



Smart Modular Biogas Plant: Sustainable Energy from Organic Waste

Hamad Almunea - CHE

Abdullah Alturaif - CHE

Coach: Muhammad Siddiquee

Sahal Alkhayat - ME

Abdulrahman Alobaid - ISE

Abdulsalam Alsuhaibani - ISE

TEAM: 76

Introduction

Homeowners face a problem with managing organic waste and reducing energy bills. So, for eco-conscious homeowners who want a sustainable way to turn waste into energy, our Biogas System is a home energy solution that provides clean biogas for cooking and heating. Unlike traditional disposal methods, the system features smart monitoring and solar heating for improved efficiency and adaptability.

Problem Statement:

Current challenges:

- Organic waste management for households, farmers, and campers in Saudi Arabia.
 - Lack of affordable and modular biogas systems.
- Demand:
- Affordable, eco-friendly, and versatile biogas plant.
 - Efficient conversion of waste into cooking gas and electricity.

Constraints and Specifications:

Constraints	Specifications
Monthly operational costs: SR 400	Reactor size reduced to 30 kg for portability
Maximum footprint: 10 m ²	Provides at least 10 hours of cooking per batch
Daily electricity consumption : < 3 kWh	Digester's Temperature at 30–40°C
Shutdown period < 3 weeks per year	pH level range of 6.5–8

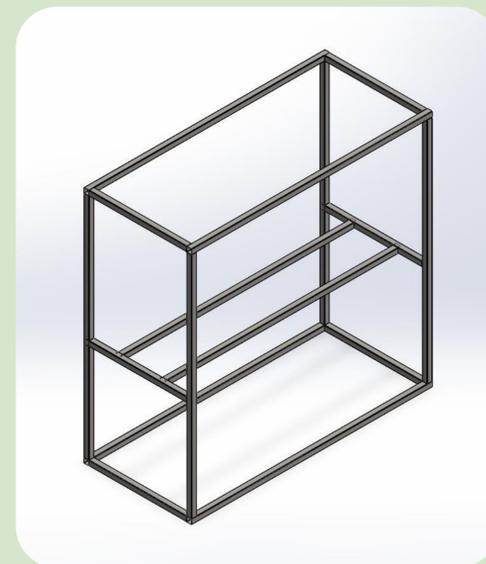
Prototype Design



The Prototype

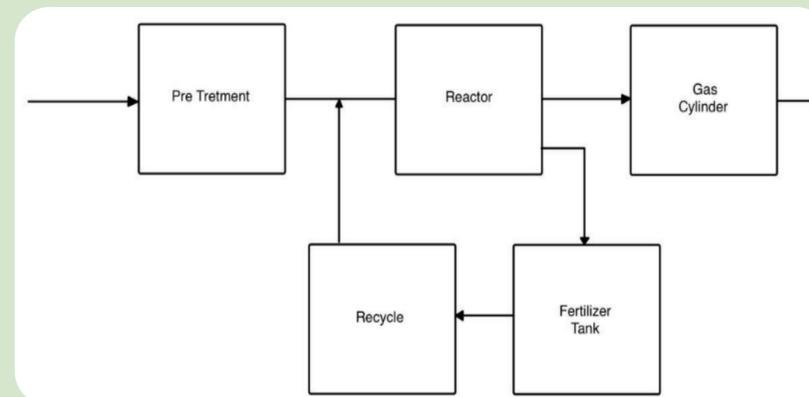
Our prototype of the Smart and Modular Home Biogas Plant showcases small-scale anaerobic digestion technology, converting organic waste into biogas for household use and fertilizer for sustainable agriculture. Controlled heat and pH optimize the process.

- Provides clean biogas for household use
- Produces eco-friendly fertilizer
- Operates with optimized conditions



System Frame

- Displays the modular and portable design of the biogas plant structure.
- Supports ease of assembly and transportation.



- Pre-Treatment: Prepares organic waste for digestion.
- Reactor: Converts waste into biogas and fertilizer.
- Recycle: Handles unused materials for reprocessing.
- Fertilizer Tank: Stores fertilizer for agriculture.
- Gas Cylinder: Stores purified biogas for household use.

Testing / Validation

Daily electricity consumption : < 3 kWh

Power available: 4 panels * 4 hr * 370 W = 2960 Whr

Part	Power
Pump	$Power = \frac{Q \cdot H \cdot \rho \cdot g}{efficiency} = 1630 \text{ Whr}$
Heating Pads	20 Whr
Grinder	120 Whr

Remaining Power: 2960 – 1630 – 1200 - 20 = **110 Whr**

Target Specification	Met
Reactor size reduced to 30 kg for portability	<input checked="" type="checkbox"/>
Provides at least 10 hours of cooking per batch	<input checked="" type="checkbox"/>
Digester's Temperature at 30–40°C	<input checked="" type="checkbox"/>
pH level range of 6.5–8	<input checked="" type="checkbox"/>

Conclusions

This innovative project transforms organic waste into clean energy using smart, modular technology, offering a sustainable and cost-effective solution for households, farmers, and various users, shaping a greener and more energy-efficient future.