The Role of AI Technology in Biogas Production to Fulfill SDG Goals: Systematic Review

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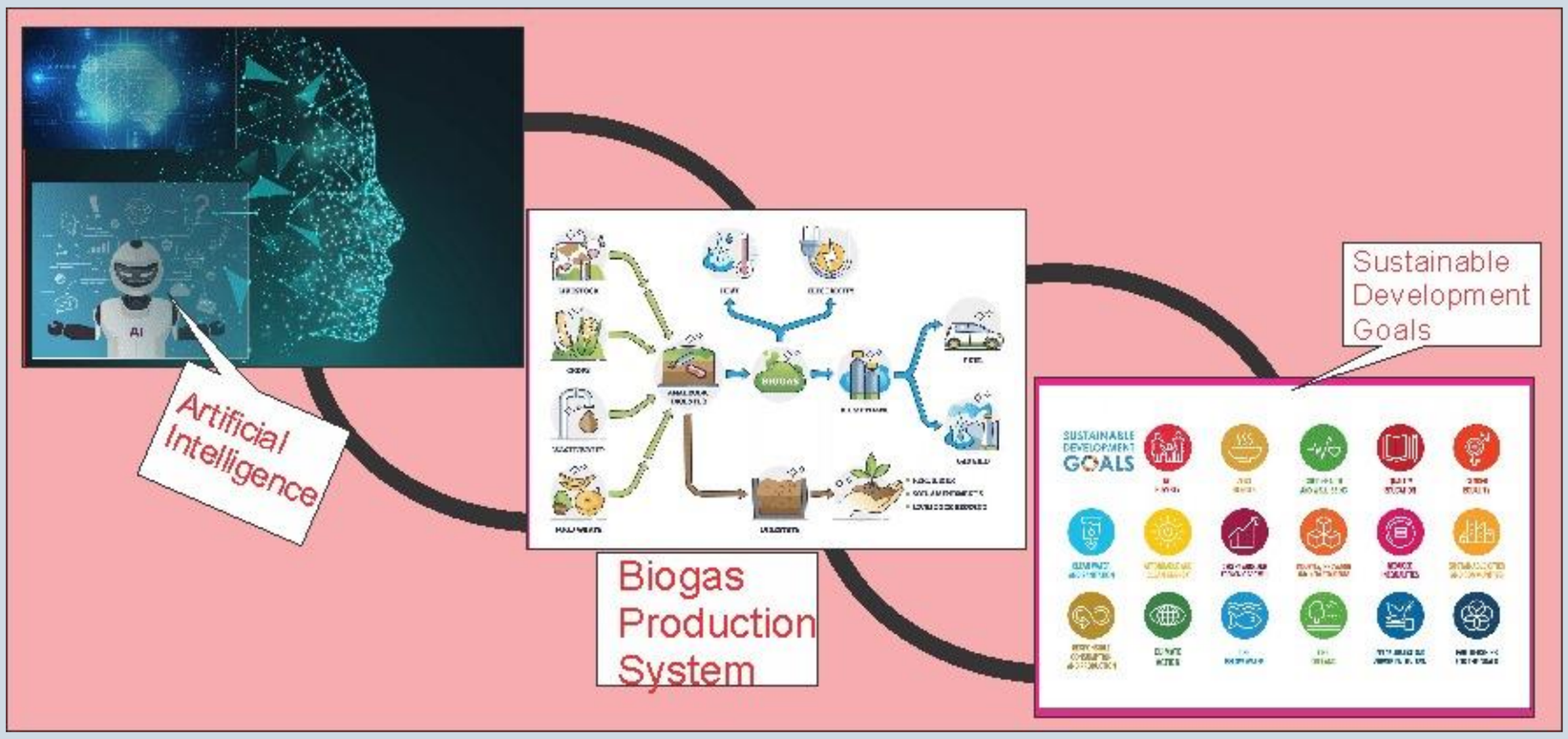
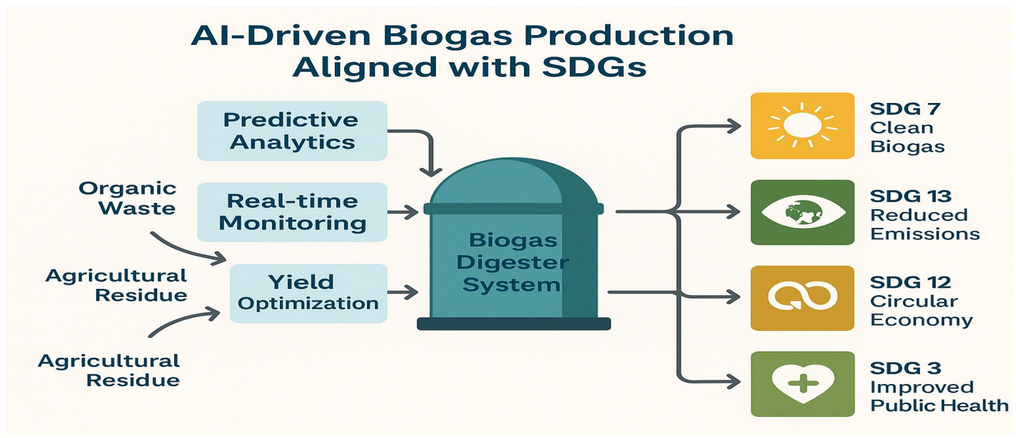


AI technologies significantly optimize biogas production processes and are key enablers in achieving Sustainable Development Goals (SDGs) through improved efficiency, resource management, and environmental sustainability.

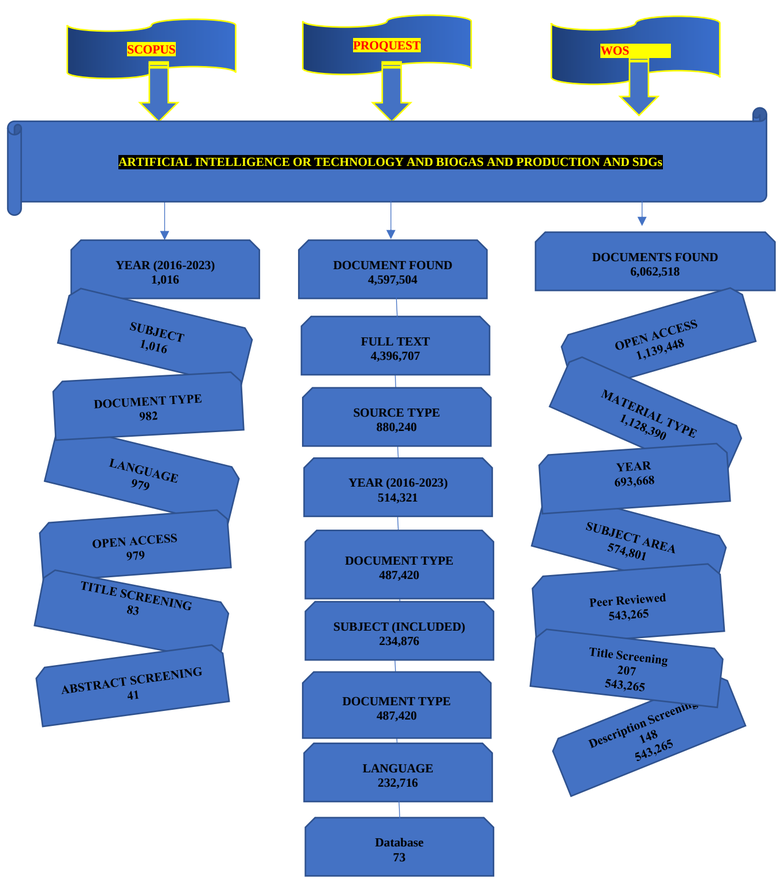
Introduction

Biogas is an environmentally friendly natural gas produced by anaerobic digestion of organic materials [Atelge et al. 2022]. It comprises trace amounts of carbon dioxide, methane, and other gases. Biogas production plays a vital role in the transition toward clean and sustainable energy. However, traditional methods often face limitations in efficiency, monitoring, and scalability. This study presents a systematic review of how **Artificial Intelligence (AI)** is transforming biogas systems by enhancing process control, optimizing feedstock utilization, and supporting data-driven decision-making. By aligning with the **Sustainable Development Goals (SDGs)**, AI-integrated biogas technologies offer a promising pathway toward **energy security**, **waste reduction**, and **climate resilience**.



Methodology

The Preferred Reporting Items for Systematic Literature Review (SLR) and Meta Analysis, PRISMA, opined by [12] (2009), was used for this study.



Results/Discussion

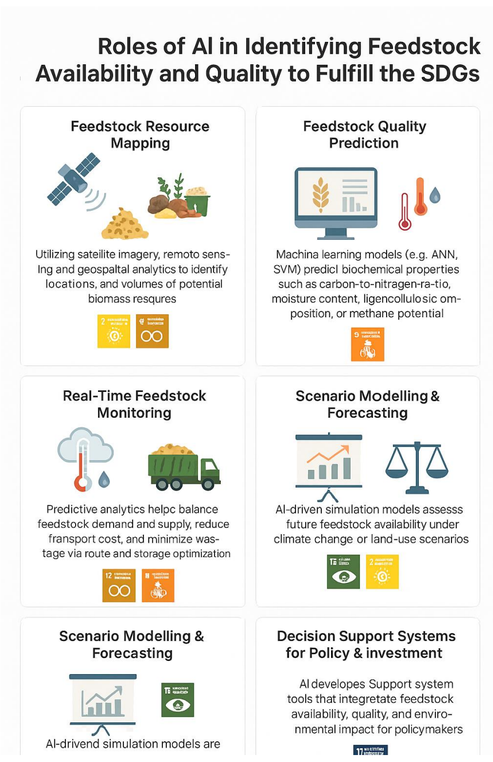


TABLE 1. SOME COMMON AI TECHNIQUES USED IN THE BIOGAS PRODUCTION PROCESS

SN	AI Technique Adopted	Author
1	Random Tree (RT) Random Forest (RF)	[Shahsavar et al. 2021]
2	Artificial Neural Network (AN N) Adaptive-Network-based Fuzzy Inference System (ANFIS)	[Abu-Qdais et al. 2023]
3	GasSim 2.5: A model for simulating gas generation and migration in landfills, LandGEM: A model used for landfill gas estimation Mexico Landfill Gas model V2 (MLFGM V2): A model specifically mentioned for use in context of Mexican landfills	[Abu-Qdais et al. 2023
5	Process Simulation of Hydrothermal Cabonization (HTC) using Aspen Plus Software.	[Villarroel-Schneider et al. 2022]
4	MicroGridsPy	[Sharma et al. 2023]
5	Propensity Score Matching (PSMT)	[Ahmad et al. 2023]

TABLE 2. ROLES OF AI IN IDENTIFYING FEEDSTOCK AVAILABILITY AND QUALITY

Role of AI in Identifying Feedstock Availability and Quality	Author
Optimisation, Prediction, Control Systems and Integration.	[Shahsavar et. 2021]
Pattern Recognition, Data Analysis, Optimization, and Monitoring	[Sharma et al. 2023]
Determinants Analysis, Welfare Impact Assessment, Feedstock Optimization, aned Suggestions for Policy Implementation	[Ahmad et. 2023]
Optimization, Resource Efficiency, Environmental Benefits and Economic Feasibility	[Misrol et al. 2022]

The systematic findings from 73 articles establish the role of AI in identifying feedstock availability and quality, predicting biogas production, and monitoring biogas production processes to answer research questions related to SDG fulfillment, informed decision-making, and anomaly detection.

Conclusion

The review emphasizes AI's capacity to enhance biogas production, refine process monitoring, and advance sustainable waste management, thereby aiding the United Nations Sustainable Development Goals through the reduction of greenhouse gas emissions.

References

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