**MARMARA UNIVERSITY**

**FACULTY OF ENGINEERING**

**ENVIRONMENTAL ENGINEERING DEPARTMENT**

**ENVE 4197/4198 ENGINEERING PROJECT**

**PROPOSAL FORM**

**FALL 2024-2025**

|  |
| --- |
| **Instructor : Prof. Dr. Barış ÇALLI****Project Title :** Estimating the Carbon Footprint Reduction through Diverting Organic Waste from Landfilling to Anaerobic Digestion**Proposal No. :** BarisCalli*-*1 **Number of Students :** Maximum of 3 students**Requirements (from students):** Students should have basic computer application skills, a strong interest in data search and analysis, and basic knowledge about anaerobic digestion of municipal solid waste (Enve3030) |
| **Scope of the Project :**The proposed project aims to perform a comprehensive carbon footprint analysis of anaerobic digestion (AD) processes used for treating organic municipal solid waste (OMSW). The study will evaluate greenhouse gas (GHG) emissions throughout the entire lifecycle of the AD system, including waste collection, transportation, pre-treatment, digestion, biogas production, and post-treatment of digestate. The project will focus on identifying key emission hotspots and quantifying the potential of AD in reducing GHG emissions compared to traditional waste management methods such as landfilling or incineration. Special attention will be given to the energy recovery from biogas and the environmental benefits of diverting organic waste from landfills. This analysis will provide valuable insights into improving the sustainability of municipal waste management systems and help guide decision-makers toward low-carbon waste treatment solutions. |
| **Hardware/Software/Lab/Equipment Requirements :**Open/Free or student version of * Carbon Accounting Software: To calculate carbon footprint (OpenLCA, CCaLC: Carbon Calculations over the Life Cycle, GaBi Education)
* Emission Calculation Tools: To quantify GHG emissions (EPA’s WARM Model, EPA’s GHG Equivalency Calculator, GREET Model)
* Energy Modeling Tools: To assess energy recovery (HOMER Energy, RETScreen, GREET)
* Standards: ISO 14067:2018 Greenhouse gases - Carbon footprint of products - Requirements and guidelines for quantification
 |
| **Development Plan :****Work Package 1: Scenario Definition*** Define different waste management scenarios to be evaluated:
	+ Scenario 1: Current landfilling practice with LFG energy recovery (baseline).
	+ Scenario 2: AD with energy recovery (electricity)
	+ Scenario 3: AD with biogas upgrading (biomethane).
* Identify necessary data for each scenario (e.g., waste input, emissions, energy consumption, biogas yield).
* Determine data sources from literature and/or municipal waste data.

**Work Package 2: Carbon Footprint Calculation:*** Quantify the carbon footprint (CO₂-eq emissions) of each scenario, considering:
	+ Direct emissions (e.g., CO₂, CH₄, N₂O).
	+ Indirect emissions (e.g., transportation, energy use).
* Assess energy recovery and digestate management practices.
* Incorporate biogas upgrading and energy recovery to estimate net GHG emissions reductions.

**Work Package 3: Scenario Comparison & Sensitivity Analysis:*** Compare the carbon footprint across scenarios to identify which AD approach offers the highest environmental benefits.
* Conduct sensitivity analysis to test the robustness of the results under varying conditions (e.g., transportation distance, waste composition changes).

**Work Package 4: Reporting*** Final Report:
	+ Compile results into a detailed report, including carbon footprint calculations, scenario comparisons, and sensitivity analysis.
	+ Include visual aids like carbon footprint graphs, flow charts, and scenario comparisons.
* Recommendations:
	+ Provide actionable recommendations for municipalities or policy-makers on the optimal use of AD for organic municipal solid waste based on the carbon footprint analysis.
 |