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IARCO RESEARCH PROPOSAL

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Research Topic: Harnessing Food Waste through Anaerobic Digestion as a Sustainable Source of Emergency Energy in Disaster-Prone Philippine Communities

Harnessing Food Waste through Anaerobic Digestion as a Sustainable Source of Emergency Energy in Disaster-Prone Philippine Communities

Abstract

The Philippines frequently experiences natural disasters such as typhoons, floods, and earthquakes, which displace thousands of people and force them into evacuation centers with limited resources. These facilities typically lack reliable electricity and cooking fuel, creating challenges for disaster response and recovery. At the same time, relief operations, while aiming to distribute food rapidly, still generate unavoidable food waste due to packaging residues, meal preparation, and uneaten portions. This study will explore the feasibility of using food waste from relief packs as feedstock for anaerobic digestion to produce biogas as a sustainable emergency energy source. A self-conducted digester will be constructed using an airtight container and a dextrose tube hose set. Relief-like food waste samples will undergo anaerobic fermentation, and gas production will be assessed qualitatively by observing buildup in the tubing and testing combustibility through a controlled ignition trial. The study is expected to demonstrate that food waste can be transformed into usable biogas, presenting a low-cost and environmentally sustainable solution to address both waste management and energy scarcity in disaster-prone Philippine communities.

Introduction

The Philippines is among the most disaster-prone countries in the world, ranking first in the World Risk Index 2025 due to its high exposure to typhoons, floods, earthquakes, and volcanic eruptions [1]. On average, 20 tropical cyclones enter the Philippine Area of Responsibility annually, many of which cause widespread displacement [2]. Displaced families are accommodated in evacuation centers, which often lack sufficient energy resources such as electricity and cooking fuel [3].

While relief operations led by the Department of Social Welfare and Development (DSWD) are designed to provide immediate food support, food waste still occurs within evacuation centers due to factors such as food preferences, dietary restrictions, partial consumption, and packaging limitations [4]. Improper disposal of food waste contributes to methane emissions and sanitation issues [5]. Anaerobic digestion is a microbial process that breaks down organic matter in the absence of oxygen, generating biogas as a renewable energy source [6], [7].

This study will investigate the feasibility of converting food waste from relief goods into biogas using a low-cost, self-conducted anaerobic digester. By doing so, the research will provide a potential dual solution: reducing food waste while supplying a supplementary energy source during disasters.

Research Problem

Disasters in the Philippines displace thousands of people into evacuation centers where energy resources are scarce. Although relief packs meet immediate food needs, food waste remains inevitable due to uneaten items, cooking residues, and preparation losses. This waste is generally discarded, creating sanitation concerns and greenhouse gas

emissions instead of being used productively. The dual challenges of energy scarcity and unmanaged food waste highlight the need for innovative, low-cost, and community-based solutions. This study will therefore examine whether food waste from evacuation centers can be processed through anaerobic digestion to generate biogas as a sustainable emergency energy source.

Existing Literature

Anaerobic digestion is widely studied as a sustainable waste-to-energy process. Food waste is particularly effective for biogas production due to its high carbohydrate, fat, and protein content [7], [8]. Previous studies emphasize its potential in agricultural and household contexts [9]. However, most disaster energy research has focused on solar and wind solutions [11], leaving a gap in exploring food waste-to-biogas approaches within evacuation centers.

In the Philippines, research has documented challenges in food consumption and nutrition management during disasters, highlighting that mismatched or uneaten relief food contributes to waste [4]. At the same time, international studies confirm that uncontrolled food waste disposal produces methane and sanitation risks [5]. While community-based biogas systems have been implemented in rural areas globally, their adaptation to disaster contexts remains underexplored.

Items commonly found in DSWD relief packs, which offer immediate food aid during disasters, include:

Table 1.

LIST OF RELIEF FOOD AND ITS POTENTIAL USE IN BIOGAS

Food Item	**Potential Use in Biogas**
Rice	High carbohydrate, good substrate
Canned goods	Protein source, contributes to methane production
Instant noodles	Carbohydrate-based, easily digestible
Biscuits	Carbohydrate-based, supplementary feedstock

Common relief food items for evacuation centers. Adapted from [10].

Previous studies on disaster energy systems have focused more on solar and wind power [11], with little emphasis on food waste utilization. This study intends to address this research gap while advancing sustainable disaster resilience measures in the Philippines by examining the conversion of rescue food waste into biogas.

Research Question

How can food waste from evacuation centers, through anaerobic digestion, be harnessed as a sustainable source of emergency energy in disaster-prone Philippine communities?

Methodology

Research Design

The research will utilize an experimental feasibility design and be carried out in a household environment. The experiment will determine whether anaerobic digestion of relief food waste can produce flammable gas.

Materials

- Relief-like food waste
- Airtight plastic container
- Dextrose tube hose set
- Water
- Adhesive/sealant materials
- Lighter or ignition source

Experimental Setup

The airtight plastic container will function as the digester. A dextrose tube hose set will be attached as the gas outlet, acting as a storage space in addition to a passage for gas release. All connections will be sealed with adhesive to maintain anaerobic conditions.

Sample Preparation

A slurry will be made by chopping or mashing relief-like food waste and adding water. After that, the slurry will be put inside the digester.

Anaerobic Digestion

The digester will be stored in a warm location for 1-2 weeks to allow microbial decomposition. The tube will be checked for indications of gas buildup or inflation during this time.

Observation and Ignition Test

Gas production will be confirmed if the tubing inflates. Once there is enough buildup, a small amount of gas will be released and exposed to a flame with a lighter. Combustibility will show whether biogas is present. Combustibility will indicate the presence of biogas.

Safety Considerations

Ignition trials will be conducted outdoors in a controlled space to prevent fire hazards. Only minimal gas quantities will be tested, and protective equipment (gloves, goggles) will be used.

Data Collection and Analysis

The study will collect qualitative observational data:

- Presence or absence of gas in the tubing.
- Combustibility of gas (ignition success or failure).
- Time duration until gas production is first observed.

Results will be described qualitatively and analyzed to determine the feasibility of using relief food waste as feedstock for biogas.

Experimental Design

Component	Description
Independent Variable	Type of food waste used (rice, noodles, canned goods, biscuits)
Dependent Variable	Gas production and combustibility
Controlled Variables	Airtightness, water ratio, retention time, temperature
Control Group	Digester with water only
Observation	Gas buildup in tubing and ignition test results

Conclusion

This study will assess the feasibility of converting food waste from relief packs into biogas using a self-conducted anaerobic digester with a dextrose tube hose set. Instead of measuring gas quantitatively, the study will focus on qualitative confirmation of gas production and combustibility. The expected outcome is to demonstrate that simple, low-cost setups can provide supplementary energy during emergencies. By addressing both waste management and energy scarcity, the study seeks to contribute to sustainable and community-based disaster resilience strategies in the Philippines.

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