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Clean energy generation through controlled incineration WTE in Ecuador

Generación de energía limpia por medio de la incineración controlada WTE en Ecuador

Carlos Fernando Pazmiño-Cujili
Msc. Instituto Superior Tecnológico Simón Bolívar, carlos.pazmino@istsb.edu.ec
https://orcid.org/0009-0006-0074-3324
Mariuxi Virginia Cartagena Muñoz
Msc. Instituto Superior Tecnológico Simón Bolívar, mariuxi.cartagena@istsb.edu.ec
https://orcid.org/0000-0003-3479-9458
Ruth Verónica Rivera España
Msc. Instituto Superior Tecnológico Simón Bolívar, ruth.rivera@istsb.edu.ec
https://orcid.org/0009-0009-4554-358X

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Corresponding Author
Carlos Fernando Pazmiño-Cujili.
carlos.pazmino@istsb.edu.ec
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Abstract

The last few decades have seen a significant increase in the global problem of solid waste management, with annual production exceeding 2 million tons. The situation of having 2010 million tons poses not only environmental, but also social and economic challenges. This is because, if waste is not properly managed, it can contaminate soil, water and air, which has a negative impact on public health and biodiversity. In Latin America, significant challenges are still faced in waste management, as many countries struggle to implement efficient and sustainable systems. Despite the efforts made by some countries to improve this situation through the development of recycling policies and adoption.

Keywords: Waste-to-Energy (WTE), Solid Waste Management, Circular Economy, Carbon Neutral, Recycling Culture

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Resumen

En las últimas décadas, se ha visto un aumento significativo en la problemática global de la gestión de residuos sólidos, con una producción anual que supera los 2 millones de toneladas. La situación de tener 2010 millones de toneladas plantea desafíos no solo ambientales, sino también sociales y económicos. Esto se debe a que, si los residuos no son manejados adecuadamente, pueden contaminar tanto el suelo como el agua y el aire, lo cual tiene un impacto negativo en la salud pública y la biodiversidad. En América Latina, aún se enfrentan importantes desafíos en la gestión de residuos, ya que muchos países luchan por implementar sistemas eficientes y sostenible. A pesar de los esfuerzos realizados por algunos países para mejorar esta situación mediante el desarrollo de políticas de reciclaje y la adopción.
Palabras clave: Waste-to-Energy (WTE), Gestión de residuos sólidos, Economía circular, Carbono neutro, Cultura de reciclaje

Introduction

In recent decades, solid waste management has become an issue of increasing concern worldwide. Every year, more than 2 million tons of waste are produced. Improper waste management not only involves environmental, but also social and economic challenges, as it can result in soil, water and air pollution. This causes damage to public health and the environment. In addition, waste that accumulates in landfills plays an important role in the generation of methane, a much more potent greenhouse gas compared to carbon dioxide. The need for innovative and sustainable solutions in waste management has been emphasized by the United Nations as an integral part of the Sustainable Development Goals, pointing out its urgency.

By 2050, global waste generation is estimated to increase by 70% over current levels, according to the World Bank report titled "What a Waste 2. 0: "Waste on the 2050 horizon: A global look at solid waste management?" (World Bank Group, 2018). The cause of this increase is accelerated urbanization and growing populations.

In 2016, 2,010 million tons of waste were recorded and it is expected that by 2,050 this figure will increase to 3,400 million tons; effective solid waste management is of vital importance, including aspects such as costs, revenues, tariffs, regulations, public communication, administrative and operational models, as well as the regulation of all actors including the informal market. In this context, plastics are particularly problematic, since, if not properly collected and managed, they can contaminate watercourses and ecosystems for hundreds or thousands of years; moreover, it is estimated that, in 2016, waste treatment and disposal generated an emission of 1.6 billion tons of carbon dioxide equivalent, which represents about 5 % of global emissions.

It is pertinent to highlight that proper waste management is essential to build a strong circular economy, where products are designed and optimized to be reduced in consumption, reused and recycled; in order to take urgent measures to address this global challenge and ensure a sustainable waste management in the future. (AERESS, 2024)

In Ecuador in 2022, the estimated weighted generation of solid waste at the national level was 82,654.31 m^3 per day, of this total, 68.13% originated in urban areas, while 31.87% came from rural areas. (MAATE, 2023)On the other hand, the special category cantons generated the largest volume of waste and solid waste, representing 46% of the national total, while the micro category cantons contributed only 2%. The large and medium categories showed relatively similar waste generation volumes, with 20% and 22% respectively. (MAATE, 2023).

WTE Technology and its impact on the SDGs. Waste-to-Energy (WTE) technology represents a novel and sustainable solution to efficiently manage solid waste; this technology and integral process consists of controlled incineration, which allows us to reduce the volume of waste by up to 90% and at the same time generate electrical and thermal energy, minimizing the amount of waste that reaches landfills and ultimately reducing greenhouse gas emissions. (World Bank Group, 2018)

The implementation of this WTE technology tributes to several Sustainable Development Goals (SDGs), such as: According to the World Bank (2018), by addressing SDGs 7, 11, and 13, Waste-to-

Energy not only addresses the waste problem, but also generates notable benefits in terms of energy sustainability and climate change reduction (World Bank Group, 2018).

WTE in Latin America, its Paradigms and Relevance. In the region there is still a shortage of facilities to valorize Municipal Solid Waste (MSW). In order to move towards the implementation of the circular economy model, it will be essential to establish different facilities to sort, recycle, compost and treat waste through anaerobic digestion and thermal treatment with energy recovery (WTE), as well as to recover construction and construction wastes, and to recover the waste from the municipal solid wastes.

"In Latin America and the Caribbean (LAC), the lack of comprehensive plans hinders effective waste management, thus hindering progress towards sustainable management. Unlike at the international level, where the European Union has established concrete and binding targets for reuse and recycling, in LAC there are no long-term national plans." (IDB, 2023).

The problem through various factors in the region has led to a lack of clear and measurable goals, which limits the implementation of effective strategies and the measurement of progress; in Brazil, however, significant progress has been made thanks to the implementation of mandatory selective collection and the National Solid Waste Policy. Brazil's national plan sets a target of 48.1% recovery of municipal solid waste by the year 2040 (IDB, 2023)

In other countries such as Chile and Uruguay, although goals have been established in strategic documents, they are not binding and their impact is limited. Chile seeks to reduce waste generation by 25% and achieve 65% recycling by 2040, while Uruguay aims to recover 85% of post-consumer packaging and decouple waste generation from economic growth by 10%, both by 2032 (IDB, 2023). (IDB, 2023)

To move towards sustainable waste management in Latin America and the Caribbean, it is crucial to implement long-term national plans with clear and binding objectives. These plans should be aligned at the subnational level and have the active participation of all stakeholders. (IDB, 2023)..

Political Will in Ecuador on the Availability of Landfill Waste. According to current legislation, municipal and metropolitan decentralized autonomous governments (GADM) are responsible for the integrated management of solid waste. MAATE, in its role as lead agency, is responsible for issuing policies, national plans, and technical guidelines to ensure compliance with its responsibilities by the GADMs and other actors.

In order to design and implement waste management projects based on historical waste, it is essential to know the daily amount generated by each city and the characteristics of this waste. In this context, the project "Solid waste management and inclusive circular economy (GRECI)" of MAATE will develop in a participatory manner the National Plan for the integrated management of non-hazardous solid waste. This plan will be the basis for the creation of policies, strategies, plans, programs and projects at the national level.

MAATE presents the results of the analysis of data on the generation and characteristics of non-hazardous solid waste at different levels (local, provincial, regional and national). These results include information on per capita production, volume, density and physical composition of waste, and will serve to establish the priority lines of action in the structuring of the National Plan for the integrated management of solid waste in Ecuador (MAATE, 2023). (MAATE, 2023)

In the Organic Law Reforming the Organic Environmental Code (CODA) and the Organic Code of Territorial Organization, Autonomy and Decentralization (COOTAD), published in Official Gazette No. 602 on December 21, 2021, Article 30 establishes regulations for the conservation and remediation of natural resources, as well as the regulation and promotion of animal welfare and protection. It also includes provisions for the management of non-hazardous solid waste and the participation of decentralized autonomous governments in the planning and execution of environmental works. (Ecuador, 2021)

How many kilos does each person produce per day in Ecuador? The Ministry of Environment of Ecuador reports that the annual amount of solid waste generated in 2022 was 5,103,087.59 tons with a population of 17,989,912.00; this gives us a national weighted average of 0.777 kilos per day per inhabitant; while for cities

considered "special" as Quito and Guayaquil, receiving this category for its population density greater than 1,000,000,000,000.00 is 0.847 kilos per inhabitant per day. This causes an important focalized contamination of soil, water and air, as well as a significant risk to public health in these 2 main cities, whose particularity is due to the increase in population income and consumption habits. (MAATE, 2023).

As we can analyze in Ecuador, waste management has been a growing concern, especially in urban areas where waste generation is higher; despite government efforts to promote recycling practices and reduce the amount of waste reaching landfills, results have been limited. Until 2024, the country has implemented several strategies, including the promotion of the circular economy and the adoption of clean technologies for waste treatment; however, controlled incineration with energy recovery, also known as Waste-to-Energy (WTE), has not yet been exploited to its full potential.

Advantages of Implementing WTE Technology in Ecuador: The use of Waste-to-Energy (WTE) technology and the influx of foreign investment offer numerous benefits in terms of solid waste management and the promotion of sustainable development. WTE technology, by converting solid waste into useful energy, has been recognized as a fundamental tool to address global environmental and energy challenges. Therefore, it is essential to analyze and understand the specific advantages that this technology can provide at the national and international level in terms of both environmental and socioeconomic benefits. Finally, this study will focus on highlighting the benefits of adopting WTE technology both in Ecuador and in other countries, in order to provide a complete picture of its potential advantages and uses.

Waste Reduction in Landfills: WTE technology can significantly reduce the volume of waste deposited in landfills, thus reducing the pressure on these sites and prolonging their useful life; this is especially relevant in a country like Ecuador, where solid waste management is a growing challenge due to urbanization and increasing consumption levels (Legal Bulletin -) (National Assembly of Ecuador). (Ecuador, 2021)

Clean Energy Generation: The conversion of waste into energy allows the production of electricity and heat from materials that would otherwise be considered waste. This contributes to diversifying the country's energy matrix and reducing dependence on fossil energy sources, in line with sustainability and carbon footprint reduction goals. (Ecuador, 2021)

Greenhouse Gas Emissions Reduction: By incinerating waste in a controlled manner, gas emissions can be captured and treated, minimizing the release of methane, a potent greenhouse gas generated in traditional landfills. This can contribute significantly to Ecuador's commitments in terms of climate change mitigation. (Ecuador, 2021)

Economic Growth and Job Creation: The construction and operation of WTE plants can generate both direct and indirect employment, from construction to facility management and maintenance. In addition, it can foster the development of a circular economy, encouraging new forms of recycling and reuse of materials. (Ecuador, 2021)

Technology and Knowledge Transfer: Collaborating with countries such as China and Denmark, which has experience and advanced technology in the WTE sector, can facilitate the transfer of know-how and best practices. This not only raises Ecuador's technological standards, but also improves local capacities for waste management and energy generation. (Ecuador, 2021)

Improved Quality of Life and Public Health: By reducing waste accumulation and pollutant emissions, air quality is improved and the risks of diseases related to poor waste management are minimized. This is crucial for public health, especially in densely populated urban areas.

The implementation of WTE technology in Ecuador is highly relevant, as it not only addresses the urgent need to improve waste management, but also offers multiple environmental, economic and social benefits. With the support of foreign investors and the adoption of advanced technologies, Ecuador can move towards a more sustainable and cleaner future.

Report to NASA. In October 2023, the Instituto Superior Tecnológico Simón Bolívar was invited to the student event "Present your challenge", whose central theme was the generation of clean energy through the controlled incineration of garbage, known as Waste to Energy (WTE), in Ecuador and Latin America. This project earned the Institute the award for Best Local Impact Project. (ISTSB_TMI, 2023)

Project Description. The research project was developed through an exhaustive bibliographic search on waste management at a global level, with a particular focus on Ecuador and Latin America. The research highlighted the importance of the impact of solid waste on the environment, including air, soil and water pollution, and concluded with the proposal of WTE technology as a viable solution to mitigate these problems, thus presenting the following key findings:

Waste Impact: Waste accumulation is a critical problem that seriously affects the environment and public health. The research highlighted that, without proper management, waste can lead to significant contamination of air, soil and water, affecting biodiversity and ecosystems. (Ecuador, 2021)

WTE technology: Controlled incineration of solid waste for energy generation is presented as an effective alternative to reduce waste volume and generate clean energy. This technology not only helps to manage waste more efficiently, but also contributes to the reduction of greenhouse gas emissions and the generation of electricity from non-fossil fuel sources. (Ecuador, 2021)

Application in Ecuador and Latin America: The adoption of WTE technologies in Ecuador and Latin America can be particularly beneficial due to the growing waste management challenges in the region. The implementation of these technologies can significantly improve waste management and environmental sustainability, as well as generate employment and foster local economic development. (ISTSB_TMI, 2023)

The Instituto Superior Tecnológico Simón Bolívar project not only addresses a critical waste management problem, but also offers an innovative and sustainable solution. By integrating WTE technology into waste management strategies, Ecuador and Latin America can

move towards a cleaner and more sustainable future, reducing pollution and harnessing waste as a valuable energy source.

The research underscores the need to continuously and systematically address waste issues in order to protect the environment and improve the quality of life of the inhabitants.

Methodology

The research was conducted using two main methodological approaches: descriptive research and field research.

Field research. According to the research conducted by Jiménez and Suárez (2021), it focuses on obtaining precise information about the object or phenomenon of study in a specific context, without making changes or altering existing conditions. Through this approach, it is possible to obtain a detailed and accurate perspective of reality, based on direct observations and data collection in situ.

Descriptive Research. On the other hand, descriptive research focuses on describing the fundamental characteristics of homogeneous sets of phenomena. According to Guevara, Verdesoto and Castro (2020), this type of research uses systematic criteria to establish the structure or behavior of the phenomena studied, providing systematic information that is comparable with other sources. This approach is useful for delineating the characteristics of a segment of people and describing the most important attributes of the group to be studied, as well as estimating the percentage of units that represent certain behaviors in a specific population.

Justification of Methods. These methods were selected to achieve the research objectives, which encompassed both identifying the characteristics of a specific segment of the population and describing the most relevant attributes of the group. The union of the two approaches allowed us to obtain a complete and thorough view of the research problem, guaranteeing the validity and comparability of the data collected.

The use of descriptive and field research allowed not only to collect accurate data on the current situation of waste generation and waste management in Ecuador and Latin America, but also to provide a solid

basis for comparisons with similar studies in other regions. These methodological approaches are essential to develop effective strategies for the implementation of Waste-to-Energy (WTE) technologies in the local context.

Results

Research conducted by the Instituto Superior Tecnológico Simón Bolívar on the generation of clean energy through controlled waste incineration (Waste-to-Energy, WTE) in Ecuador and Latin America produced several important results.

Classification of cantons in Ecuador. In order to effectively evaluate the management of solid waste by the Municipal Decentralized Autonomous Governments (GADM) in their respective areas, the GRECI Project has created a document called "Methodology for selecting cantons in Ecuador and compiling information on waste and residues; in this report, a proposal for the classification of cantons is presented, which arises from the analysis of different factors linked to demographic, institutional, technical, legal, social and economic aspects. The purpose of this proposal is to classify the cantons that have similarities in their characteristics, showing the results in Table N°1 and Figure N°2.

Solid Waste Generation In Ecuador: The report of the Ministry of Environment, Water and Ecological Transition of Ecuador (2023) indicates a remarkable growth in solid waste generation at the national level during the last decades; Ecuador's environmental management faces a significant challenge due to this upward trend. It is imperative to implement effective strategies in order to diminish this negative effect and progress towards a more sustainable waste management. Taking into account the above ideas, it was determined that the weighted average density at the national level is 180.85 kg/m3. These data are also used to estimate the amount of solid waste generated, and the results are presented in Table N°2 (MAATE, 2023)

The weighted generation of solid waste in Ecuador in 2022 was 82,654.31 m3/day; this figure is distributed in 68.13% of the volume generated in urban areas and 31.87% in rural areas. Below is an

estimate of its composition according to the proposed categorization of cantons, see Figure N°2.

Waste-to-Energy (WTE) or waste-to-energy technology is presented as a viable and highly beneficial solution for solid waste management in Ecuador and Latin America. The results of the research show that its implementation offers significant advantages from several perspectives:

Environmental Impact: Reduction of soil, water and air pollution: The energetic valorization of waste avoids its disposal in landfills, minimizing the leaching of pollutants and the proliferation of disease vectors.

Reduction of greenhouse gas emissions: By taking advantage of the energy value of waste, dependence on fossil fuels is reduced, contributing to climate change mitigation.

Technical and Economic Feasibility: It is crucial to highlight that the successful introduction of waste-to-energy (WTE) technology requires careful planning, appropriate technology selection, effective emissions management and active community participation. Experience from other countries shows that WTE technology can be a viable, efficient and highly effective tool to manage solid waste and eradicate it responsibly, contributing to environmental protection, clean energy production and economic development. The implementation of appropriate technology such as WTE are available and have been successfully tested in several countries such as:

Denmark: Amager Bakke / Copenhill, A pioneer in WTE technology, Denmark has one of the highest waste recycling and recovery rates in the world, with more than 90% of its waste diverted from landfills. WTE technology plays a crucial role in this success, with plants generating around 30% of the country's electricity. (Babcock & Wilcox, 2021)

Sweden: SYSAV (Sysav South Scania Waste), another leader in WTE, Sweden has succeeded in reducing the amount of waste going to landfill to less than 1%. WTE technology generates approximately 20% of the country's heat energy and contributes to the production of electricity. (SYSAV, 2024)

Germany: With a waste recycling and recovery rate of over 65%, Germany has also successfully implemented WTE technology. WTE plants generate about 10% of the country's electricity and contribute to the reduction of greenhouse gas emissions. (ResearchGate, 2024)

United States: Although the recycling and waste recovery rate in the United States is lower than in some European countries, WTE technology has gained ground in recent years. There are more than 80 WTE plants in operation in the country, generating electricity and reducing the amount of waste going to landfills. (Gran View Research, 2024)

Canada: It has also successfully implemented WTE technology, with more than 30 plants in operation across the country. WTE plants generate electricity and heat, contributing to the reduction of greenhouse gas emissions and the country's energy security. (Mordor Intelligence, 2024)

Japan: With a recycling rate of over 80%, it has also successfully implemented WTE technology. WTE plants generate electricity and contribute to the reduction of greenhouse gas emissions. (Wtert Japan, 2024)

Taiwan: With a waste recycling and recovery rate of over 50%, it has also successfully implemented WTE technology. WTE plants generate electricity and contribute to the reduction of greenhouse gas emissions. Kaohsiung, Taiwan's second largest city, has faced significant environmental challenges in recent decades, especially in waste management due to the large amount of urban and industrial waste generated daily. In this context, waste-to-energy (WTE) systems present themselves as a beneficial solution.

These systems not only help generate electricity, reducing dependence on imported fossil fuels and greenhouse gas emissions, but also help address environmental problems. A recent study assessed the current status of municipal solid waste (MSW) and WTE plants in Kaohsiung using official data. The operating efficiencies of the four WTE plants in Kaohsiung during the period from 2003 to 2018 were analyzed, revealing an efficiency pattern similar to a "bathtub curve," with values ranging from 0.287 to 0.568 kW-h/kg. In addition, the operational efficiency progress of WTE's Gangshan

plant modernization project was examined, which showed a significant increase from 0.506 kW-h/kg in 2016 to 0.587 kW-h/kg in 2018. Finally, recommendations were provided on technological measures and regulatory incentives to improve the operational efficiency of existing WTE plants (MDPI, 2019)

China: Everbright International Limited is one of the leading companies generating clean energy through controlled waste incineration in China; this company has been noted for its ability to transform municipal solid waste into usable energy; with projects in several Chinese cities, Everbright International is committed to developing sustainable solutions and reducing reliance on landfill sites. (Everbright Environment, 2024)

Dynagreen Environmental Protection Group Co., Ltd. specializes in generating energy from solid waste through advanced Waste-to-Energy (WTE) technologies; the company operates numerous plants in China that process thousands of tons of waste daily, converting it into electricity and heat; Dynagreen focuses on energy efficiency and minimizing environmental impact.

Shanghai Environmental Group Co., Ltd. is another leader in the WTE industry in China; with a strong presence in the domestic market, the company has implemented controlled incineration technologies to generate clean energy; its projects are designed to maximize energy recovery and minimize pollutant emissions, supporting the country's environmental goals (Shanghai Electric, 2013)

China Everbright Greentech Limited, a subsidiary of China Everbright Group, focuses on renewable energy and environmental protection projects; the company has developed multiple WTE facilities that help manage municipal solid waste sustainably; Everbright Greentech promotes the circular economy and energy efficiency, contributing to the development of cleaner and healthier cities (China Everbright Greentech Limited, 2024)

China leads the way in Waste-to-Energy (WTE) technology,

Clean energy generation through the controlled incineration of solid waste, known as Waste-to-Energy (WTE), has gained popularity in China due to its ability to simultaneously address waste management

issues and energy demand. Companies such as China Everbright International Limited and Dynagreen Environmental Protection Group Co., Ltd. have led the way in implementing advanced WTE technologies; these companies not only reduce the amount of waste going to landfills, but also generate electricity and heat from waste that would otherwise be discarded.

China Everbright International Limited, for example, operates numerous WTE plants throughout the country, demonstrating the viability and efficiency of this technology. The company focuses on maximizing energy recovery from municipal solid waste and minimizing pollutant gas emissions; with a strong commitment to sustainability, Everbright International has set high standards for the WTE industry in China and has contributed significantly to the reduction of the country's carbon footprint (Everbright Environment, 2024)

On the other hand, Dynagreen Environmental Protection Group Co., Ltd. has been noted for its focus on energy efficiency and environmental protection. Its WTE plants use advanced incineration technologies to convert waste into clean energy; this conversion not only helps reduce the amount of waste in landfills, but also provides a renewable energy source; Dynagreen operates under strict environmental standards, ensuring that its processes are sustainable and beneficial to the environment.

Shanghai Environmental Group Co., Ltd. has also been a key player in China's WTE industry, implementing projects that support national sustainable development goals. The company is engaged in the efficient management of municipal solid waste through controlled incineration and energy recovery; its facilities are designed to operate with high efficiency and low emissions, contributing to improved air quality and reduced pollution (Shanghai Electric, 2013).

In addition, China Everbright Greentech Limited has expanded its operations in the WTE sector, focusing on the integration of advanced technological solutions for waste management and energy generation; the company promotes circular economy practices, where waste is viewed as valuable resources that can be reused and converted into energy; this perspective not only helps to better

manage waste, but also encourages a more sustainable and efficient use of available resources (Everbright Environment, 2024).

Brazil: It has the largest WTE plant in Latin America, located in the city of Manaus. The plant processes around 600 tons of waste per day, generating electricity and reducing the amount of waste going to landfills. The overview of waste-to-energy (WtE) technology in Brazil, from initial barriers to current and future projects, points out that, twenty years ago.

Brazil faced difficulties in implementing these technologies due to lack of funds, coherent policies, and technical know-how, among other factors; however, a gradual change is observed, with some successful projects in operation, such as biogas plants in São Paulo and Bahia. In addition, mention is made of Brazil's incursion into waste co-processing in the cement industry since 1992. Despite these advances, there are still challenges to be faced, such as public opposition and the need for greater sectoral articulation. However, with recent regulatory changes and the promotion of energy recovery as a priority, further expansion of WtE technology in Brazil is expected in the coming years.

Chile: Has implemented WTE technology in several cities, including Santiago, the country's capital. WTE plants generate electricity and contribute to the reduction of greenhouse gas emissions. (ENC Energy, 2020)

In the research conducted, it was found that several countries are implementing the generation of clean energy through the controlled incineration of solid waste, known as Waste-to-Energy (WTE), which represents a significant opportunity for Ecuador. This technology converts solid waste into electricity and heat, reducing the amount of waste going to landfills and mitigating environmental pollution. It also contributes to the diversification of the country's energy matrix, taking advantage of waste as a valuable resource for generating renewable energy.

Implementing WTE technology in Ecuador can help reduce greenhouse gas emissions, such as methane, from traditional landfills. By converting waste to energy, the release of these harmful gases into the environment is reduced, supporting the country's climate change

commitments. In addition, controlled incineration includes advanced systems to capture and treat emissions, minimizing environmental impact.

The infrastructure required for the WTE plants would generate employment and economic development opportunities in Ecuador; the construction and operation of these facilities require skilled labor and can foster training and professional development in the waste management sector for the entire academic community of the Instituto Superior Tecnológico Simón Bolívar. In addition, the sale of the energy generated provides an additional source of income, which can be reinvested in sustainability and community development projects.

A comprehensive waste management approach that includes WTE technology would complement current recycling and composting efforts in Ecuador. This technology integrates efficiently into a waste management system where reduction, reuse and recycling are priorities. Thus, non-recyclable waste can be used to generate energy, ensuring maximum resource utilization and minimizing waste sent to landfills.

For the implementation of WTE technology to be effective, it is crucial to promote community participation and environmental education. Informing and educating the population about the benefits and operation of WTE plants can increase social acceptance and support for these projects. In addition, active community participation in waste management ensures a more collaborative and sustainable approach, aligned with Ecuador's environmental and economic development goals.

Conclusions

Chinese companies are at the forefront of clean energy generation through controlled waste incineration; their leadership and commitment to sustainability have demonstrated that WTE technology is a viable and effective solution to contemporary environmental challenges; with the right support and implementation, Ecuador and other Latin American countries can greatly benefit from signing long-term relationship agreements implementing this

technology, thus promoting a cleaner and more sustainable future for their regions.

The implementation of Waste-to-Energy (WTE) technology in Ecuador represents a transformative opportunity to address solid waste management, clean energy generation and sustainable development. The research, development and innovation teaching of the Instituto Superior Simón Bolívar, and with the backing of the award-winning project at the NASA event in Samborondón in October 2023, leaves the challenge to the authorities of Ecuador and Latin America to take up this challenge. The adoption of WTE is not only feasible, but essential for the future of Ecuador and Latin America.

This project will contribute significantly to the achievement of several Sustainable Development Goals (SDGs), including Climate Action (SDG 13), Affordable and Clean Energy (SDG 7), and Decent Work and Economic Growth (SDG 8). By reducing reliance on landfills and minimizing greenhouse gas emissions, Ecuador can position itself as a leader in the fight against climate change; generating clean energy from waste is a pragmatic and sustainable solution that needs to be seriously considered.

The implementation of WTE plants will create numerous employment opportunities, fostering professional development in areas of high technological and environmental demand; this innovative approach will not only provide renewable energy, but will also stimulate local and national economic growth; authorities should see this as an investment in the future, one that will strengthen the economy and improve the quality of life for all citizens.

In addition, this project opens doors to address other environmental challenges, such as the cleanup of rivers, seas and Ecuador's Galapagos Islands; by incorporating advanced technologies and promoting community participation, it will create a lasting and positive impact on our natural environment: now is the time to act decisively and responsibly to protect our natural heritage and ensure a sustainable future for generations to come.

This article makes a call to the authorities of Ecuador and Latin America: accept this challenge and lead the change towards a more sustainable waste management and clean energy generation; the

implementation of WTE is an opportunity to innovate, grow and preserve our environment. Collaborative and participatory work makes a significant difference and sets a precedent for a cleaner, healthier and more prosperous future.

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