Electrohydrolysis as a strategy to unlock biomethane production from concentrated waste-activated sludge

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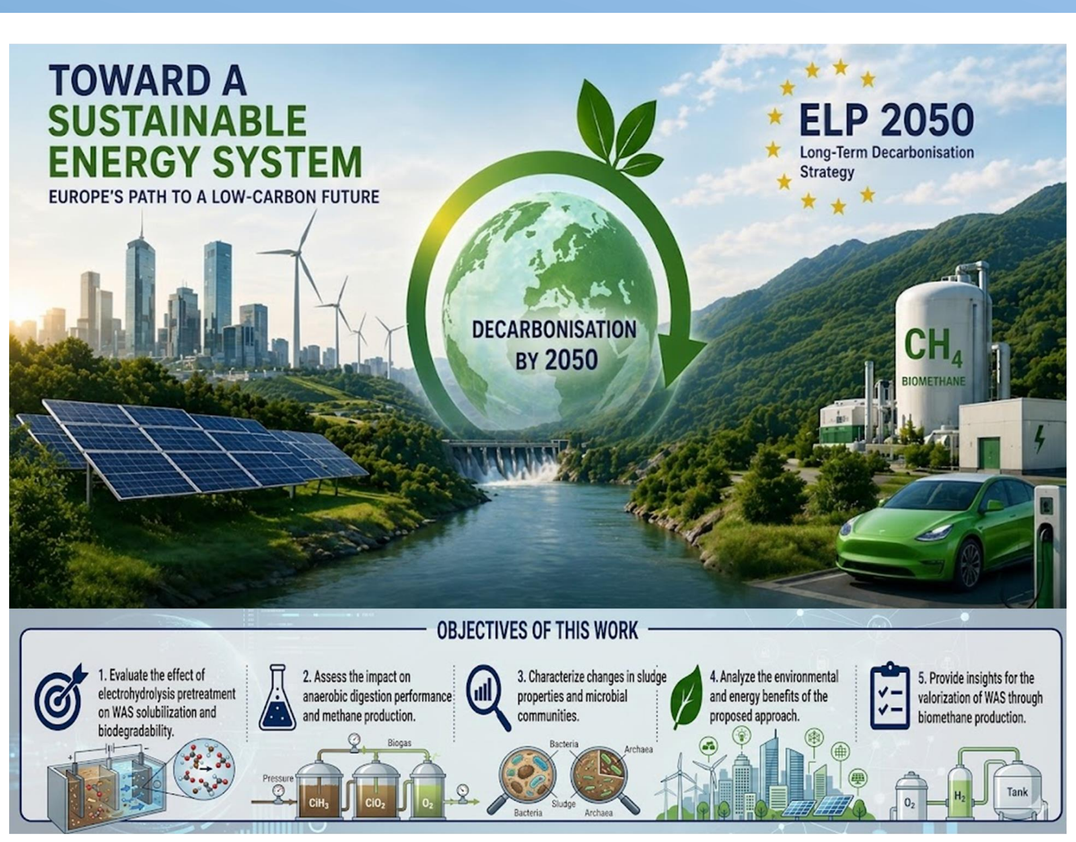
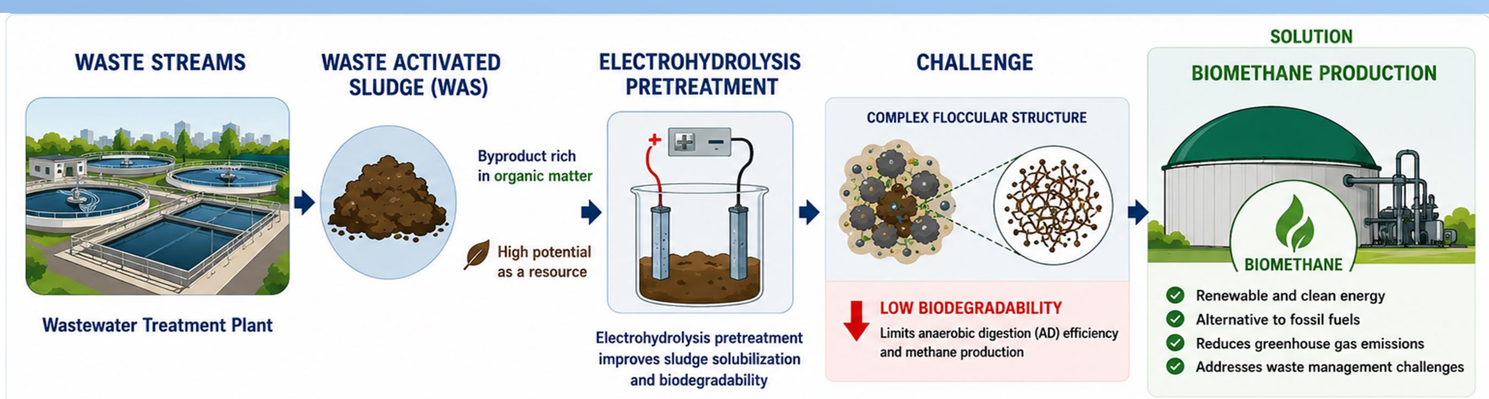
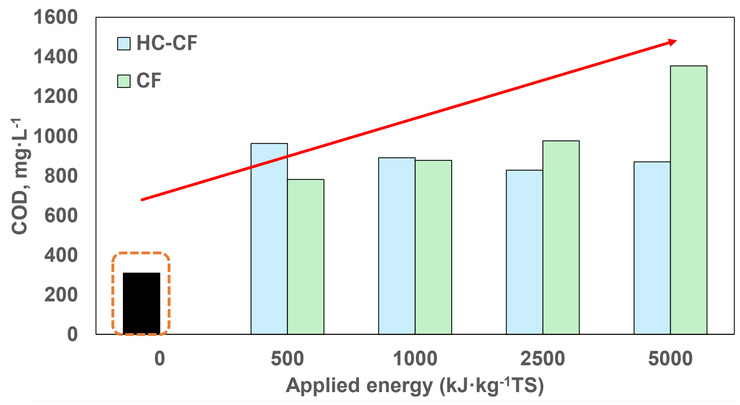
INTRODUCTION



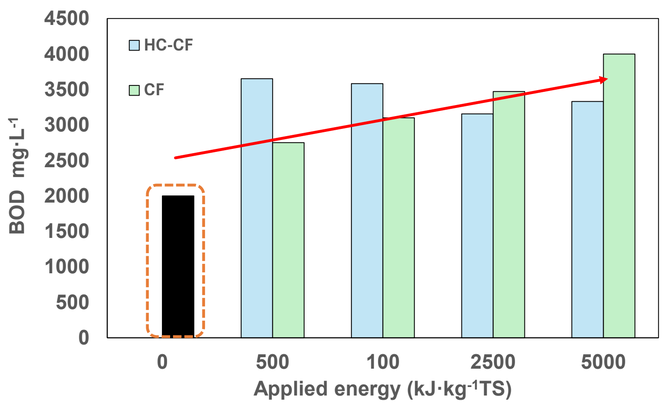


RESULTS

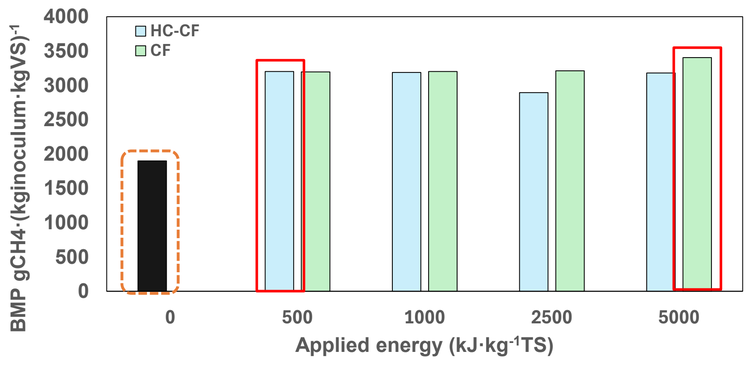
Solubilization



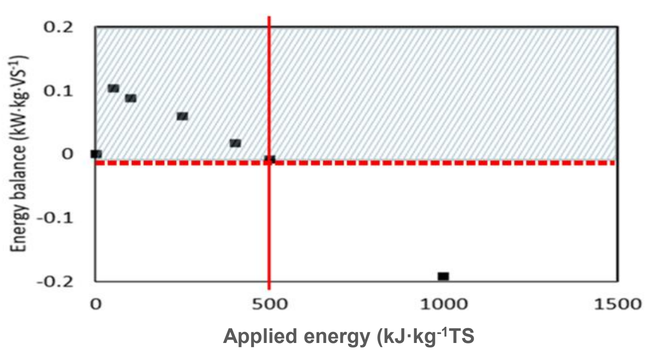
Biodegradability



Biochemical methane production



Energy Balance



EH pretreatment improved organic matter solubilization and biodegradability, as shown by ↑ soluble COD, BOD_5, and DDCOD. This was supported by EPS disruption and ↓ sludge particle size, enhancing substrate accessibility for anaerobic microorganisms.

The highest disintegration degree (**3.80% ± 0.01**) was achieved using carbon felt electrodes at **15 mA·cm^{-2}**.

CF showed the greatest BMP increase (**+79.27%**), while HC-CF performed better at low energy inputs (**+68.61%**).

Optimal conditions: 1000 kJ·kg^{-1} TS and 0.35-0.4 A.

Methane production followed the modified Gompertz model (R^2 **= 0.95-0.99**), confirming data reliability.

At low energy input, HC-CF achieved higher methane yields than CF, but this advantage decreased at higher energy levels, likely due to mass transfer limitations.

Increasing current density improved BMP, although its effect became marginal at high energy inputs.

Key insight: Moderate energy input is sufficient to maximize methane production.

Overall, EH pretreatment is a feasible strategy for biomethane generation.

CONCLUSIONS

- EH pretreatment significantly enhances anaerobic digestion performance, enabling efficient valorization of waste activated sludge (WAS) for biomethane production.
- Electrode properties and current density are key parameters, directly influencing methane yield and process predictability.
- Lower energy inputs combined with higher current densities optimize treatment efficiency, while the modified Gompertz model reliably predicts AD performance.

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