Zero GHG. Innovative technologies for E-fuel production from the CO_2 from waste to energy (WtE)

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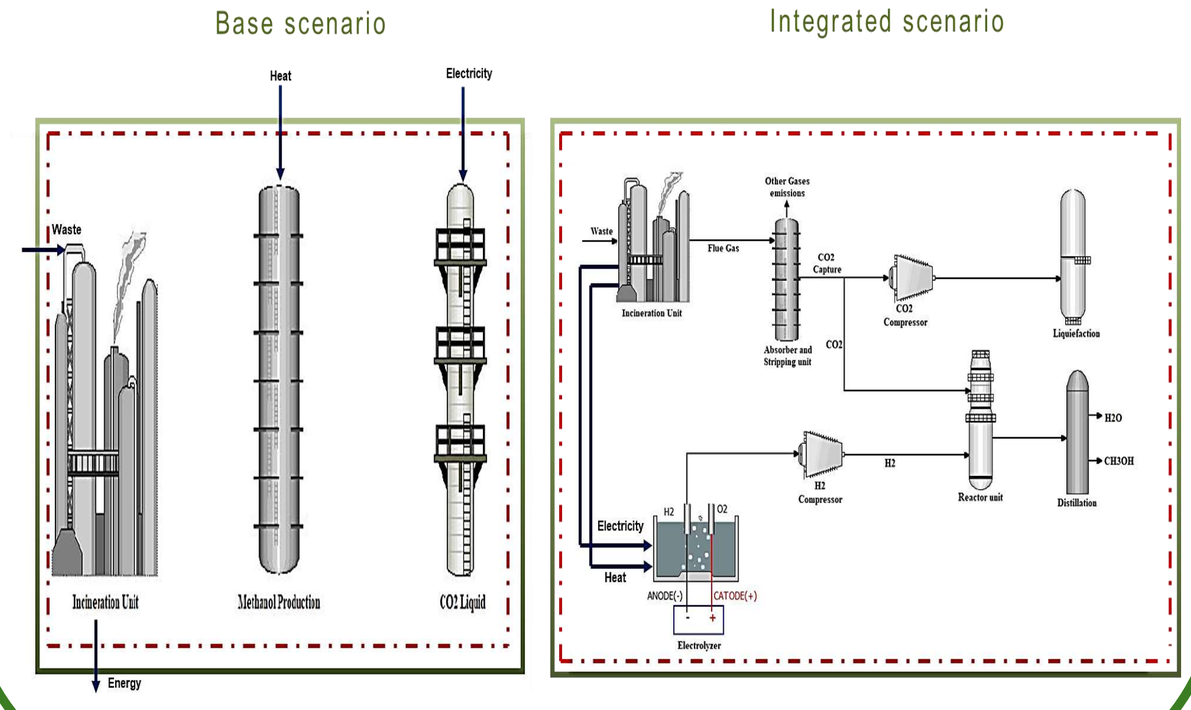
Objective

The primary objective of this study is to investigate the environmental impacts through the lens of LCA when capturing CO_2 emissions from a waste-to-energy (WtE) plant to produce methanol and liquid CO_2 for industrial purposes. This study will evaluate an integrated approach and compare it to a reference scenario where WtE, methanol production, and CO_2 production are conducted individually using state-of-the-art market technologies. These studies offer long-term benefits by enhancing efficiency and energy generation. LCA is increasingly crucial for assessing the environmental performance of solid waste management systems.

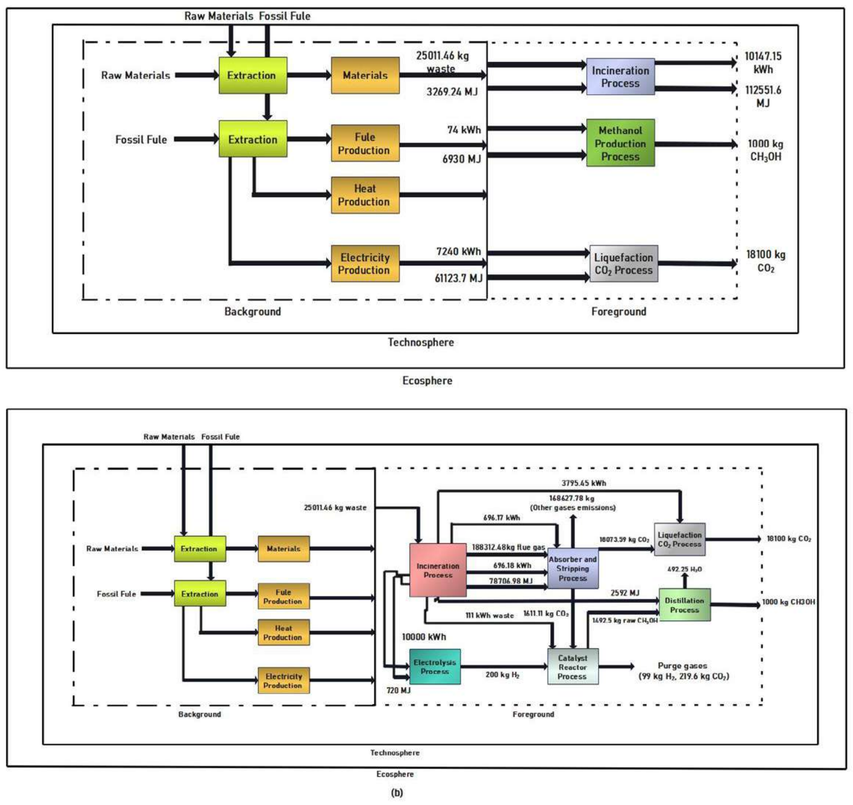
Methodology

The methodology for this study involves using a Life Cycle Assessment (LCA) approach to evaluate the environmental impacts of capturing CO_2 emissions from a waste-to-energy (WtE) plant to produce methanol and liquid CO_2 for industrial uses. The study compares an integrated scenario, where CO_2 capture, methanol production, and CO_2 production are combined, against a base scenario where these processes are conducted independently using existing market technologies. The WtE facility processes municipal solid waste to generate electrical and thermal energy, which are then utilized for CO_2 capture through a monoethanolamine (MEA) absorption process, and for producing methanol via a catalytic reaction with hydrogen produced by alkaline electrolysis. The study adheres to ISO 14040 standards, encompassing goal and scope definition, life cycle inventory (LCI), impact assessment, and interpretation stages. Data are compiled from the Ecoinvent database and direct measurements, with Monte Carlo simulations used for uncertainty analysis to provide robust environmental impact evaluations .



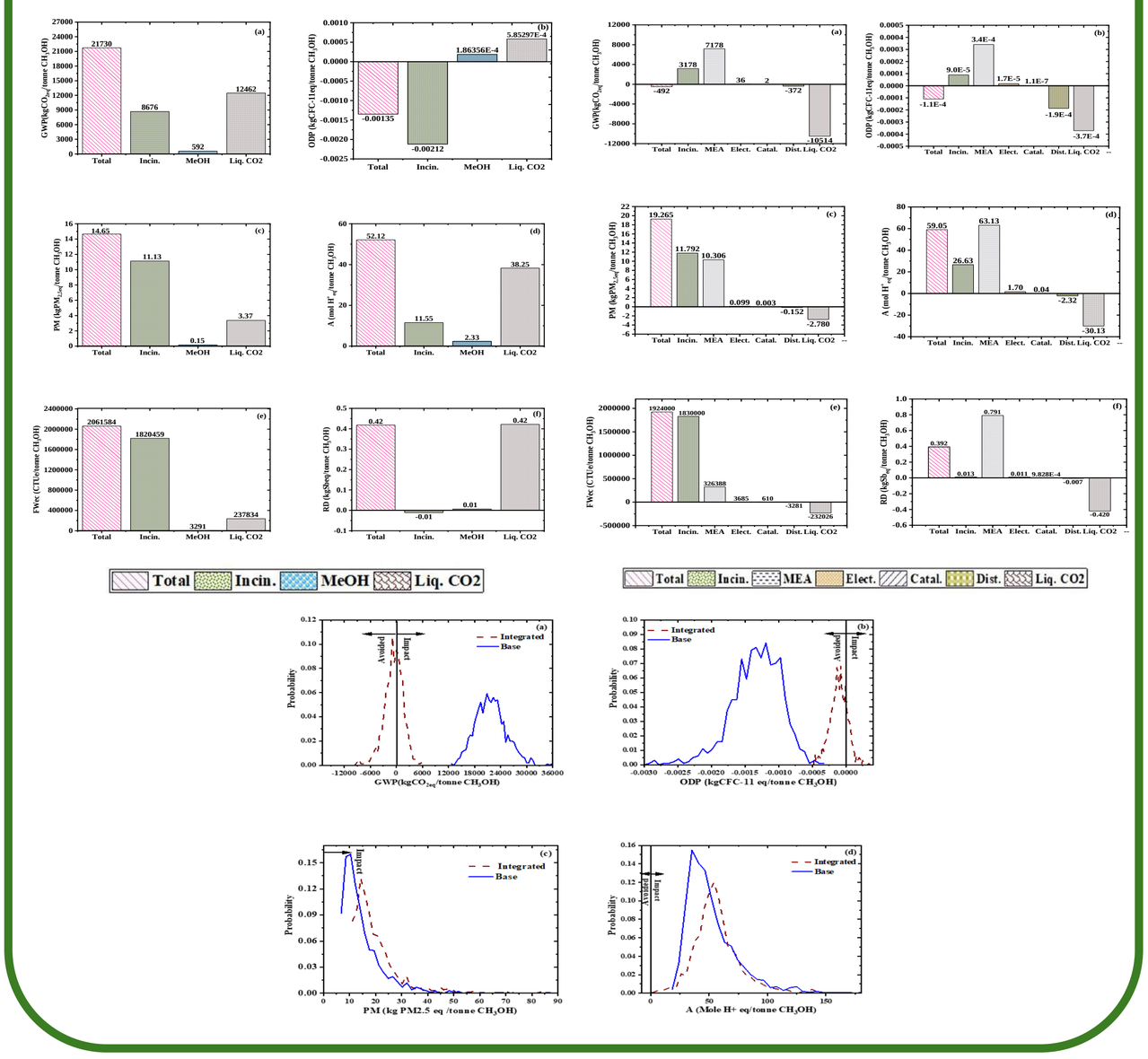
Life Cycle Assessment

The Life Cycle Assessment (LCA) for this study evaluates the environmental impacts of capturing CO2 emissions from a waste-to-energy (WtE) plant to produce methanol and liquid CO2. The assessment follows ISO 14040 standards, including goal and scope definition, life cycle inventory (LCI), impact assessment, and interpretation. The study compares an integrated scenario, where CO2 capture and methanol production are combined, against a base scenario with separate processes. Data are sourced from the Ecoinvent database and direct measurements, and Monte Carlo simulations are used to analyze uncertainties, ensuring robust and reliable results.



Results

The study concludes that integrating CO_2 capture and utilization within the waste-to-energy (WtE) framework significantly reduces CO_2 emissions and supports the EU's goals for a circular and carbon-neutral economy. The integrated system demonstrates environmental benefits, including lower global warming potential, while maintaining similar impacts on particulate matter, acidification, freshwater ecotoxicity, and resource depletion compared to conventional methods. This approach highlights the potential for sustainable waste management and renewable chemical production, suggesting future research to optimize the process and assess its economic feasibility.



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