Cost-Benefit Analysis between Source Separated Organic Material for Composting and Landfill Gas Collection System for an RNG Plant

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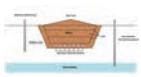
Abstract

Waste management has become a critical issue in today's world, particularly in the United States. The most common type of waste is Municipal Solid Waste (MSW), a byproduct of the urban lifestyle generated mainly by households. Popular waste management methods include composting, landfill disposal, incineration, and recycling. This study assesses the waste management system of a county based on economic, environmental, and sustainable aspects, using two methods: (i) the SSO composting operation, and (ii) the landfill with a gas collection system and an RNG plant.

Problem Statement

The municipality owned landfill has been operating since 1985. Both rural and industrial waste is fed into this landfill. The landfill will be Based on current projections, the landfill is expected to reach its capacity within nine years. In this study, it is determined that whether the county should proceed with (i) the SSO composting operation or (ii) the landfill with a gas collection system and an RNG plant.

SSO Composting Operation



Landfill Waste Management System

Objective

The Objectives of this project are

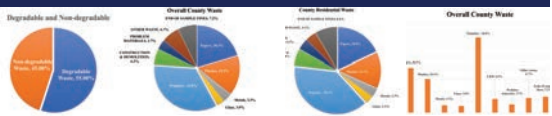
•Analyzing the cost-benefit ratio of both of the processes.

•Evaluating the environmental and economic benefits of the two approaches

•Proposing a suitable landfill gas reuse technology that will be cost-effective, profitable, and beneficial to the county.

Our company ReSTORE stands for Renovation for Sustainable Technology for Organic Waste Recycling toward Energy. The goal of our company is to maximize the utlization of a product by recycling waste into energy. To achieve maximum utilization of the waste from the given county, we need to consider a way where maximum benefit is reached without harming the environ ment and creating any problems in the process. Recycling and reusing is the primary motto of ReSTORE. In this study, the highest use of a product is ensured through recycling.

Data of Waste Composition

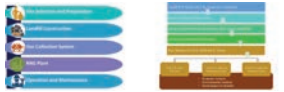


Methodology

For composting operation OrganEcs tool was used and 2 cases were considered depending upon the aeration. LFG Cost-Web tool c and landGEM models were used for cost analysis in landfill with an RNG project and 4 cases were considered depending upon the variation in optional input values. All of the tools were created by the US EPA.

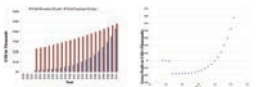
SSO Composting Operation

Landfill with a gas collection system and RNG plant

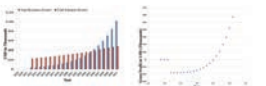


Result Analysis

SSO Composting Operation



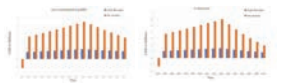
Without Forced Aeration



With Forced Aeration

The total revenue was higher than the total expenses only for the composting without forced aeration, even after the year 2045. Composting with forced aeration does not show any profit during the project timeline. Aeration requires extra cost.

Landfill with a gas collection system and RNG plant



Total Revenue and Net Income from RNG Project for (a) Convetional Landfill (b) Bio-reactor (c) Biocell

Cost- Benefit analysis of landfill with a gas collection system and a RNG plant was done for 3 different cases. Here three differenr RNG plant type is produced. Conventional, Bioreactor and Biocell. Different k values were assumed based on the literature Review. Bioreactor is the most beneficial approach.

Comparison

SSO Composting Operation

Strengths

- Reduced GHG emissions into the environment
- Improved waste reuse
- Simple technology
- Lower capital cost
- Low maintenance
- No high skilled labor

Weakness

- Sorting out organic waste
- Mixing the existing waste adds additional cost
- No leachate treatment
- No additional revenue

Composing Project

Opportunities

- New job opportunities
- Reduced demand for chemical fertilizer

Threats

- No gross profit
- Negative IRR
- Odor issue
- Social barriers to reusing waste as fertilizer for food crops

Landfill with a gas collection system and RNG plant

Strengths

- Advanced technology
- High LFG emission
- Reduced GHG emissions
- Immediate LFG production
- RN credits for fuel
- No additional leachate treatment in case of bioreactor
- Improved LFG reuse

Weakness

- High capital cost
- High-level expertise for construction and operation
- Greater maintenance cost

RNG Project

Opportunities

- High profit
- New job opportunities
- Higher IRR
- Low breakeven points
- Public acceptance
- High market demand for vehicle fuel

Threats

- Surplus or shortage of leachate
- Nuisance due to the construction and operation of a large plant
- Risk of accidents due to high temperatures
- Legal restrictions on gas emission

Recommendation

After careful consideration, ReSTORE recommends the county to build a new RNG plant with landfilling gas collection system due to significant IRR and net income. Bioreactors are a profitable option, with benefits such as faster LFG generation and odor removal, but contingency plans are needed for leachate management and temperature monitoring to prevent fire incidence and also mining cost need to be included.