energyexplained/biomass/waste-to-energy-in-depth.php (Accessed on 02/07/2025)
[36] What is Waste-to-Energy?., Available at https://www.ibm.com/think/topics/waste-to-energy (Accessed on 02/07/2025)
[37] Waste to Energy., Op Cit
[38] Ibid
[39] Ibid

chemically convert waste products into clean liquid fuels[40]. In addition, landfill gas recovery involves the process of capturing the gases emitted from municipal landfills and converting them into energy[41].

Waste-to-energy technologies provide an effective and environmental-friendly solution to the problem of municipal waste in cities[42]. It has been correctly noted that waste-to-energy technology reduces the volume of municipal waste while also converting waste into usable forms of energy including electricity and fuel[43]. According to the United Nations Environment Programme (UNEP), waste-to-energy technology has potential benefits of waste reduction and energy generation[44]. Further, it has been argued that waste-to-energy technology can potentially reduce waste sector greenhouse gas emissions in comparison to open burning and landfills without methane gas capture and use[45]. Waste-to-energy technology can also foster human health by tackling urban air and water pollution associated with burning waste and dumping waste into unsuitable landfills[46].

With the generation of municipal solid waste expected to rise in the coming years especially in developing countries, waste-to-energy technology provides a potential and effective solution to the global waste problem[47]. UNEP notes that effective municipal solid waste management is one of the key drivers for countries to achieve the goals of both the Paris Agreement towards confronting climate change and the 2030 Agenda for

[40] Ibid
[41] Ibid
[42] United Nations Climate Change., 'Municipal Waste' Available at https://unfccc.int/climate-action/momentum-for-change/activity-database/Municipal%20Waste (Accessed on 02/07/2025)
[43] Ibid
[44] United Nations Environment Programme., 'Waste to Energy: Considerations for Informed Decision-making' Available at https://www.unep.org/ietc/resources/publication/waste-energy-considerations-informed-decision-making (Accessed on 02/07/2025)
[45] Ibid
[46] United Nations Climate Change., 'Municipal Waste' Op Cit
[47] United Nations Environment Programme., 'Waste-to-Energy Incineration' Available at https://www.unep.org/ietc/resources/toolkits-manuals-and-guides/waste-energy-incineration (Accessed on 02/07/2025)

Sustainable Development geared towards fostering sustainability[48]. Waste-to-energy technology can therefore help cities and countries to foster sound waste management towards combating climate change and ensuring Sustainable Development[49].

Waste-to-energy technology is both beneficial to people and planet. This technology can make cities and human settlements clean, healthy, sustainable and liveable by tackling the problem of waste[50]. It also fosters human health by reducing the problem of air and water pollution associated with poor waste management practices[51]. Further, waste-to-energy technology can promote environmental sustainability by addressing environmental pollution and the generation of greenhouse gases from waste[52]. This technology can also reduce the volume of waste that is landfilled thus ensuring clean and healthy urban environments[53].

There has been progress towards utilising waste-to-energy technology to power cities. For instance, thermal waste-to-energy also known as incineration with energy recovery, is a major waste-to-energy technology that has been embraced in some developed countries and the most widely adopted technology that dominates the global waste-to-energy market[54]. China for example has utilised public-private partnerships that offer concessions to municipal governments to build waste-to-energy plants in several cities with appropriate and clean technologies[55]. Further, it has been observed that developing

[48] Ibid
[49] Ibid
[50] United Nations Climate Change., 'Municipal Waste' Op Cit
[51] Ibid
[52] United Nations Environment Programme., 'Waste to Energy: Considerations for Informed Decision-making' Op Cit
[53] Guberman. R., 'What is Waste-to-Energy?' Available at https://www.rts.com/blog/what-is-waste-to-energy/ (Accessed on 02/07/2025)
[54] United Nations Environment Programme., 'Waste to Energy: Considerations for Informed Decision-making' Op Cit
[55] United Nations Climate Change., 'Municipal Waste to Energy Project – China' Available at https://unfccc.int/climate-action/momentum-for-change/activity-database/momentum-for-change-municipal-waste-to-energy-project (Accessed on 02/07/2025)

countries especially in the Asia-Pacific region including India and Thailand are increasingly utilising waste-to-energy technologies to power their cities and economies[56].

Waste-to-energy technology therefore provides potential solutions to foster clean and healthy urban environments by converting waste to energy that can be utilised to power cities. Despite its benefits, it has been observed that waste-to-energy is underutilised globally with most cities and urban areas still using landfills as their primary disposal method[57]. However, this practice is unsustainable and poses serious risks to human health and the environment[58]. Further, waste-to-energy technologies that utilise fossil fuels to burn waste can generate greenhouse gases thus causing environmental concerns including pollution and climate change[59]. Waste-to-energy technology also requires significant investment for startup, operation and maintenance which can be out of reach for some cities and urban areas especially in developing countries[60]. It has also been argued that waste-to-energy technology can undermine circularity which is the most effective way of dealing with the global waste problem[61]. It is imperative to address these concerns in order to effectively harness waste-to-energy technology to power cities towards fostering clean and healthy urban environments.

4.0 Conclusion

Waste-to-energy technology is an appropriate solution to the problem of municipal waste in cities and urban areas. This technology converts waste to energy that can power cities while fostering clean and healthy urban areas[62]. Waste-to-energy technology provides benefits for people and planet by reducing the impacts of waste on human health and the

[56] United Nations Environment Programme., 'Waste to Energy: Considerations for Informed Decision-making' Op Cit
[57] Waste to Energy., Op Cit
[58] Ibid
[59] Guberman. R., 'What is Waste-to-Energy?' Op Cit
[60] United Nations Environment Programme., 'Waste to Energy: Considerations for Informed Decision-making' Op Cit
[61] Ibid
[62] Ibid

environment including water, air and urban biodiversity and ecosystems[63]. It is therefore imperative for cities and urban areas including those in developing countries to enhance investments in waste-to-energy technology in order to promote clean and healthy urban environments[64]. Further, there is need to ensure that waste-to-energy technologies utilise appropriate and clean technology that do not require additional burning of fossil fuels in order to avoid generating more greenhouse gases[65]. It is also necessary to ensure that waste-to-energy technology is employed alongside the principles of circular economy with priority being placed on reducing, re-using and recycling waste for effective waste management[66]. Utilising waste-to-energy to power cities is therefore a viable and effective option towards achieving clean and healthy urban environments. It is vital for all cities globally to embrace this approach for the benefit of people and planet.

[63] Ibid
[64] United Nations Climate Change., 'Municipal Waste to Energy Project – China' Op Cit
[65] Ibid
[66] United Nations Environment Programme., 'Waste-to-Energy Incineration' Op Cit

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