Clean Technologies and Environmental Policy

Supplementary Materials for

Technological roadmap for sustainable production of biomethane integrated with hydrogen from municipal solid waste

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Fig. S1.

Patents families by protection country (Source: Created using Questel Orbit Intelligence software).

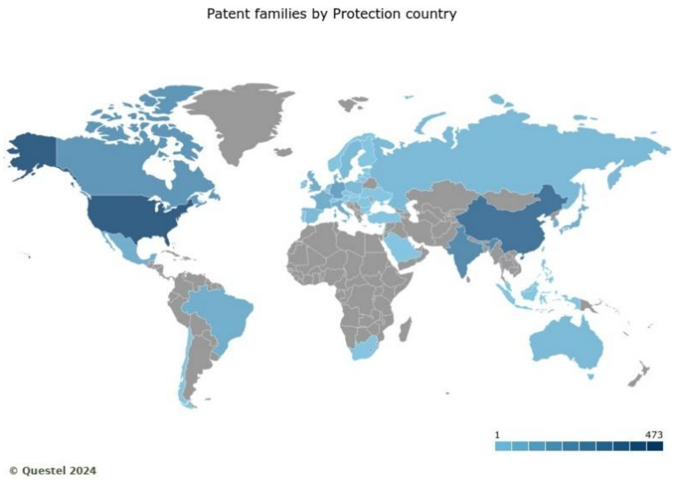

Fig. S2.

Concepts by assignee chart (Source: Created using Questel Orbit Intelligence software).

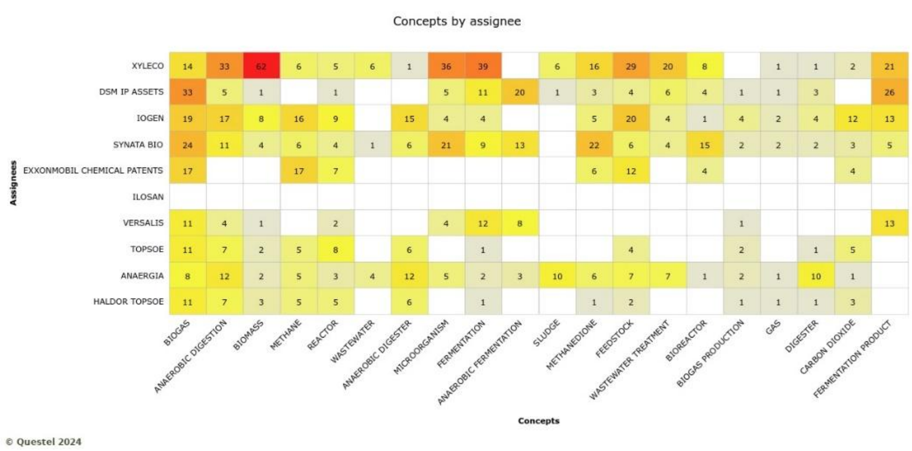

Table S1.

Main characteristics and results of the ten articles selected (Source: Scopus).

Author (s)	Title	Keywords finds	Energy conversion Technologies	Wastes used for energy production	Goal	Methodology

1 -Ennouri H.; Miladi B.; Diaz S.Z.; Güelfo L.A.F.; Solera R.; Hamdi M.; Bouallagui H.	Effect of thermal pretreatment on the biogas production and microbial communities balance during anaerobic digestion of urban and industrial waste activated sludge	Anaerobic digestion; Fluorescent in situ hybridization; Industrial sludge; Microbial balance; Thermal pre-treatment; Urban sludge.	Anaerobic digestion	Waste activated sludge from urban and industrial sludge and wastewater.	Analyze the effect of thermal pre-treatment on the improvement of the anaerobic bioconversion of urban and industrial active sludge into biogas, using anaerobic sequencing batch reactors (ASBR).	Thermal pre-treatment of activated sludge through different temperatures, subsequently subjected to anaerobic digestion to evaluate biogas production. DNA sequencing techniques were also used to identify and quantify microbial populations before and after pre-treatment and anaerobic digestion.
2 - Li Y.; Alaimo C.P.; Kim M.; Kado N.Y.; Peppers J.; Xue J.; Wan C.; Green P.G.; Zhang R.; Jenkins B.M.; Vogel C.F.A.; Wuertz S.; Young T.M.; Kleeman M.J.	Composition and Toxicity of Biogas Produced from Different Feedstocks in California	Feedstock; Greenhouse gas reduction goals; Biogas production systems; Toxicity; California biogas streams; Dairy manure; Food waste biogas; Biogas combustion exhaust.	Anaerobic digestion	Dairy manure, food waste and municipal solid waste.	Investigate the chemical composition and toxicity of biogas produced from different substrates, including cow manure, food waste, and municipal solid waste.	Anaerobic digestion of selected substrates including cow manure, food waste, and municipal solid waste for biogas production, with a comparative analysis of the chemical composition generated for each substrate, as well as the degree of toxicity, through the simulation of atmospheric aging using a photochemical smog chamber.
3 - Kuo J.; Dow J.	Biogas production from anaerobic digestion of food waste and relevant air quality implications	Biogas; anaerobic digestion; food waste; air quality; greenhouse gases; renewable energy.	Anaerobic digestion	Food waste	Investigate biogas production from anaerobic digestion of food waste and evaluate the implications for air quality.	Different types of food waste were subjected to anaerobic digestion, with monitoring of conversion efficiency and measurement of greenhouse gas emissions and other pollutants during biogas combustion. Air quality analyses were also performed, with an analysis of the emission results compared to current environmental standards.
4 - Hoppe W.; Thonemann N.; Bringezu S.	Life Cycle Assessment of Carbon Dioxide–Based Production of Methane and Methanol and Derived Polymers	carbon capture and utilization (CCU); CO₂ capture and use; global warming potential; life cycle assessment (LCA); power-to-X; resource efficiency.	Electrolysis of water using wind energy to produce hydrogen and carbon capture and utilization (CCU).	Industrial and environmental sources (Biomass residues, Carbon dioxide from biogas production, lignite-fired power plants and waste incineration plants).	Conduct a life cycle assessment (LCA) of the production of methane, methanol, and derived polymers using CO_2 as a raw material.	Catalytic chemical reactions were used to convert CO_2 and hydrogen into methane and methanol. Intermediate products, such as synthesis gas, were converted into polymers like polyoxymethylene, polyethylene, and polypropylene. Measurements of greenhouse gas emissions were conducted throughout the life cycle, along with an assessment of the number of resources required in the process. A trade-off analysis was also performed between the reduction of GHG emissions and the increase in the use of abiotic resources.
5- Peters R.; Baltruweit M.; Grube T.; Samsun R.C.; Stolten D.	A techno economic analysis of the power to gas route.	Methanation; Power to gas; Sector coupling; Techno economic analysis.	Electrolysis of water using wind energy to produce hydrogen and capture of carbon dioxide (CO_2) from various sources to produce synthetic methane (CH_4).	liquid manure, municipal waste, biomass and dry manure.	Conduct a techno-economic analysis of the Power-to-Gas process, evaluating the economic viability and environmental benefits of producing synthetic methane from renewable hydrogen and captured CO_2.	The economic feasibility assessment was conducted by comparing the costs of synthetic methane with methane from conventional sources, considering eight scenarios: four using renewable hydrogen produced via electrolysis powered by wind energy, combined with CO_2 from different sources (biogas, waste gases from power plants, CO_2 supplied by providers, and direct air capture), and four additional scenarios using hydrogen and CO_2 from conventional sources to provide a comprehensive comparison. The environmental impacts of the Power-to-Gas process were based on the production of

						synthetic methane. The technical analysis considered process efficiency, production costs, and environmental implications.
6 - Feki E.; Khoufi S.; Loukil S.; Sayadi S.	Improvement of anaerobic digestion of waste-activated sludge by using H2O2 oxidation, electrolysis, electro-oxidation and thermo-alkaline pretreatments.	Anaerobic digestion; COD solubilization; Electro-oxidation; Thermo-alkaline; Waste-activated sludge.	Anaerobic digestion.	waste-activated sludge.	Investigate the solubilization of COD (Chemical Oxygen Demand) and the increase in biogas production and compare the pre-treatment methods of waste activated sludge (WAS) regarding the processes of oxidation with H_2O_2, electrolysis, electro-oxidation, and thermo-alkaline pre-treatment, focusing on the improvement of anaerobic digestion, to identify the most effective method.	The parameters of COD solubilization and the amount of biogas produced after pre-treatment and anaerobic digestion were evaluated under various operational conditions, considering the processes of oxidation with H_2O_2, electrolysis, electro-oxidation (EO), and thermo-alkaline pre-treatment (TA).
7 - Elsamadony M.; Tawfik A.	Dry anaerobic co-digestion of organic fraction of municipal waste with paperboard mill sludge and gelatin solid waste for enhancement of hydrogen production.	Bio-hydrogen; Dry anaerobic co-fermentation; Gelatin solid waste; Organic fraction of municipal solid waste; Paperboard mill sludge.	Dry anaerobic digestion.	Organic fraction municipal solid waste, gelatin solid waste and paperboard mill sludge.	Identification of optimal conditions to maximize hydrogen generation.	Dry anaerobic reactors were set up to perform co-digestion of different waste mixtures, properly prepared in specific proportions for this type of treatment. These different mixtures were subjected to various operational conditions, and a comparison was made between them to identify the best co-digestion efficiency and hydrogen yield.
8 - Rebosura M., Jr.; Salehin S.; Pikaar I.; Sun X.; Keller J.; Sharma K.; Yuan Z.	A comprehensive laboratory assessment of the effects of sewer-dosed iron salts on wastewater treatment processes.	Anaerobic digestion; Dewaterability; Integrated urban water system; Iron salt dosing; Sequencing batch reactor; Sewer system.	Anaerobic digestion.	Digestate sludge.	Investigate the effects of iron salt dosing in wastewater on the wastewater treatment processes.	Iron salts were applied to wastewater and sewage sludge samples before anaerobic digestion, and the results obtained with and without iron salt dosing were compared to evaluate the impacts on the treatment processes.
9 - Rózsenberszki T.; Koók L.; Bakonyi P.; Nemestóthy N.; Logroño W.; Pérez M.; Urquizo G.; Recalde C.; Kurdi R.; Sarkady A.	Municipal waste liquor treatment via bioelectrochemical and fermentation (H2 + CH4) processes: Assessment of various technological sequences.	Biogas; Biohydrogen; Microbial fuel cell; Multi-stage process; OFMSW; Wastewater.	Anaerobic digestion, dark fermentation and Microbial Fuel Cells – MFCs.	Liquid fraction of municipal solid waste.	Maximization of organic matter removal and energy recovery.	Fermentation, anaerobic digestion, and microbial fuel cell processes were carried out using the liquid fraction of municipal solid waste to produce biohydrogen, biogas, and electricity. Tests were conducted with various process combinations to determine the most efficient sequence for organic matter removal and energy recovery.
10 - Kong Z.; Li L.; Wu J.; Wang T.; Rong C.; Luo Z.; Pan Y.; Li D.; Li Y.; Huang Y.; Li Y.-Y.	Evaluation of bio-energy recovery from the anaerobic treatment of municipal wastewater by a pilot-scale submerged anaerobic	Anaerobic digestion; AnMBR; Carbon neutrality; Energy recovery; Municipal	Anaerobic digestion.	Municipal wastewater	Evaluate bioenergy recovery from the anaerobic treatment of municipal wastewater using a pilot-scale submerged anaerobic membrane bioreactor (AnMBR).	Biogas production through the treatment of municipal wastewater using a pilot-scale submerged anaerobic membrane bioreactor (AnMBR), evaluating the bioreactor's performance through COD removal efficiency and the amount of biogas produced.

membrane bioreactor (AnMBR) at ambient temperature.	wastewater; Pilot-scale.

Table S2.

Main characteristics and results of the ten articles selected (Source: Scopus).

Results and Conclusion	Economic dimension	Environmental dimension	Social dimension	Governance dimension
1 - The study showed that with the thermal pre-treatment process, there was an increase in biogas production and methane proportion during anaerobic digestion of activated sludge, leading to an increase in methanogenic and hydrolytic bacteria. It concluded that the pre-treatment temperature is a critical parameter and should be optimized to maximize the benefits in biogas production.	**Value Added and Decoupled Growth:** Economic benefits generated by the increased efficiency and productivity of biogas production, achieved through the optimization of pre-treatment temperature, implying a cost-benefit analysis that considers the pre-treatment costs relative to the gains in energy production.	**Energy and Carbon Cycle**: Reduction of greenhouse gases and replacement of fossil fuels through increased biogas production and methane proportion; **Resources and Recycling:** The anaerobic digestion of urban and industrial waste mentioned in the article promotes the recycling of organic waste, converting it into biogas and digestate, which can be used as fertilizer. **Pollution Risks and Safety:** Reduction of environmental pollution through anaerobic digestion.	**Access to Energy and Resources:** The production of biogas provides an alternative energy source, improving access to energy in areas that use urban and industrial waste for biogas production	**Policy Commitment and coherence:** The article presented the approach that incentive policies, such as subsidies and tax incentives, are fundamental to attracting investments and supporting the development of biogas infrastructures. **Standards and certification:** The study showed that well-defined regulatory frameworks are necessary to ensure the quality and safety of biogas and biomethane. This includes regulations for the injection of biomethane into natural gas grids and the use of digestate as fertilizer.
2 - The study showed that the biogas generated from municipal solid waste and food waste contained the highest levels of toxic compounds compared to the biogas generated from cow manure. It concluded that the type of substrate has a significant impact on the chemical composition and toxicity of the produced biogas, suggesting the need for proper control and treatment of combustion products, even when dealing with waste containing lower concentrations of chemical compounds, as observed in the biogas generated from cow manure, to minimize negative impacts on public health and the environment.	**Value Added and Decoupled Growth:** Possibilities of financial implications associated with the economic viability and operational costs of biogas plants, resulting from the optimization of biogas production from different substrates.	**Energy and Carbon Cycle:** Reduction of greenhouse gas emissions through biogas production: **Resources and Recycling**: The production of biogas involves the use of waste as raw material, promoting the recycling of organic waste. **Pollution Risks and Safety:** The toxicity analysis of the combustion products generated, helps in identifying the pollution risks associated, contributing to efforts to improve air quality and environmental health.	**Access to Energy and Resources:** The production of biogas can improve access to renewable energy sources, contributing to a more sustainable energy matrix. **Health and safety:** Indirect improvement of public health through the analysis of the chemical composition and toxicity of the types of biogas generated aims to ensure safety for human health, benefiting communities near biogas production plants.	**Policy Commitment and coherence:** The article presented the approach that incentive policies, such as subsidies and tax incentives, are fundamental to attracting investments and supporting the development of biogas infrastructures.
3 - The results showed a high yield of methane in the biogas produced from anaerobic digestion of food waste, and the combustion process resulted in emissions of nitrogen oxides (NOx) and particulates. The emission analysis demonstrated a reduction in greenhouse gases compared to usual fossil fuels, concluding that anaerobic digestion of food waste is a viable technology for renewable energy production. However, pollutant emissions during combustion still need to be addressed to minimize impacts on air quality. Emission control technologies are suggested to mitigate the environmental impacts of biogas combustion.	**Value Added and Decoupled Growth:** The production of biogas from food waste can create economic value by transforming waste into a renewable energy source, contributing to more sustainable economic growth	**Energy and Carbon Cycle:** Reduction of greenhouse gases through the use of renewable energy and the suggestion of food waste management. **Resources and Recycling**: The use of food waste for biogas production promotes the recycling of organic waste, converting it into energy and fertilizers **Pollution Risks and Safety:** Implications for air quality related to biogas production, including the assessment of potential pollutants emitted during the anaerobic digestion process.	**Access to Energy and Resources**: The production of biogas can improve access to renewable energy sources, providing a sustainable alternative for communities.	**Stability and rule of law:** The study suggests the need for policies and regulations to control pollutant emissions from biogas combustion, guiding governance in the implementation of biogas technologies.

4 - The results of CO_2-based processes were compared with conventional production routes to evaluate the environmental benefits and drawbacks, concluding that there is potential to significantly reduce greenhouse gas emissions compared to conventional alternatives, provided there is an increase in the use of abiotic resources. Additionally, the use of wind energy contributes to achieving good environmental outcomes for the process.	**Trade and technology transfer:** Evaluation of trade-offs between the reduction of GHG emissions and the increase in the use of abiotic resources. **Energy Mix and Transformation:** The production of fuels and chemicals from CO2 can be integrated into the existing energy mix, contributing to the energy transition towards more sustainable sources.	**Energy and Carbon Cycle:** Reduction of greenhouse gas (GHG) emissions through the use of CO_2 as a raw material. **Resources and Recycling:** The life cycle analysis includes the assessment of resource utilization in the production of methane, methanol, and derived polymers, as well as the recycling options for the final products. **Pollution Risks and Safety:** The study addresses the environmental impacts related to the production and use of methane, methanol, and polymer derivatives, including potential emissions and pollutants.	**Access to Energy and Resources:** The production of methane and methanol from CO2 can provide access to new sustainable energy resources, benefiting communities and industries.	No cluster was addressed.
5 - The production costs of synthetic methane were calculated, considering different sources of CO_2 and hydrogen. The environmental analysis results showed that CO_2-based processes can significantly reduce GHG emissions compared to conventional methods. It was noted that there is a need to evaluate the overall sustainability of the process due to the higher scale use of abiotic resources in CO_2-based processes compared to conventional methods. Each scenario from one of the CO_2 sources used in the study provided a different perspective on trade-offs between economic efficiency and environmental impact. "Although the study showed that the cost of the Power-to-Gas route for methane production is higher compared to methane from conventional sources, it was seen that the focus on sustainability and the reduction of GHG emissions would justify the use of these technologies in the future. Public policies should consider these environmental benefits to support the implementation of these technologies through incentives and favorable regulations, even when the direct economic benefits are not immediately apparent.	**Value Added and Decoupled Growth:** The economic analysis considers the potential for generating economic value through the production of gas from electricity, promoting sustainable economic growth. **Trade and technology transfer:** Analysis of synthetic methane production costs in different scenarios, detailing production costs and comparing them with conventional methane, as well as informing the related economic trade-offs. **Energy Mix and Transformation:** The production of hydrogen and methane from electricity can be integrated into the existing energy mix, contributing to the diversification and transformation of the energy matrix. **Investment and public finance**: The article addresses the economic feasibility and necessary investments for the implementation of power-to-gas projects, including costs, returns, and financial support.	**Energy and Carbon Cycle:** Mitigation of GHG emissions, reduction of ecological impacts such as acidification and eutrophication, and reduction of the carbon footprint of the process. **Resources and Recycling:** The analysis considers the efficiency of resource use in the power-to-gas process, including the utilization of excess electricity and integration with other energy systems. **Pollution Risks and Safety:** The article assesses the environmental impacts of gas production from electricity, including potential emissions and pollutants during production, storage, and transportation.	**Access to Energy and Resources:** The production of gas from electricity can improve access to sustainable energy sources, benefiting communities and industries. **Jobs and skills:** The implementation of power-to-gas technologies can create new jobs and require new skills, contributing to local economic development.	No cluster was addressed.
6 - Electro-oxidation (EO) showed the highest efficiency, with a 28% COD solubilization under optimal conditions and up to a 78% increase in biogas production compared to untreated sludge. The thermo-alkaline pre-treatment (TA) method followed, with up to a 40% increase in biogas production. Concluding that the TA also proved effective, although with a smaller increase in biogas production compared to EO.	Indirectly addressed through **Value Added & Decoupled Growth:** The potential reduction of operational costs and increased economic viability of waste treatment plants through the increased efficiency in biogas production. **Energy Mix & Transformation:** The production of biogas from activated sludge can be integrated into the existing energy mix, contributing to the diversification of the energy matrix and the transition to cleaner energy sources.	**Energy and Carbon Cycle:** Reduction of environmental impacts through improved anaerobic digestion efficiency, resulting in higher biogas production and better waste management. **Resources and Recycling**: The use of activated sludge as a raw material for biogas production promotes the recycling of organic waste, transforming it into energy and useful products such as digestate.	**Access to Energy and Resources:** The production of biogas from waste can improve access to renewable energy sources, benefiting local communities and industries. **Jobs and skills:** The implementation of pretreatment and anaerobic digestion technologies can create new jobs and require new skills, contributing to local economic development.	No cluster was addressed.

7 - The mixtures achieved high levels of hydrogen production, concluding that optimizing the operational conditions of dry anaerobic co-digestion of OFMSW with paper mill sludge and gelatin waste can lead to a significant increase in hydrogen production, contributing to more efficient organic waste management and renewable energy production.	**Value Added & Decoupled Growth:** Improvement of the economic viability of waste management processes and renewable energy production through the increased hydrogen production by co-digestion. **Energy Mix & Transformation**: The production of hydrogen from waste can be integrated into the existing energy mix, contributing to the diversification and transformation of the energy matrix towards cleaner sources	**Energy and Carbon Cycle:** The production of hydrogen through anaerobic digestion, as discussed in the study, is a form of renewable energy that can potentially replace fossil fuels and contribute to the reduction of greenhouse gas emissions. **Resources and Recycling:** The co-digestion of municipal solid waste, paper sludge, and gelatin solid waste promotes the recycling of organic materials, converting them into bioenergy and useful byproducts such as digestate. **Pollution Risks and Safety:** Co-digestion improves the biodegradation efficiency of carbohydrates, proteins, and lipids, resulting in a significant reduction of pollutants in the treated waste.	**Access to Energy and Resources:** Improvements in waste management and hydrogen production as a renewable energy source contribute positively to public health and community well-being. **Health and safety:** Anaerobic digestion, especially under thermophilic conditions, is highlighted for its pathogen disinfection capability, contributing to public health.	No cluster was addressed.
8 - The results showed that after the addition of iron salts to wastewater and sewage sludge samples before anaerobic digestion, there was an increase in biogas production during sludge anaerobic digestion, as well as improved removal of sulfides and eutrophication problems in receiving water bodies due to phosphorus control. It concluded that there was greater biogas production and better removal of contaminants due to the improved efficiency of wastewater treatment processes because of iron salt dosing in the samples, proving to be an effective strategy to optimize anaerobic digestion.	**Value Added & Decoupled Growth:** Economic efficiency in wastewater treatment facilities with reduced disposal and handling costs of sludge, achieved by improving the dewaterability of anaerobically digested sludge. **Energy Mix & Transformation**: Increased biogas production efficiency through the reduction of H_2S in the biogas.	**Energy and Carbon Cycle:** Improvement in air quality due to the reduction of hydrogen sulfide (H_2S) emissions in biogas, resulting from the dosing of $FeCl_3$ in the sewage system, which reduces the concentration of dissolved sulfide in sewage and anaerobically digested sludge. **Resources and Recycling:** Nutrient recycling with the elimination of eutrophication in water bodies through the removal of phosphorus during wastewater treatment with the addition of iron salts. **Pollution Risks and Safety:** Reduction of environmental risks associated with wastewater disposal through the improvement of treated effluent quality by removing pollutants such as sulfides and phosphates from sewage using $FeCl_3$.	**Access to Energy and Resources:** The improvement in treated water quality through the effective removal of phosphorus and sulfides benefiting the communities around wastewater treatment plants. **Health and safety:** The reduction of odor problems associated with wastewater treatment, resulting from the decrease of H_2S in biogas and, enhances working conditions and public acceptance of treatment facilities.	No cluster was addressed.
9 - The results showed that the microbial fuel cell (MFC) method achieved the highest COD removal efficiency, being the most effective in terms of wastewater cleaning compared to the digestion and fermentation methods, with the latter being the least efficient in terms of organic matter treatment. In terms of energy gain, the fermentation process was the most efficient. It concluded that a three-stage approach (hydrogen fermentation, anaerobic digestion, and MFCs) is necessary to maximize both organic matter removal and energy recovery, recommending the combination of hydrogen fermentation followed by biomethanation and MFCs for greater effectiveness.	**Value Added & Decoupled Growth:** The production of biogas and hydrogen from municipal waste can add economic value by transforming waste into useful energy resources, promoting sustainable economic growth **Energy Mix & Transformation:** Diversification and transformation of the energy matrix towards cleaner sources through the production of hydrogen and methane from waste. **Investment and public finance:** The study evaluates the economic viability of waste treatment and energy recovery technologies through specific energy gain data and the efficiency of the different processes presented in the study.	**Energy and Carbon Cycle:** The study addresses the production of hydrogen (H_2) and methane (CH_4) through fermentation and bioelectrochemical processes, contributing to the reduction of fossil fuel use and greenhouse gas emissions **Resources and Recycling:** Recycling waste and recovering energy resources through the use of liquid fractions of municipal solid waste for energy production promotes a circular economy and sustainable resource management. **Pollution Risks and Safety:** Reduction of pollutant load in treated effluents through improved removal of organic matter with anaerobic and bioelectrochemical treatment.	**Access to Energy and Resources**: Improving access to sustainable energy sources through the production of hydrogen and methane from waste, benefiting local communities and industries. **Health and safety:** The reduction of odor problems associated with wastewater treatment, resulting from the decrease of H_2S in biogas and, enhances working conditions and public acceptance of treatment facilities.	No cluster was addressed.

10 - The bioreactor demonstrated high efficiency in COD removal from municipal wastewater and bioenergy recovery through significant biogas production, concluding that it is an effective solution for municipal wastewater treatment and bioenergy recovery.	**Value Added & Decoupled Growth:** Generation of renewable energy through the production of biogas from wastewater, adding economic value and promoting sustainable economic growth. Economic efficiency with the use of AnMBR, which has superior energy efficiency compared to the conventional activated sludge (CAS) process, resulting in energy savings and reduced operational costs **Energy Mix & Transformation:** Diversification of the energy matrix and reduction of dependence on fossil fuels through the integration of biogas produced by AnMBR into the existing energy mix.	**Energy and Carbon Cycle:** The substitution of fossil fuels with biogas produced in the bioenergy recovery process from anaerobic treatment of municipal wastewater contributes to the reduction of greenhouse gas emissions. The use of AnMBR is considered a carbon-neutral technology due to carbon capture in the produced biogas, promoting environmental sustainability. **Resources and Recycling:** Anaerobic digestion of wastewater promotes the recycling of organic waste, converting it into biogas and digestate, which can be used as fertilizer. **Pollution Risks and Safety:** The reduction of pollutant load in treated effluents due to the high efficiency of COD (chemical oxygen demand) removal in AnMBR, contributing to the improvement of water quality.	**Access to Energy and Resources:** The production of biogas from municipal wastewater can improve access to renewable energy sources, benefiting local communities and industries. **Health and safety:** The reduction of odor problems associated with wastewater treatment, resulting from the decrease of H2S in biogas and, enhances working conditions and public acceptance of treatment facilities.	No cluster was addressed.

Table S3.

Map of Co-authorship by Country (Source: Created by authors).

Country	Number of documents	Citations
China	14	279
United Sates	8	292
Turkey	7	134
Australia	8	242
Canada	7	142
Germany	7	179
Spain	7	181
Italy	5	79
Poland	9	81

Table S4.

Detailing the Clusters of Co-occurrence of Author Keywords (Source: Created by author).

Author's Keywords	Cluster	Nº of Occurrence
Anaerobic digestion	1	24
Biogas	2	20
Biohydrogen	3	7
Methane	4	6
Municipal wastewater	5	5
Hydrogen sulfide	6	4
Biomethane	7	2

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