Review

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Social Acceptability of Waste-to-Energy: Research Hotspots, Technologies, and Factors

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Review

Social Acceptability of Waste-to-Energy: Research Hotspots, Technologies, and Factors

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Abstract: Waste-to-energy (WtE) are clean technologies that support a circular economy by providing solutions to managing non-recyclable waste while generating alternative energy sources. Despite the promising benefits, technology adoption is challenged by financing constraints, technical maturity, environmental impacts, supporting policies, and public acceptance. A growing number of studies analyzed the acceptability of WtE and identified the factors affecting the adoption of WtE technologies. This study aims to analyze these research hotspots, technologies, and acceptability factors by combining bibliometric and systematic analyses. Initial search from Web of Science and Scopus databases identified 1328 unique documents, and the refinement resulted in 109 for data analysis. The results present a comprehensive overview of the state-of-the-art, providing researchers bases for future research directions. Among the WtE technologies in the reviewed literature are incineration, anaerobic digestion, gasification, and pyrolysis, with limited studies about refuse-derived fuel and landfilling with gas recovery. The identified common factors include perceived risks, trust, attitudes, perceived benefits, 'Not-In-My-BackYard' (NIMBY), awareness, and knowledge. Moreover, the findings present valuable insights for policymakers, practitioners, and WtE project planners to support WtE adoption while achieving sustainable, circular, and low-carbon economies.

Keywords: bibliometric analysis; circular economy; social acceptability; systematic review; waste-to-energy

1. Introduction

Due to the increasing population and economic growth, sustainable management of municipal solid waste (MSW) remains one of the challenging issues for developing and even developed countries. According to the United Nations Environment Programme (UNEP) report, the global generation of municipal solid waste (MSW) is around 2.1 billion tonnes in 2023 and is projected to grow up to 3.8 billion tonnes by 2050 [1]. This contributes to approximately 5% of the global greenhouse gas (GHG) emissions [2]. If not properly managed, MSW poses adverse impacts on the health of humans and the environment [3]. This costs around USD 361 billion, including the social costs and externalities, and is expected to double to a staggering USD 640.3 billion in 2050 without drastic interventions [1].

To address these problems, different countries are implementing various strategies and technologies to decrease the environmental footprints of MSW. These include the 3Rs (reduce, reuse, recycle), segregation at source, composting, circular economy, and sanitary landfilling [4–8]. Another promising technology is waste-to-energy (WtE), which complements the previous strategies by closing the loop of a circular economy. It helps reduce the need for new landfills, processes unrecyclable wastes, supports recycling and the recovery of valuable materials, and contributes to energy security by converting wastes into usable fuel, heat, or electricity [9–11].

As shown in Figure 1, WtE encompasses a range of technologies from biological treatment, thermal treatment, and landfilling. Biological treatment pertains to anaerobic digestion (AD) of the organic fraction of MSW, which involves a biodegradation process carried out by microorganisms without oxygen to produce biogas [12]. Thermal conversion includes incineration (burning all types of MSW) and refuse-derived fuel (RDF), which produces heat and power; pyrolysis or thermal decomposition of organic wastes that produce biochar, bio-oil, and syngas; and gasification or organic wastes that also produces syngas [10,13,14]. On the other hand, landfilling can be converted into a WtE facility if it captures landfill gas, usually composed of methane, and generates electricity or heat through turbines [10]. Moreover, landfill leachates can be processed through AD to produce biogas and microbial fuel cells or biohydrogen [15].

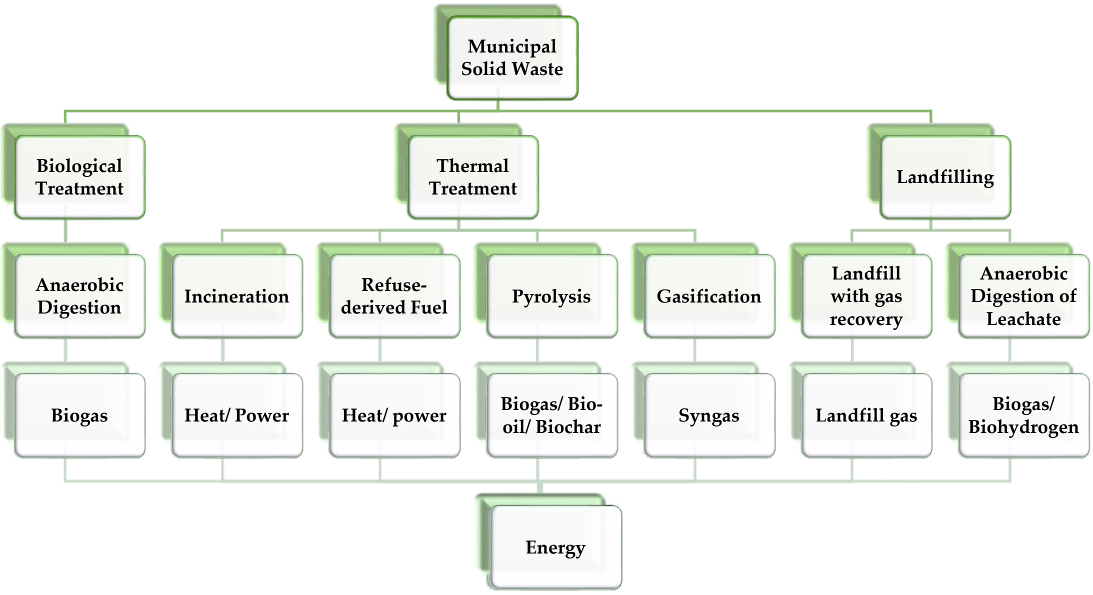

Figure 1. Waste-to-energy technologies and their products.

In recent years, the increasing number of studies on WtE has brought scholars to review the literature from different perspectives, including technical, economic, environmental, and social perspectives. For instance, Kumar & Samadder [16] reviewed the global scenario of WtE technological options such as incineration, pyrolysis, gasification, AD, and landfilling with gas recovery. Hsu et al. [17] covered various perspectives, such as value chain analysis, thermal treatment, techno-economic analysis, life-cycle assessment, power generation, and energy/exergy analysis. Ramos & Rouboa [18] also covered socio-economic and environmental aspects by reviewing the WtE literature on the life cycle assessment (LCA), life cycle costing, and social impact assessment. Furthermore, several studies also employed multi-criteria decision analysis (MCDA). In one study, Vlachokostas et al. [19] applied MCDA, integrating economic, technological, environmental, social, and political factors in the decision-making process towards promoting WtE management strategies. Patil et al. [20] also applied MCDA using an analytical hierarchy process comparing WtE technologies with four aspects such as technical, sociocultural, economic, and environmental with fifteen sub-criteria.

Nonetheless, there is a limited review of literature specifically focusing on the social acceptability of WtE technologies. To name a few, Ramos [21] conducted a literature review on social and sustainability assessments related to the thermal conversion of wastes. The study found that there is a lack of consistent reporting practices for social-LCA of WtE implementation and identified social concerns on employment, human health, accessibility, safety, and odor-related issues. Balla [22] applied a systematic literature review and revealed the factors affecting the social acceptability of WtE technology projects, including public perceptions of fairness, trust, and climate change. In the case of Ghana, Williams et al. [23] identified the factors challenging the implementation of WtE projects, such as limited funding, inadequate logistics, expertise, and infrastructure, growing population, and negative attitudes toward the environment, among others. These reviews, albeit provided an overview of the factors affecting the implementation of WtE technologies, had limited samples of selected studies analyzed. A substantial number of WtE studies recently published were not included, yet worthy of investigation.

Hence, this study aims to provide a more comprehensive overview of current research hotspots in WtE as well as to present a more in-depth review of academic papers analyzing the acceptability of WtE technologies. Specifically, the study aims to (1) review the extant literature that analyzes the acceptability of WtE technologies; (2) identify the research hotspots in the field; (3) provide a comprehensive overview of WtE technologies; (4) enumerate the factors affecting the adoption of WtE technologies; and (5) identify the knowledge gaps that serve as a basis for research direction. This study employs a combination of bibliometric analysis and systematic literature review. The results summarize the reviewed WtE literature, provide several insights on the social acceptability of WtE that need further research, and present implications that might be useful for policymakers, practitioners, and project planners for the successful adoption and implementation of WtE projects.

2. Materials and Methods

To provide a comprehensive review of the literature on the social acceptability of WtE, this paper combines bibliometric and systematic analyses. Bibliometric analysis is a systematic study carried out on scientific literature for the identification of patterns, trends, and impacts within a certain field [24]. It is used to analyze emerging trends in article and journal performances, collaboration patterns, and research constituents, as well as to explore the intellectual structure of a specific domain in the extant literature [25]. The main steps for bibliometric analysis are defining research objectives, literature search and data collection, data cleaning and processing, selection of bibliometric techniques, data analysis, visualization, and interpretation and reporting [24].

On the other hand, a systematic literature review is a research methodology that is transparent and reproducible, aiming to synthesize scientific evidence to answer a particular research question seeking to include all published evidence on the topic, and evaluating the quality of the evidence [26]. It comprises eight steps divided into three phases: (A) Review Planning Phase – (1) formulating research issue and (2) devising and verifying the review protocol, (B) Conducting Review Phase – (3) examining and searching literature, (4) filtering for inclusion, (5) evaluating quality, (6) data extraction, and (7) data analysis and synthesis, and lastly (C) Establishing Reports based on Review Outcomes – (8) summarizing the results in the form of reports [27].

Following previous studies [28,29], this review combines the advantages of bibliometric analysis and systematic literature review to present a comprehensive overview of the literature, identify gaps, and recommend future directions for research and implementation of WtE projects. As shown in Figure 2, the sequence of steps includes (1) sample preparation and database selection, (2) adjustment and refinement of research criteria, (3) bibliometric information analysis, and (4) systematic review of WtE literature.

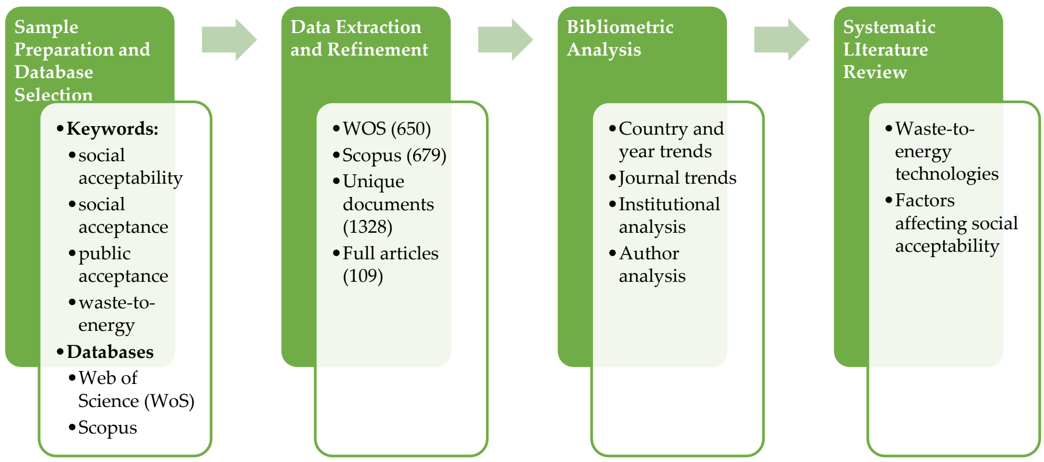

Figure 2. Waste-to-energy literature review framework.

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In the first step, the initial search was limited by the following inclusion criteria: (1) the acceptability of WtE is analyzed; (2) WtE processes MSW; (3) at least one of the WtE technologies is evaluated; and (4) factors affecting acceptability are presented. The following combination of keywords was used as a search criterion: "social acceptability" OR "social acceptance" OR "public acceptance" OR "public acceptability" AND "waste-to-energy." Meanwhile, the database selection was delimited to Web of Science (WoS) and Scopus. The WoS Core Collection database, a product of Clarivate, is the world's oldest, most widely used, and authoritative database of scientific and scholarly research publications and citations covering journals, proceedings, books, and data compilations [30]. To date, the WoS platform covers over 235 million records from over 34,865 journals, more than 157,000 books, over 314,000 conferences, more than 128 million patents, and over 15 million data sets. On the other hand, the Scopus database, a product of Elsevier, is one of the largest curated databases covering scientific journals, books, conference proceedings, etc., which are selected through a process of content selection followed by continuous re-evaluation [31]. Currently, Scopus covers 97.3+ million records from 368+ thousand books, 28.3+ thousand serials, and 2.33 million preprints. Google Scholar, albeit the most comprehensive database covering journals, books, conference papers, unpublished materials, and non-academic documents, has been greatly debated, and its low data quality raises questions about its suitability for research evaluation [28]. Hence, this review only covered the literature from WoS and Scopus.

The preliminary search resulted in 650 documents from WoS and 679 from Scopus. Upon removal of duplicates, there were 1328 unique documents left. Documents from conference papers and proceedings were excluded due to the limited discussion of acceptability, methods, and methodology, which were crucial in the systematic literature review. Documents analyzing the social acceptability of other types of wastes were also removed, such as nuclear or radioactive wastes [32], wastewater [33,34], and carbon capture and storage [35]. Furthermore, review articles [21,36] were also removed. In total, 109 research articles were reviewed for the bibliometric analysis and systematic literature review. The list of reviewed documents is presented in Appendix A Table A1.

In the third step, research hotspots from bibliometric information were analyzed, including the country and year of publication trends, authors and institutions, journals, and the number of citations as of 5 February 2025. Finally, a systematic literature review was conducted focusing on the types of WtE technology and the factors affecting the acceptability and implementation of WtE projects.

3. Bibliometric Analysis of Waste-to-Energy Literature

3.1. Country and Year Trends

A total of 109 documents were reviewed for the bibliometric analysis. These documents were published by authors from 38 countries. As presented in Figure 3, China has the highest number of documents published at 50 (46%), followed by Australia and the United Kingdom with 12 (11%), Germany, Greece, and the United States of America with 7 (6%), Italy with 6 (6%), Spain with 5 (5%), Indonesia with 4 (4%), and Czech Republic with four documents (3%). The top spot was expected as China has the highest number of WtE plants globally and the amount of MSW treated by WtE [1]. Among the top 10 countries, only two were from developing countries: China and Indonesia. This implies that developed countries play an important role in managing MSW with WtE technologies, while social acceptability research from developing countries is lagging relative to the trend in developed countries [37].

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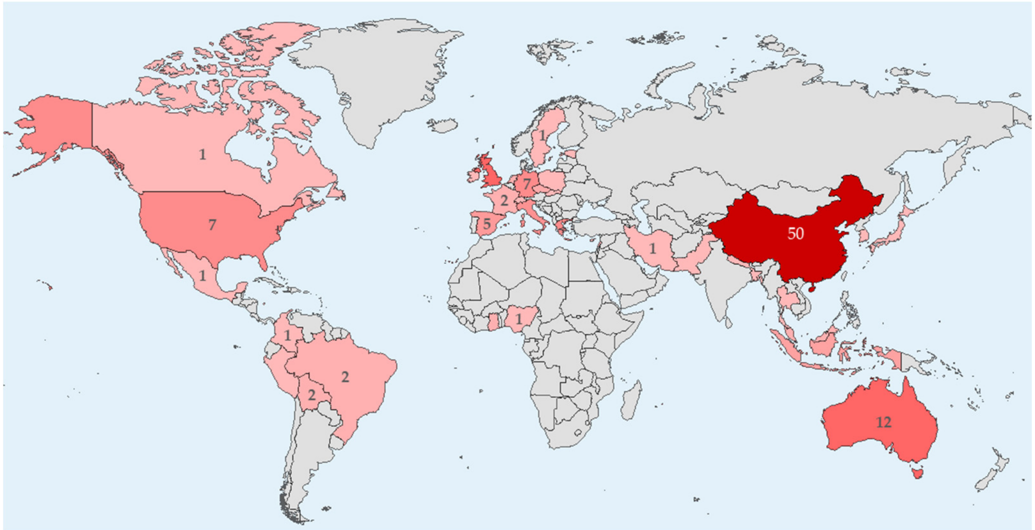

China	50	Germany	7	Italy	6	Indonesia	4
Australia	12	Greece	7	Spain	5	Czech Republic	3
UK	12	USA	7				

Figure 3. Geographical distribution of WtE literature on social acceptability. (*figure generated by authors using Microsoft Excel*).

In terms of the year of publication, the review result, as shown in Figure 4, revealed an increasing trend in WtE literature on social acceptability. The post-pandemic period had the highest number of documents published, with 17 in 2022, 16 in 2023, and 13 in 2024. This trend is expected to be the increasing urban population densities and the associated consumption pattern result in a rapid increase in the volume of waste generation. With the limited land in urban areas and the scarcity of new sites for landfills, the demand for WtE technologies is also increasing [38]. This requires thorough studies not only on the technical and economic aspects but also on these technologies' environmental impacts and social acceptability. Moreover, the situation was exacerbated during the COVID-19 pandemic as the infectious and hazardous medical wastes required immediate treatment, and WtE technologies were significantly considered to address the problem [39].

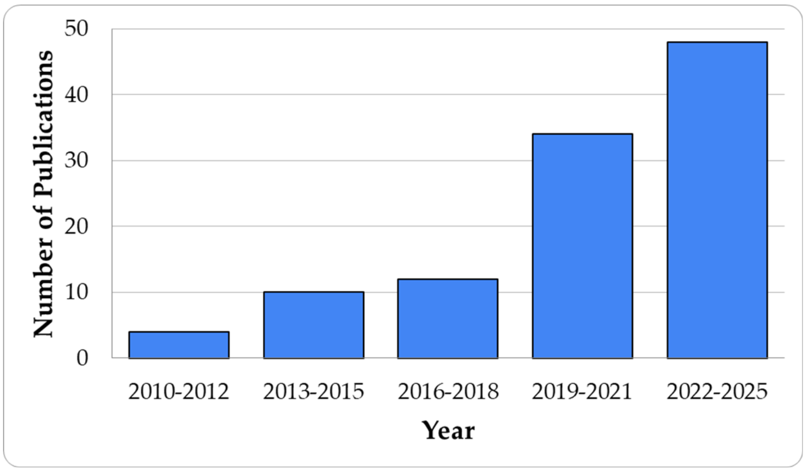

Figure 4. Trends the year of publication.

Meanwhile, the first two documents were published in 2010 by Jamasb et al. [40] who looked at the institutional and policy issues of WtE and Scheffran [41] on criteria for sustainable bioenergy infrastructure and lifecycle. On the other hand, the most recent (in 2025) publication indexed in WoS

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was authored by Luna-delRisco et al. [42] who evaluated the socio-economic drivers of household adoption of biodigester systems for domestic energy in rural Colombia.

3.2. Journal Analysis

With the multidisciplinary and interdisciplinary natures of WtE projects, the acceptability of WtE technologies was positioned in various subjects of management, sustainability, technology, energy, environment, energy, and engineering. Out of 67 serials (journals and books), the top journals with the most number of publications were Waste Management (11), Journal of Cleaner Production (10), Energy (4), Environmental Impact Assessment Review (4), Technological Forecasting and Social Change (3), Sustainable Energy Technologies and Assessment (3), and Energies (3).

Table 1. Journals with the most publications.

Rank	Title	Total Publications	Percentage
1	Waste Management	11	10%
2	Journal of Cleaner Production	10	9%
3-4	Energy	4	4%
5-8	Environmental Impact Assessment Review	4	4%
5-8	Technological Forecasting and Social Change	3	3%
5-8	Sustainable Energy Technologies and Assessment	3	3%
5-8	Energies	3	3%

The top journals also received the highest number of citations, led by Waste Management with 558 and the Journal of Cleaner Production (289) as shown in Table 2. It can be observed that some journals with fewer publications received high citations including the International Journal of Energy and Environmental Engineering (141), Habitat International (100), and Sustainable Cities and Society (89). These journals have only 1 document, such as Amoo & Fagbenle [43] in the International Journal of Energy and Environmental Engineering, Huang et al. [44] in Habitat International, and Liu et al. [45] in Sustainable Cities and Society.

Table 2. Top 10 most cited journals.

Rank	Title	Total Citations
1	Waste Management	558
2	Journal of Cleaner Production	289
3	Resources, Conservation and Recycling	190
4	International Journal of Energy and Environmental Engineering	141
5	Energy	108
6	Habitat International	100
7	Environmental Impact Assessment Review	92
8	Sustainable Cities and Society	89
9	Technological Forecasting and Social Change	88
10	Sustainability	85

3.3. Institutional Analysis

The 108 documents were published by the authors from 189 institutions worldwide. As presented in Table 3, seven out of the top 11 most productive institutions came from China headed by Zhejiang Sci-Tech University with 13 documents. This was followed by North China Institute of Science and Technology at #3 with 8, East China Normal University, Xiamen University, and Tongji University at #6-10 with 4, and lastly, Nanjing University of Science & Technology and Hefei University of Technology at #11-12 with 3 documents. Among the most recent works from Zhejiang Sci-Tech University include Zhou et al. [46] assessing the impact of psychological distance on public

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acceptance of waste-to-energy combustion projects, He et al. [47] evaluating the social license to operate waste-to-energy incineration projects, and Chen et al. [48] analyzing the effects of perceived stress on public acceptance of waste incineration projects. Other institutions in the top 10 are (2) Queensland University of Technology with 10 documents, (#4) Aristotle University with 7, (#5) Bond University with 5, and (#6-10) Cranfield University and University of Technology Sydney with 4 documents.

Table 3. Top 12 most productive institutions.

Rank	Institution	Documents
1	Zhejiang Sci-Tech University	13
2	Queensland University of Technology	10
3	North China Institute of Science and Technology	8
4	Aristotle University	7
5	Bond University	5
6-10	Cranfield University	4
6-10	East China Normal University	4
6-10	Xiamen University	4
6-10	Tongji University	4
6-10	University of Technology Sydney	4
11-12	Nanjing University of Science & Technology	3
11-12	Hefei University of Technology	3

Similarly, eight out of the top 10 most productive were included in the most cited institutions as presented in Table 4. The top 10 was headed by Zhejiang Sci-Tech University with 393 citations, followed by Queensland University of Technology, Aristotle University, North China Institute of Science and Technology, Cranfield University, Tongji University, East China Normal University, Nottingham Trent University, Xiamen University, and Hefei University of Technology.

Table 4. Top 10 most cited institutions.

Rank	Institution	Citations
1	Zhejiang Sci-Tech University	393
2	Queensland University of Technology	357
3	Aristotle University	324
4	North China Institute of Science and Technology	321
5	Cranfield University	197
6	Tongji University	167
7	East China Normal University	154
8	Nottingham Trent University	138
9	Xiamen University	119
10	Hefei University of Technology	111

It is interesting to note that Nottingham Trent University, which had only two documents, placed in the 8th spot. These publications were in collaboration with Cranfield University, such as Garnett & Cooper [49] analyzing the enhanced public engagement as a legitimizing tool for municipal waste management decision-making and Garnett et al. [50] presenting a conceptual framework for negotiating public involvement in municipal waste management decision-making.

3.4. Author Analysis

A total of 367 authors around the world studied the social acceptability of WtE technologies. The top 7 spots were dominated by five authors from China headed by (#1) Liu, Y. with 13 documents, followed by (#2-3) Cui, C. and Xia, B. with 10, and (#5-7) Ke, Y and Xu, M. with four documents.

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Other spots in the top are #4 Martin Skitmore from Australia with nine documents and #5-7 Christos Vlachokostas from Greece with four documents.

Table 5. Top 7 most productive authors.

Rank	Author	Documents
1	Liu Y.	13
2-3	Cui C.	10
2-3	Xia B.	10
4	Skitmore M.	9
5-7	Ke Y.	4
5-7	Vlachokostas C.	4
5-7	Xu M.	4

Likewise, Yong Liu from Zhejiang Sci-Tech University dominated the top 10 most-cited authors, as presented in Table 6. Among his most cited publications include "Impact of community engagement on public acceptance towards waste-to-energy incineration projects: Empirical evidence from China" [51] with 109 citations and "Enhancing public acceptance towards waste-to-energy incineration projects: Lessons learned from a case study in China" [45] with 89 citations.

Other most-cited authors were Xia B. with 357, Vlachokostas C. with 270, Moussiopoulos N.with 266, Skitmore M. with 248, Sun C.J.Y. with 168, Cooper T. with 138, Garnett K. with 138, Ge Y. with 131, and Jiang X. with 113 citations. It can be noticed that some of these authors were not included in the Top 7 most productive. For instance, Moussiopoulos N. ranked 4th with only 3 documents. His publications included Achillas et al. [52] analyzing the social acceptance of the development of a waste-to-energy plant in urban areas, Vlachocostas et al. [53] presenting a decision support system to implement units of alternative biowaste treatment for producing bioenergy and boosting local bioeconomy, and Vlachocostas et al. [54] evaluating the externalities of the operation of a municipal solid waste-to-energy incineration facility.

Table 6. Top 10 most-cited authors.

Rank	Author	Citations
1	Liu Y.	400
2	Xia B.	357
3	Vlachokostas C.	270
4	Moussiopoulos N.	266
5	Skitmore M.	248
6	Sun CJY.	168
7-8	Garnett K.	138
7-8	Cooper T.	138
9	Ge YJ.	131
10	Jiang X	113

Another is example in the list is CJY Sun with only 3 documents such as Sun et al. [55] estimating the impact of residential risk perception on the willingness to pay (WTP) to avoid having WtE power plants in the neighborhood, Sun et al. [56] identifying the determinants of risk perception and how the risk perception influences WtE facility expansion, and Cui et al. [37] investigating the potential risk factors in public-private partnership WtE incineration projects. Moreover, K. Garnett and T. Cooper only had two papers [49,50], XY. Jiang had two [37,45], and Y. Ge had two [45,57]. On the other hand, M. Xu [47,57–59] and YJ. Ke [46,47,58,59], despite having 4 papers each, were not included due to a lower number of citations.

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4. Social Acceptability of Waste-to-Energy Technologies

With the growing interest in the application of WtE in addressing MSW management challenges, the acceptability of various WtE has been analyzed. This review presents the analysis of these technologies, the methodologies used in evaluating the acceptability of these technologies, and the factors affecting them.

4.1. Waste-to-Energy Technologies

While Figure 1 outlined seven WtE technologies, the reviewed literature included only 6 of these (see Table 7). Incineration has been mostly studied with 72 documents (66%), followed by AD with 46 (42%), gasification with 7 (6%), pyrolysis with 6 (6%), and RDF and landfill with gas recovery with two documents (2%). Incineration stands out as a practical and sustainable solution for MSW, given the potential adverse environmental consequences of landfilling, incineration can reduce the volume of domestic waste by 50-80%, as other WtE technologies cannot process all types of waste [8,60,61]. Moreover, incineration is winning support among policymakers as it could reduce GHG emissions and enhance the transition toward a circular economy [60,62]. On the contrary, incineration is considered a 'not in my backyard' (NIMBY) technology due to the perceived negative externalities, lack of accurate information about the technology, and lack of effective risk communication [63].

Table 7. Technologies analyzed the acceptability of waste-to-energy.

Rank	Technology	Total Documents	Percentage
1	Incineration	72	66%
2	Anaerobic digestion	46	42%
3	Gasification	7	6%
4	Pyrolysis	6	6%
5-6	Refuse-derived fuel	2	2%
5-6	Landfill with gas recovery	2	2%

Anaerobic digestion (AD) is another WtE technology that involves a biodegradation process of the organic portion of MSW, carried out by microorganisms in the absence of oxygen. It produces biogas, a methane-rich gas that can be used as fuel, and digestate, which is a source of nutrients that can be used as a fertilizer [64]. AD can be classified as a dry (60–75% water) with clear advantages in terms of digester volume, water consumption, and the production of wastewater, or a wet (85–90% water) process with higher methane productivity, lower mixing and pumping costs, and can dilute peak concentrations of substrate and inhibitors [12].

The third on the list is gasification, which is considered a suitable WtE method for the chemical co-processing of most sophisticated plastic wastes. It involves the thermal decomposition of solid carbonaceous materials in the presence of steam, oxygen, or carbon dioxide to produce a syngas comprising mainly of combustible gases (hydrogen, carbon monoxide, and methane), noncombustible gas (carbon dioxide, oxygen, and nitrogen), and trace amounts of other higher series of hydrocarbons [65]. The syngas produced from the gasification process can be used to produce other chemicals and generate heat, lighting, and electricity [18]. Compared to incineration, the gasification technique has a promising environmental and economic performance [65]. However, its utilization is limited to plastics and their derivatives as compared to 'burn all' waste using incineration [66].

Another WtE technology is pyrolysis, which involves the thermal decomposition of organic materials into simple molecules at elevated temperatures in the absence of oxygen [67]. Applying heat (300 and 850^{0}C) indirectly to waste causes the thermal decomposition of the waste to produce biochar, bio-oil, and biogas [10,13]. In the thermal process, fractions of MSW with high moisture content are either removed from the MSW or pre-dried before pyrolysis to reduce the amount of heat that needs to be input into the facility [68]. Along with other thermal treatment technologies such as gasification and plasma gasification, pyrolysis was proven to have limited applicability due to the complexity of the processes, the inability to process a variety of waste streams that require pre-treatment, and lower net-energy recovery [67].

Refuse-derived fuel (RDF) is a type of fuel produced from the remaining organic and combustible non-recyclable components of MSW [69]. From RDF, a range of energy products can be derived, including heat, power, and biofuels, such as biomethane or biochar [70]. Its main advantages are the reduction of landfill waste and the generation of power from materials that would otherwise contribute to environmental issues. For instance, in the cement industry, using RDF instead of conventional fossil fuel demonstrated environmental benefits such as reduction in acidification, GHG emissions, eutrophication, summer smog, landfill costs, and carcinogenic risk potential [71]. However, combustion of these fuels could raise hazardous gas emissions such as NOx, SOx, CO_2, and dioxins, which the cogeneration requires the treatment of flue gas [72]. Moreover, RDF to power technology is perceived to be greatly affected by completion risk, environment, health & safety, revenue risk, concessionaire risk, and planning risk [14].

Last on the list is landfilling with gas recovery, which refers to a sanitary landfill (SLF) that has a system that captures, manages, and often utilizes the gases from the decomposition of waste [73]. The process produces methane and carbon dioxide, which are naturally produced during the anaerobic breakdown of organic materials in the landfill. Among its advantages over traditional landfilling and open dumpsites include reduction of GHG emissions, production of renewable energy, improvement of air quality, and other societal benefits [16,74]. On the other hand, landfills have some disadvantages, like the generation of odors and leachate that can contaminate the water resources [75].

Yet, microbial cells, microbial fuel cells, and landfill leachate are technologies that have not been analyzed from a social perspective. They are capable of transforming organic materials into valuable products such as energy and chemical compounds [76]. The technology remains at a laboratory scale, albeit offering promising results, because of the lack of industrial-scale applications due to difficulties in achieving stable performance under real operating conditions [77]. To utilize these technologies for the production of bioenergy/energy, technologies such as fermentation, anaerobic digestion (AD), supercritical water gasification (SCWG), and bio-electrochemical systems seem to be prospective options [15].

Meanwhile, it can be observed in Table 7 that the total percentage is above 100%, as several studies analyzed and compared different WtE technologies. For instance, Mertzanakis et al. [78] compared incineration, AD, gasification, and pyrolysis using a holistic assessment of the scientific literature, a public survey, and an experts' opinion survey. The study found AD as the most preferable choice due to its cost-effectiveness and lower environmental impact, while incineration became the most preferred choice if the social criterion is in high focus [78]. On the contrary, Neehaul et al. [68] found that AD ranked as the prioritized technology when the social acceptance indicator was identified as the critical criterion, while incineration emerged as the preferred technology when the social aspect was either attenuated or eliminated during the sensitivity analysis.

4.2. Factors Affecting the Acceptability of Waste-to-Energy

The social factors affecting the acceptability of a technology or intervention are crucial because they influence the project's ability to be sustained, scaled up, or replicated [79,80]. This review analyzed the factors affecting the social acceptability of WtE technologies. The analysis identified 126 factors, as presented in a word cloud in Figure 5 and summarized in Table 8.

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Figure 5. Factors affecting the acceptability of waste-to-energy projects.

A total of 29 papers, or 27% of the documents, recognized the 'perceived risks as a major factor that hinders WtE adoption. Construction of WtE facilities faces considerable and strong opposition from local communities due to the perceived potential risks [51]. The level of public acceptance is low if the perceived potential risks to the environment/health of the local communities are high [57,58]. Among the potential health risks include adverse birth and neonatal outcomes, congenital anomalies, post-neonatal and infant mortality, and cancer [81]. Environmental risks include pollution, decrease in environmental quality, and environmental degradation [82]. Excessive risk perception would significantly increase the probability of opposing the WtE facility expansion as risks would result in social costs, such as a reduction in net benefits for operating WtE facilities and market failure in the housing market due to negative externalities [56].

Second to the list is 'trust,' which includes the public trust in the institution, government, experts, developers, and private enterprises operating the WtE facility [60,66]. The trust serves as a foundation of cooperation and participation in the successful and effective implementation of MSW treatment policy, including WtE facilities [83]. Moreover, interpersonal trust and institutional trust have a significant impact on households' perceived value of energy utilization, particularly from agricultural wastes [84].

The third factor identified in the reviewed literature is the 'attitudes.' Understanding the public attitudes towards WtE projects forms a good interaction between the government, the private sector, and the public by encouraging the development of WtE projects, helping local governments prevent risks, and forming policy suggestions [47]. Another factor affecting the acceptability of WtE is the 'perceived benefits.' Economic compensation effectively improves residents' acceptance by being positively associated with their perceived economic benefit and trust in the local government [85]. The acceptance of WtE can be viewed at both individual and community levels, which can be attributed to the expectations of cost savings, improved health information, and gas and electricity produced from the WtE facility may, in return, bring financial benefits to the community as well as individual household [86]. Nonetheless, the government ought to offer attractive benefits and incentives for the rapid growth and development of WtE projects [87].

Meanwhile, if some projects may cause potential environmental or social risks, their construction will be protested and boycotted by the public [88]. This phenomenon is called "Not-In-My-BackYard" or NIMBY, which is demonstrated by residents in the surrounding area who adopt a protectionist attitude and take measures to resist and protest against the construction of an unwelcome facility near their homes [89]. On the other hand, if an established WtE plant with designs blending art and function serving the citizens for a long time has built up healthy relationships with the communities, the NIMBY syndrome is converted to the Beauty-In-My-BackYard (BIMBY) synergy [90].

Table 8. The top 7 most common factors affecting the acceptability of waste-to-energy technologies.

Rank	Technology	Total Documents	Percentage
1	Perceived risks	29	27%
2	Trust	23	21%
3	Attitudes	21	19%
4	Perceived benefits	18	17%
5	NIMBY	17	15%
6	Awareness	15	14%
7	Knowledge	11	10%

Other major factors affecting the acceptability of WtE are awareness and knowledge. Public awareness pertains to familiarity with the concept of WtE technology, the national policies about WtE, and the technology's environmental impacts [91,92]. The more residents are aware of the WtE project, the more they realize it provides more benefits and poses fewer risks [63]. Additionally, public awareness about various waste management issues can lower waste production and enhance management techniques [93]. Meanwhile, a higher level of knowledge would allow the public to have a better-founded evaluation of WtE-based products, and they could make an informed decision about whether these can become environmentally friendly alternatives contributing to policy goals for energy transition [94]. On the other hand, citizens with little to no knowledge are significantly less willing to pay compared to respondents with knowledge of WtE [95].

5. Conclusion and Recommendations

This study presented a literature review of the social acceptability of WtE technologies. The data refinement resulted in 109 documents from the WoS and Scopus databases. The year-trends revealed research progress from 2 papers published in 2010 to 48 in the last three years. China emerged as a significant contributor to the literature related to the social acceptability of WtE technologies in terms of the most number of publications as well as the most productive and most-cited authors and institutions. Over 20% of the papers were published in *Waste Management* and the *Journal of Cleaner Production*, which also received the most citations. Most of the papers analyzed the acceptability of incineration at 66%, followed by anaerobic digestion at 42%. Among the factors affecting the acceptability of WtE technologies were perceived risks, public trust, attitudes toward WtE, perceived benefits, and the NIMBY syndrome.

There were only a few studies analyzing the acceptability of pyrolysis and gasification due to their limited applicability, the complexity of the processes, and the inability to process a variety of MSW. With their huge potential to complement other MSW management strategies, future studies may consider analyzing the acceptability of pyrolysis and gasification, particularly those that are still in the planning and feasibility stages of project cycle development. Moreover, the acceptability of other WtE technologies, such as gas recovery and anaerobic digestion of leachate from landfills, can be considered for further social acceptability analysis.

The major factors supporting the implementation of WtE technologies were trust, attitudes, perceived benefits, awareness, and knowledge. On the other hand, perceived risk and NIMBY syndrome were the barriers to implementing WtE technologies. The findings provide valuable insights for policymakers, practitioners, and WtE project planners to support WtE adoption while achieving sustainable, circular, and low-carbon economies.

- *Information, Education, and Communication (IEC).* The acceptability of WtE depends on how well information about the technology, the project implementation, and its impacts are communicated to the public. IEC strategies such as public forums, stakeholder consultations, educational campaigns, and distributing IEC materials in both print and online platforms can foster positive perceptions while reducing resistance towards WtE technologies.

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- *Community Involvement*. Communities are more likely to accept WtE projects if they are well-informed, engaged, and invested. They can be involved in the conceptualization, participatory planning, implementation, decision-making, and monitoring and evaluation of the project. These activities foster transparency, collaboration, ownership, and long-term commitment, creating a positive relationship between the project and the community.
- *Transparency*. Openly communicating the project benefits, addressing potential risks, sharing the progress monitoring of the project, and involving the community in decision-making improve the social acceptability of WtE. This builds public trust, dispels misconceptions, and mitigates resistance while fostering co-management of MSW through WtE technologies.
- *Systems Approach*. A systems approach to planning and implementation considers the interdependencies of social, environmental, economic, and technological aspects of WtE projects. This approach ensures that all stakeholders are considered, concerns are addressed, and the technology is integrated sustainably within the community. This comprehensive, participatory, inclusive, and long-term WtE planning ensures that WTE technologies contribute to sustainable MSW management and energy production while gaining the trust and support of local communities turning NIMBY into BIMBY.

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Abbreviations

The following abbreviations are used in this manuscript:

AD	Anaerobic digestion
BIMBY	Beauty-In-My-BackYard
GHG	Greenhouse gas
IEC	Information, Education, and Communication
LCA	Life cycle assessment
MCDA	Multi-criteria decision analysis
MSW	Municipal solid waste
NIMBY	Not-In-My-BackYard
RDF	Refuse-derived fuel
SLF	Sanitary landfill
UNEP	United Nations Environment Programme
WOS	Web of Science
WtE	Waste-to-energy
WTP	Willingness to pay
3Rs	Reduce, reuse, recycle

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Appendix A

Table A1. List of the Reviewed Literature.

Author	Year	Title
Achillas et al. [52]	2011	Social acceptance for the development of a waste-to-energy plant in an urban area
Ahmed et al. [87]	2022	Systematic analysis of factors affecting biogas technology acceptance: Insights from the diffusion of innovation
Ajieh et al. [96]	2021	Assessment of sociocultural acceptability of biogas from fecal waste as an alternative energy source in selected areas of Benin City, Edo State, Nigeria
Amir et al. [97]	2015	Socio-Economic Considerations of Converting Food Waste into Biogas on a Household Level in Indonesia: The Case of the City of Bandung
Amoo & Fagbenle [43]	2013	Renewable municipal solid waste pathways for energy generation and sustainable development in the Nigerian context
Asare et al. [95]	2024	Assessment of Knowledge, Attitudes and Practices Towards Waste Management in Ghana: Implications for Energy Production
Baxter et al. [98]	2020	How energy from waste (EFW) facilities impact waste diversion behavior: A case study of Ontario, Canada
Benassai [99]	2023	Environmental Conflict and Contingent Valuation Method: Setting Up a Pilot Study on Biogas Plants Acceptance in Emilia Romagna
Borges et al. [100]	2023	Scaling actors' perspectives about innovation system functions: Diffusion of biogas in Brazil
Caferra et al. [101]	2023	Wasting energy or energizing waste? The public acceptance of waste-to-energy technology
Calle Mendoza et al. [102]	2024	Social acceptance, emissions analysis and potential applications of paper-waste briquettes in Andean areas
Chalhoub M.S. [103]	2018	Public policy and technology choices for municipal solid waste management a recent case in Lebanon
Chen et al. [48]	2023	Effects of perceived stress on public acceptance of waste incineration projects: evidence from three cities in China
Chen et al. [104]	2022	Demographic differences in public acceptance of waste-to-energy incinerators in China: High perceived stress group vs. low perceived stress group
Cong et al. [105]	2021	Exploring critical influencing factors for the site selection failure of waste-to-energy projects in China caused by the not in my back yard effect
Cudjoe & Wang [65]	2024	Public acceptance towards plastic waste-to-energy gasification projects: The role of social trust and health consciousness
Cui et al. [37]	2020	Determining critical risk factors affecting public-private partnership waste-to-energy incineration projects in China
Dolla & Laishram [14]	2021	Effect of energy from waste technologies on the risk profile of public-private partnership waste treatment projects of India
Ellacuriaga et al. [77]	2022	Is Decentralized Anaerobic Digestion a Solution? Analyzing Biogas Production and Residential Energy Demand
Emmanouil et al. [106]	2022	Pay-as-You-Throw (PAYT) for Municipal Solid Waste Management in Greece: On Public Opinion and Acceptance
Eom et al. [86]	2021	Social acceptance and willingness to pay for a smart Eco-toilet system producing a Community-based bioenergy in Korea
Falconer et al. [64]	2020	Anaerobic Digestion of food waste: Eliciting sustainable water-energy-food nexus practices with Agent Based Modelling and visual analytics
Fetanat et al. [13]	2019	Informing energy justice based decision-making framework for waste-to-energy technologies selection in sustainable waste management: A case of Iran
Fu et al. [107]	2021	Three-stage model based evaluation of local residents' acceptance towards waste-to-energy incineration project under construction: A Chinese perspective
Garnett & Cooper [49]	2014	Effective dialogue: Enhanced public engagement as a legitimising tool for municipal waste management decision-making

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Garnett et al. [50]	2017	A conceptual framework for negotiating public involvement in municipal waste management decision-making in the UK
Ghimire et al. [108]	2024	Assessing stakeholders' risk perception in public-private partnerships for waste-to-energy projects: A case study of Nepal
He, K. et al. [84]	2020	Rural households' perceived value of energy utilization of crop residues: A case study from China
He, X. et al. [47]	2023	Evaluating the social license to operate of waste-to-energy incineration projects: A case study from the Yangtze River Delta of China
He, K. et al. [109]	2018	Rural households' willingness to accept compensation for energy utilization of crop straw in China
Herbes et al. [94]	2018	Towards marketing biomethane in France-French consumers' perception of biomethane
Hobbs et al. [110]	2017	Sustainability approach: Food waste-to-energy solutions for small rural developing communities
Hou et al. [111]	2019	Improving social acceptance of waste-to-energy incinerators in China: Role of place attachment, trust, and fairness
Huang, YL et al. [44]	2015	Public acceptance of waste incineration power plants in China: Comparative case studies
Huang, YS et al. [60]	2022	Perceptional differences in the factors of local acceptance of waste incineration plant
Jamasb et al. [40]	2010	Waste to energy in the UK: Policy and institutional issues
Jin et al. [112]	2022	A signaling game approach of siting conflict mediation for the construction of waste incineration facilities under information asymmetry
Joneset al. [66]	2022	Understanding public perceptions of chemical recycling: A comparative study of public attitudes towards coal and waste gasification in Germany and the United Kingdom
Kanto et al. [74]	2015	From waste-to-energy (An awareness campaign in converting waste into energy in supit urang Landfill, Malang, Indonesia)
Kong et al. [113]	2023	How Does Differential Public Participation Influence Outcome Justice in Energy Transitions? Evidence from a Waste-to-Energy (WTE) Project in China
Lahl & Zeschmar-Lahl [114]	2018	Prerequisites for Public Acceptance of Waste-to-Energy Plants: Evidence from Germany and Indonesia
Lee et al. [115]	2021	Subjectivity Analysis of Underground Incinerators: Focus on Academic and Industry Experts
Liu et al. [45]	2019	Enhancing public acceptance towards waste-to-energy incineration projects: Lessons learned from a case study in China
Liu et al. [85]	2021a	Effects of economic compensation on public acceptance of waste-to-energy incineration projects: an attribution theory perspective
Liu et al. [51]	2018a	Impact of community engagement on public acceptance towards waste-to-energy incineration projects: Empirical evidence from China
Liu et al. [116]	2018b	Identification of Risk Factors Affecting PPP Waste-to-Energy Incineration Projects in China: A Multiple Case Study
Liu et al. [57]	2021b	Influences of environmental impact assessment on public acceptance of waste-to-energy incineration projects
Lu, J-W et al. [90]	2019	From NIMBY to BIMBY: An evaluation of aesthetic appearance and social sustainability of MSW incineration plants in China
Lu, JT et al. [117]	2023	Constraints affecting the promotion of waste incineration power generation project in China: A perspective of improved technology acceptance model
Luna-delRisco et al. [42]	2025	Evaluating the socio-economic drivers of household adoption of biodigester systems for domestic energy in rural Colombia
Martinat et al. [118]	2017	Interpreting regional and local diversities of the social acceptance of agricultural AD plants in the rural space of the Moravian-Silesian Region (Czech Republic)
Martinát et al. [119]	2022	Best Practice Forever? Dynamics behind the Perception of Farm-Fed Anaerobic Digestion Plants in Rural Peripheries
Martinát et al. [120]	2020	Rich or poor? Who actually lives in proximity to AD plants in Wales?

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Mazzanti et al. [121]	2021	The biogas dilemma: An analysis on the social approval of large new plants
Mendoza et al. [102]	2024	Social acceptance, emissions analysis and potential applications of paper-waste briquettes in Andean areas
Mertzanakis et al. [78]	2024	Closing the Loop between Waste-to-Energy Technologies: A Holistic Assessment Based on Multiple Criteria
Neehaul et al. [68]	2020	Energy recovery from municipal solid waste in Mauritius: Opportunities and challenges
Niang et al. [122]	2022	How do local actors coordinate to implement a successful biogas project?
Nketiah et al. [123]	2022	Citizens? willingness to pay for local anaerobic digestion energy: The influence of altruistic value and knowledge
Pérez et al. [124]	2020	Polyhydroxyalkanoates (PHA) production from biogas in waste treatment facilities: Assessing the potential impacts on economy, environment and society
Phillips et al. [125]	2014	Assessing the perception and reality of arguments against thermal waste treatment plants in terms of property prices
Qiao & Wang [126]	2023	An intuitionistic fuzzy site selection decision framework for waste-to-energy projects from the perspective of ‘‘Not In My Backyard’’ risk
Quan & Zuo [127]	2022	An Empirical Study of Public Response to a Waste-to-Energy Plant in China: Effects of Knowledge, Risk, Benefit and Systematic Processing
Quan et al. [89]	2022	Risk Perception Thresholds and Their Impact on the Behavior of Nearby Residents in Waste to Energy Project Conflict: An Evolutionary Game Analysis
Ren et al. [82]	2016	Risk perception and public acceptance toward a highly protested Waste-to-Energy facility
Ribeiro & Quintanilla [128]	2015	Transitions in biofuel technologies: An appraisal of the social impacts of cellulosic ethanol using the Delphi method
Roach [129]	2013	Examining public understanding of the environmental effects of an energy-from-waste facility
Sarker et al. [93]	2024	Household solid waste management in a recently established municipality of Bangladesh: Prevailing practices, residents' perceptions, attitude and awareness
Scheffran [41]	2010	Criteria for a sustainable bioenergy infrastructure and lifecycle
Schumacher & Schultmann [130]	2017	Local Acceptance of Biogas Plants: A Comparative Study in the Trinational Upper Rhine Region
Shan et al. [83]	2021	The impact of environmental benefits and institutional trust on residents' willingness to participate in municipal solid waste treatment: a case study in Beijing, China
Song et al. [131]	2015	Modeling the Concession Period and Subsidy for BOT Waste-to-Energy Incineration Projects
Strano et al. [62]	2019	Communication as a prevention tool: A key lever for general acceptance of the role of incineration (waste-to-energy) and transformation plants towards circular economy
Subiza-Pérez et al. [132]	2023	Waste-to-energy risk perception typology: health, politics and environmental impacts
Subiza-Pérez et al. [81]	2020	Explaining social acceptance of a municipal waste incineration plant through sociodemographic and psycho-environmental variables
Sun et al. [56]	2023	Social cost of waste-to-energy (WTE) incineration siting: From the perspective of risk perception
Sun et al. [55]	2019	Public acceptance towards waste-to-energy power plants: a new quantified assessment based on "willingness to pay"
Suryawan et al. [92]	2023	Acceptance of Waste to Energy Technology by Local Residents of Jakarta City, Indonesia to Achieve Sustainable Clean and Environmentally Friendly Energy
Tahiru et al. [91]	2024	Public perceptions of waste-to-energy technology in developing countries: A case study of Tamale, Ghana
Talang & Sirivithayapakorn [69]	2022	Comparative analysis of environmental costs, economic return and social impact of national-level municipal solid waste management schemes in Thailand
Tehupeiory et al. [133]	2023	Evaluating Community Preferences for Waste-to-Energy Development in Jakarta: An Analysis Using the Choice Experiment Method
Upham & Jones [134]	2012	Don't lock me in: Public opinion on the prospective use of waste process heat for district heating

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van Dijk et al. [135]	2024	Public acceptance of biomass for bioenergy: The need for feedstock differentiation and communicating a waste utilization frame
Vlachokostas et al. [53]	2020a	Decision support system to implement units of alternative biowaste treatment for producing bioenergy and boosting local bioeconomy
Vlachokostas et al. [54]	2020b	Externalities of energy sources: The operation of a municipal solid waste-to-energy incineration facility in the greater Thessaloniki area, Greece
Wan et al. [136]	2024	Influence of Stakeholder Identities on Unfairness Perception of Local Residents toward Public Facilities: Neurocognition Evidence from the Case of Waste-to-Energy Projects in China
Wu et al. [137]	2018	Site Selection of Waste-to-Energy (WtE) Plant considering Public Satisfaction by an Extended VIKOR Method
Xexakis & Trutnevyte [138]	2022	Model-based scenarios of EU27 electricity supply are not aligned with the perspectives of French, German, and Polish citizens
Xu, M & Lin [88]	2023	Accessing people's attitudes towards garbage incineration power plants: Evidence from models correcting sample selection bias
Xu, MM & Lin [61]	2020	Exploring the not in my backyard effect in the construction of waste incineration power plants - based on a survey in metropolises of China
Xu, MM et al. [59]	2023	Social acceptance of NIMBY facilities: A comparative study between public acceptance and the social license to operate analytical frameworks
Xu, XM et al. [139]	2024	Examining behavioral strategies of residents and enterprises in the context of subsidy phase-outs for waste incineration power plants
Xue et al. [140]	2021	Residents' intention to take collective action through participation in not-in-my-backyard protests in China
Yamane & Kaneko [141]	2023	Exploring the impact of awareness on public acceptance of emerging energy technologies: An analysis of the oil palm industry
Yang et al. [142]	2019	Bayesian-Based NIMBY Crisis Transformation Path Discovery for Municipal Solid Waste Incineration in China
Yu et al. [143]	2022	Unlocking key factors affecting utilization of biomass briquettes in Africa through SWOT and analytic hierarchy process: A case of Madagascar
Yuan et al. [144]	2019	Public perception towards waste-to-energy as a waste management strategy: A case from Shandong, China
Zabaniotou et al. [67]	2014	Analysis of good practices, barriers and drivers for ELTs pyrolysis industrial application
Zabaniotou et al. [145]	2019	Transition to bioenergy: Engineering and technology undergraduate students' perceptions of and readiness for agricultural waste-based bioenergy in Greece
Zander et al. [146]	2015	Biogas production and society: Evidence from Germany
Zeng et al. [147]	2024a	Seeking information about waste-to-energy incineration projects: The role of objective knowledge and benefit perceptions in an extended PRISM
Zeng et al. [63]	2024b	Understanding residents' risk information seeking, processing and sharing regarding waste incineration power projects
Zeng et al. [63]	2023	Exploring the effects of information insufficiency on residents' intention to seek information about waste-to-energy incineration projects
Zhang et al. [148]	2021	Identifying the Predictors of Community Acceptance of Waste Incineration Plants in Urban China: A Qualitative Analysis from a Public Perspective
Zhao, H et al. [149]	2022	Evaluation on the implementation effect of public participation in the decision-making of NIMBY facilities
Zhao, R et al. [150]	2019	Public risk perception towards power generation by municipal waste incineration: Word-frequency-based decision making
Zheng et al. [151]	2021	Residents' acceptance towards waste-to-energy facilities: formation, diffusion and policy implications
Zhou et al. [46]	2024	Impact of psychological distance on public acceptance of waste-to-energy combustion projects
Zhou et al. [58]	2022	Exploring the effects of spatial distance on public perception of waste-to-energy incineration projects

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