Cost-Benefit Analysis between SSO Materials for Composting and LFG Collection for RNG Plant

March 2023

JSU 1877 JACKSON STATE UNIVERSITY

RESTORE

About Us

Renovation for Sustainable Technology for Organic Waste Recycling toward Energy (ReSTORE)

Mission Statement

Committed to reducing waste volume, decreasing greenhouse gas emissions, conserving nature, and combating the challenges of climate change

Problem Statement and Objectives

- Existing landfill site of the county is almost at full capacity
- Projected to reach capacity in the next 9 years
- County is planning for the next phase

Analyze the cost-benefit ratio of a new RNG plant and source separated organics and propose suitable landfill gas reuse technology

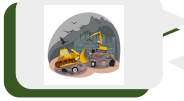
JSU JACKSON STATE UNIVERSITY

RESTORE

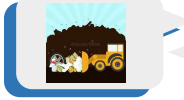
Waste Management Scenario of the County

Landfill Components: Household Hazardous Waste (HHW), Wood yard, C&D, Material Recovery Facility (MRF)

Accommodates all municipalities



Every municipality independently handles its waste and recycling program



County collects waste with collection trucks

55% degradable waste

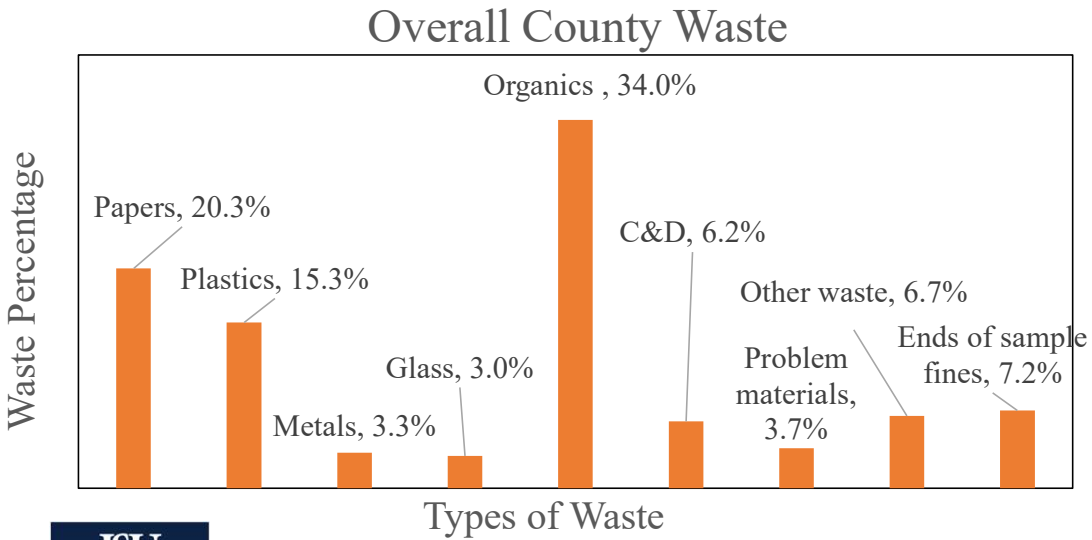
Non-degradable portion needs to be separated

JSU JACKSON STATE UNIVERSITY

RESTORE

Background Information

Landfill Opened	Year of Closure	Area	Area of Wellfield	Capacity
1985	2032	250 acres	79 acres	9.9 million ton

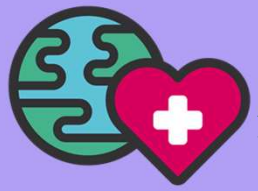


Renewable Natural Gas (RNG)

Biogas Produced from organic waste

Purified to remove impurities such as CO_2, H_2S

Renewable Energy Source



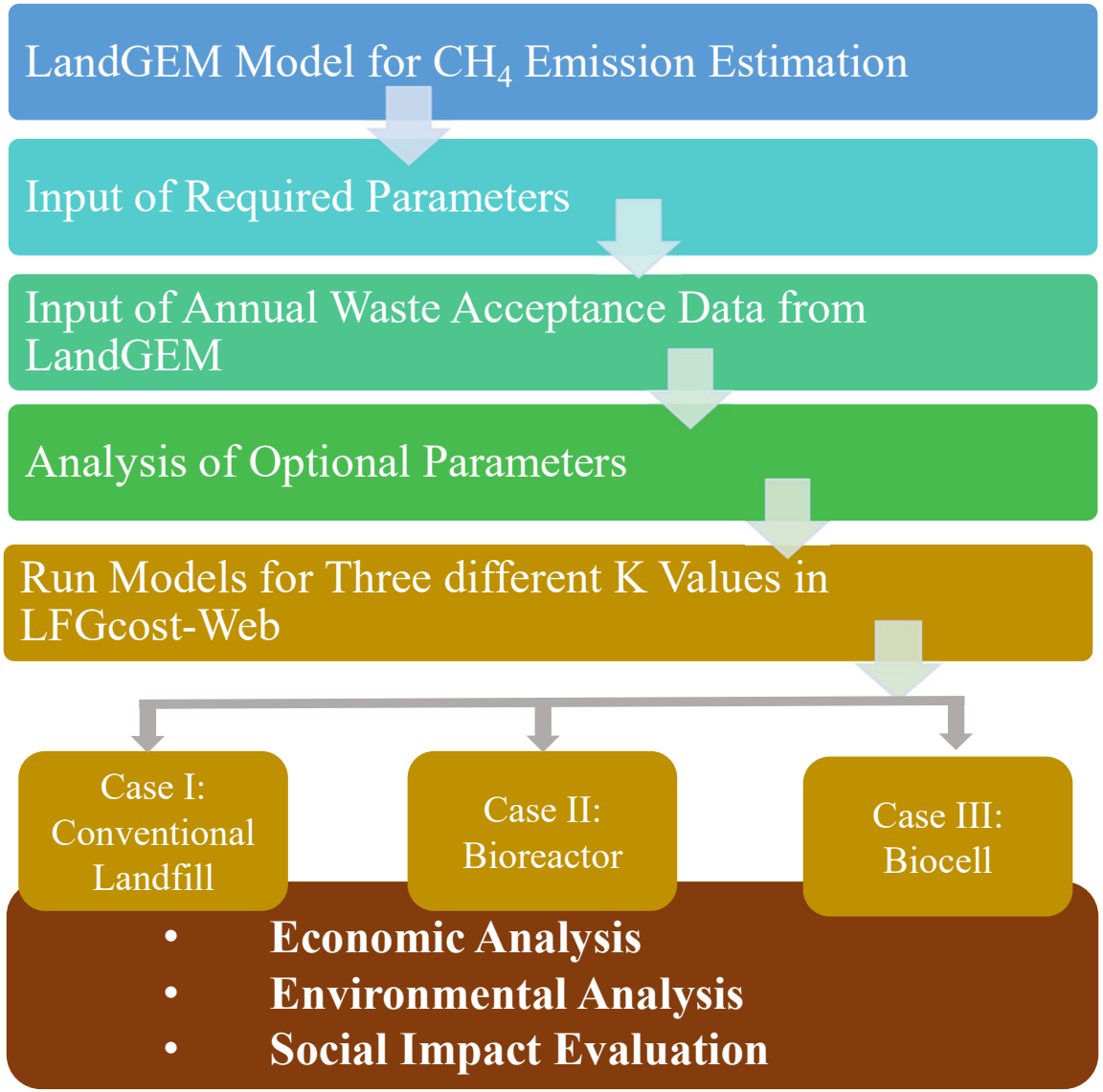
Carbon-negative Gas

Reduced Greenhouse Gas Emission and Waste

JSU JACKSON STATE UNIVERSITY

RESTORE

Analysis for RNG Project: Process Flow



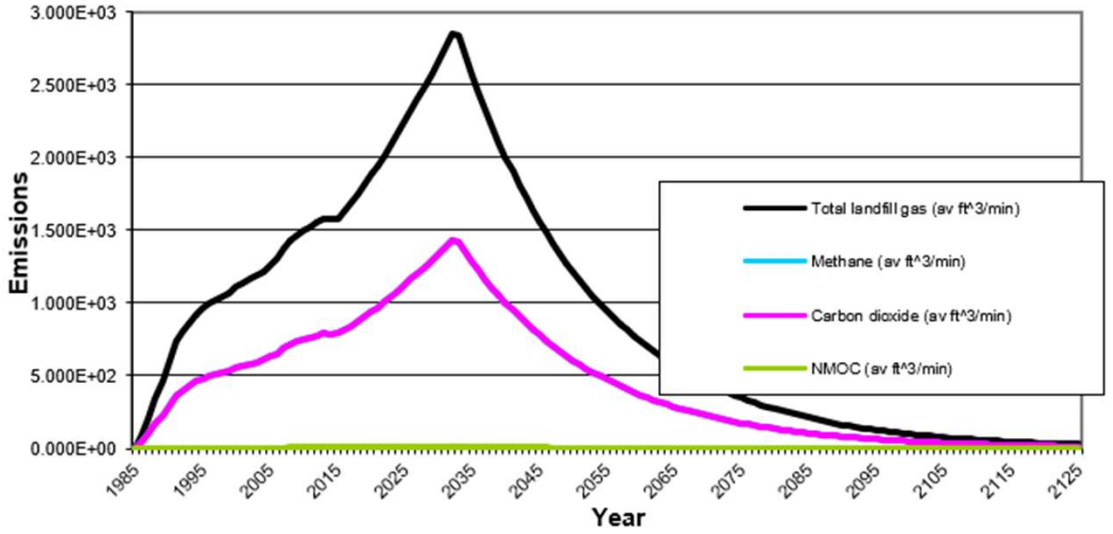
LandGEM Model for Methane Estimation

Equation used in the Model:

$$Q_{CH4} = \sum_{i=0}^{n} \sum_{j=0.1}^{1} k.L_0\left(\frac{M_i}{10}\right).e^{-k_{ti,j}}$$

More than 1000 ft^3/min

Result from the Model:



JSU JACKSON STATE UNIVERSITY

RESTORE

Different Cases considering K values

Case I

- Conventional Landfill
- K=0.05/year
- Based on rainfall of 37 in/year

Case II

- Bioreactor
- K=0.1/year

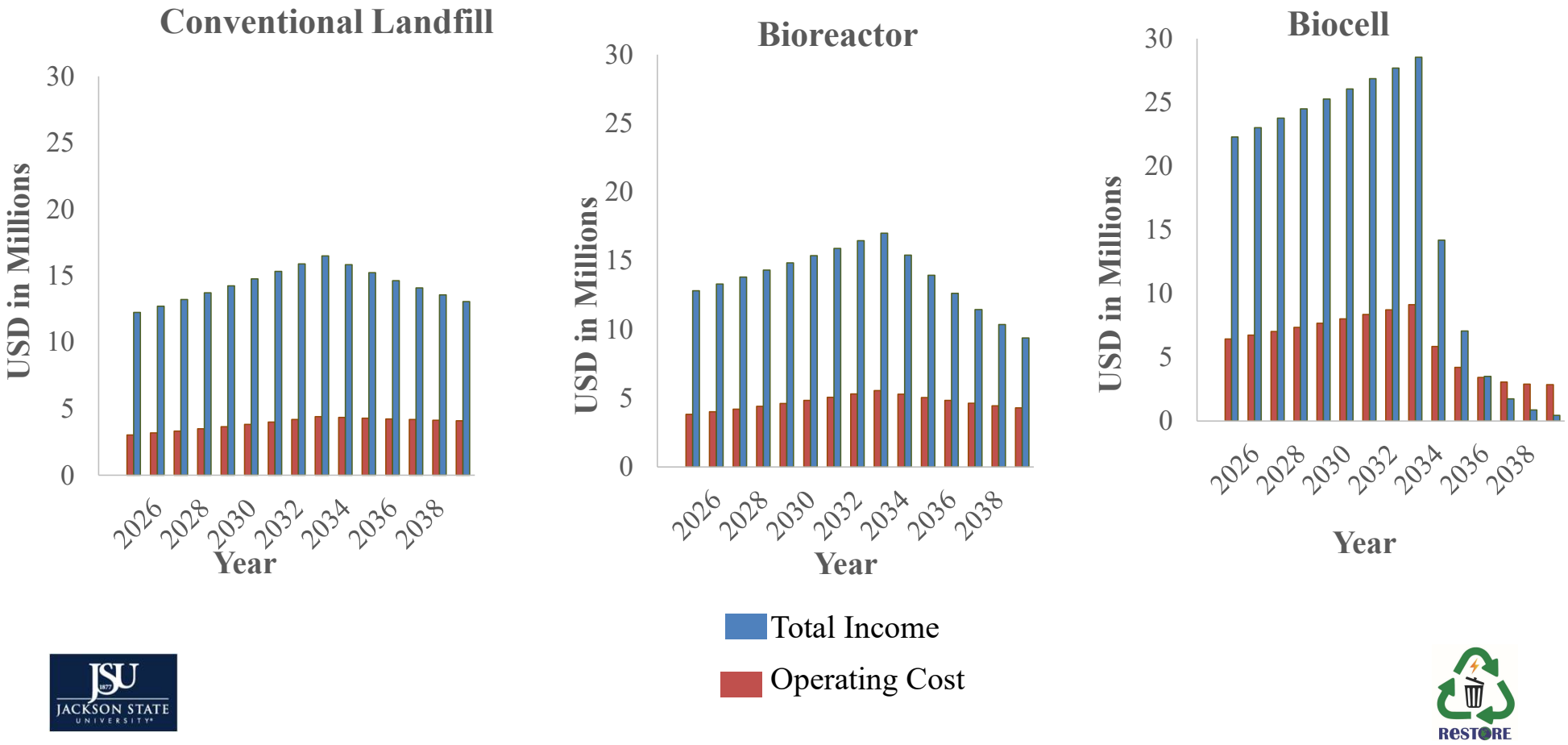
Case III

- Biocell
- K=0.7/year, maximum allowed
- Agricultural industry for cow manure

Economic Outputs

Output Type	Output Data		
	Case I (Conventional landfill)	Case II (Bioreactor)	Case III (Biocell)
Design project size (ft^3/min LFG)	2,824	3,618	**6,701**
Total installed capital cost (USD)	**27,136,002**	31,797,621	53,115,449
Internal rate of return	37%	**42%**	-31%
Years to breakeven	4	**3**	**3**

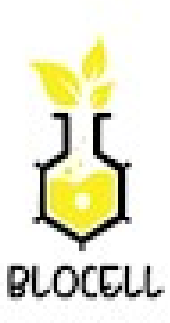
Economic Outputs



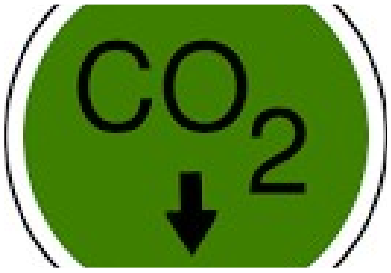
Evaluation of Economic Outputs

- Biocell gave the largest flow
- Capital cost for Biocell was highest due to the proportional relationship of capital cost and increased flow rate
- Internal rate of return (IRR) was highest for Bioreactor: 42%
- Renewable projects are capable of delivering an IRR of 12-16%
- Breakeven years of 3 to 4 years for all the cases were feasible for 15-year project
- Additional renewable credit increased the net income for conventional and bioreactor cases
- Total incomes were higher than the operating cost, throughout the project duration for conventional and bioreactor case

Evaluation of Environmental Outputs



Biocell case showed the best results



Significant removal of CO_2 emissions for all three cases

Collect 9000 million ft^3 of CH_4

Has the potential to reduce GHGs emissions by 75% compared to gasoline or diesel fuel

JSU JACKSON STATE UNIVERSITY

RESTORE

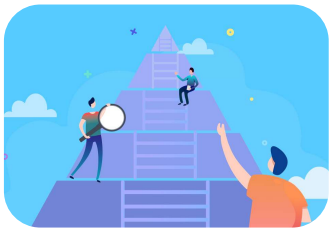
Evaluation of Social Impact

Job opportunities

Increased sale

Fresh revenue

Increased cash flow



Migration to the county

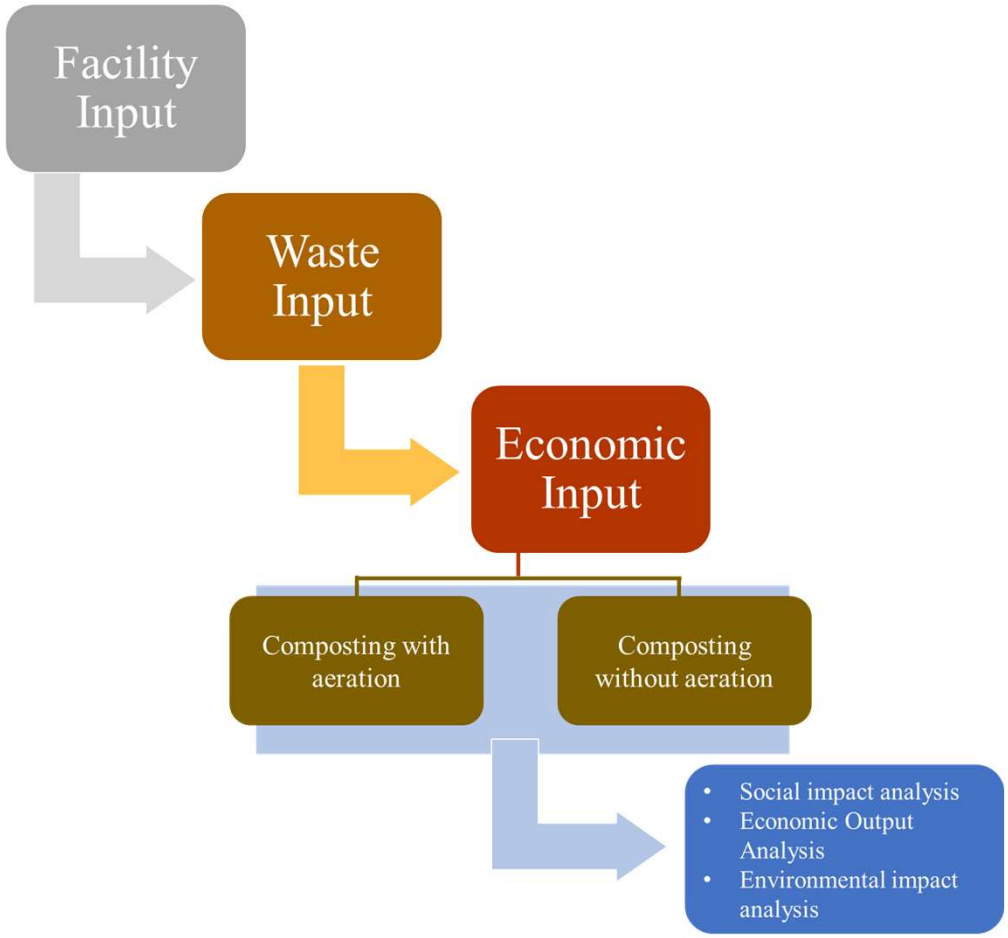
New business center

Improved public perception

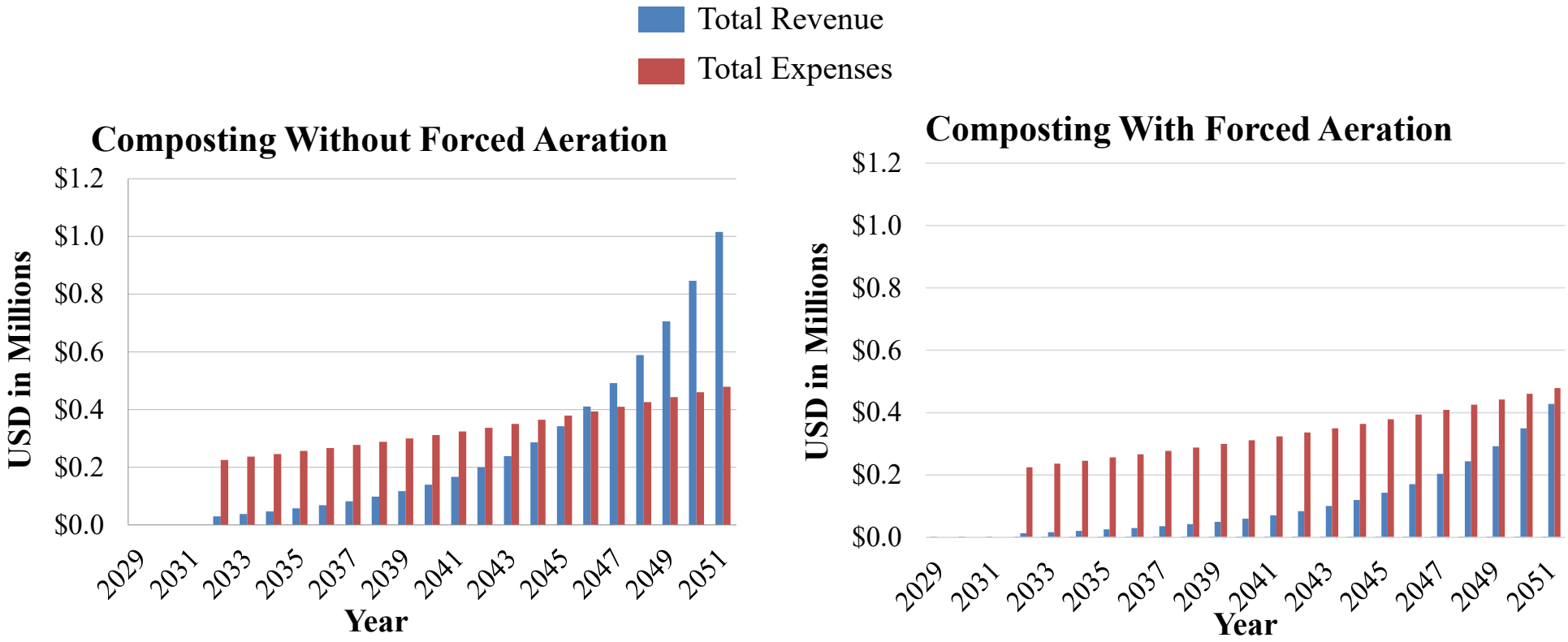
JSU JACKSON STATE UNIVERSITY

RESTORE

Analysis using OrganEcs Model



Economic Outputs from OrganEcs Model



JSU JACKSON STATE UNIVERSITY

RESTORE

Evaluation of Outputs for Composting

- IRR for forced aeration: −4%
- Forced aeration system will not be viable
- Total expense were higher than the total revenue
- System without aeration showed profit after 13 years
- Forced aeration system does not show any profit
- Additional mining and sorting out of organic waste will be required

JSU JACKSON STATE UNIVERSITY

RESTORE

Evaluation of Environmental Impact

Reduced use of chemical tilizers

Securing public health

Carbon capture

Reduced GHGs emissions

Less chemicals in waterbodies

JSU JACKSON STATE UNIVERSITY

RESTORE

Evaluation of Social Impact

Job opportunities

Improved agriculture

Cost reduction for food crops

Reuse of cow manure

Improved lifestyle

JSU JACKSON STATE UNIVERSITY

RESTORE

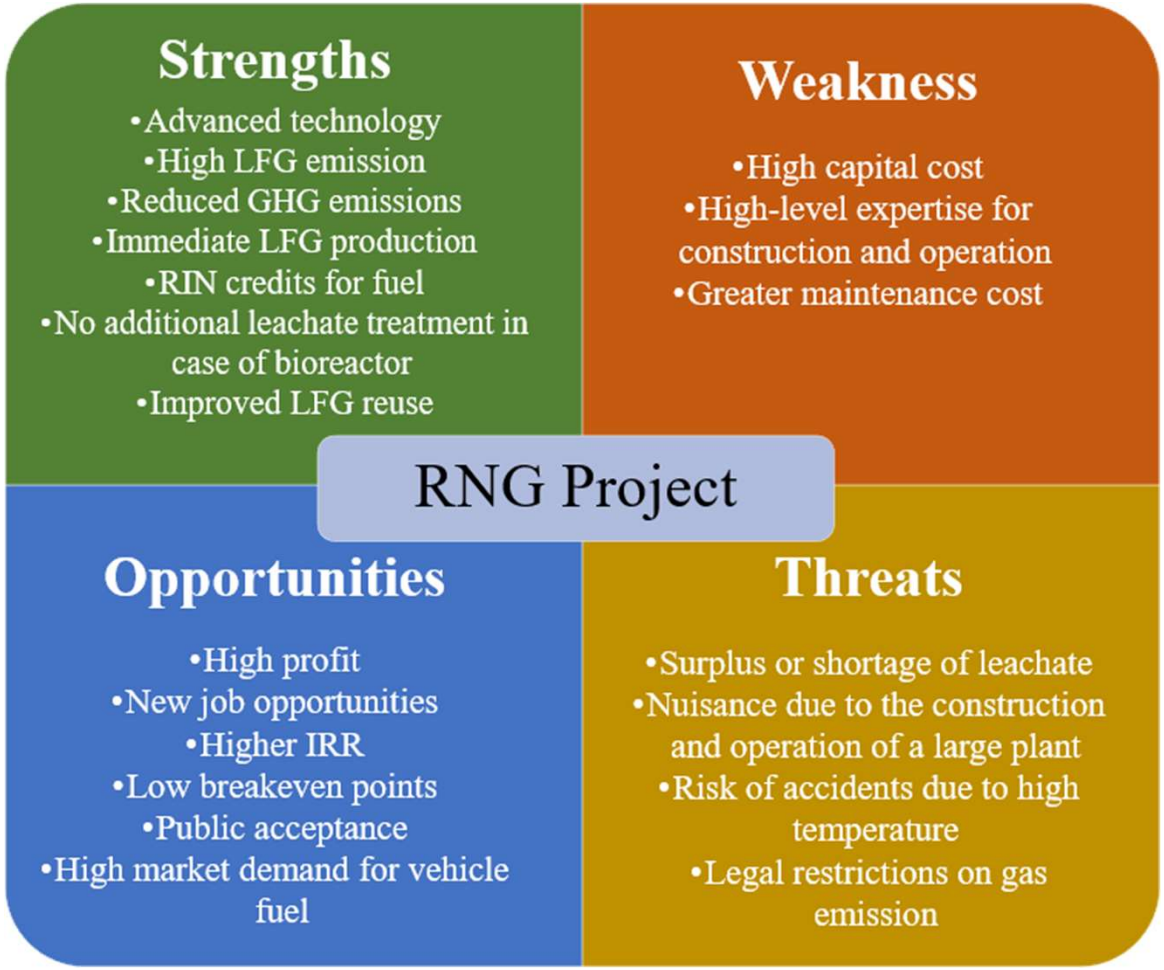
Comparison between Two Approaches

	RNG Plant	Composting
Profit	**Two cases showed significant profit**	No considerable profit
IRR	**37-42%**, negative for case III	Negative or non-viable
Breakeven years	**3 or 4 years**	After 13 years or none
Capital Cost	Higher	**Lower than RNG**
Revenue	**Additional revenue from RIN credit**	No additional revenue
Leachate treatment	**Recirculation of leachate for bioreactor or biocell**	Mining and separating of waste is needed before production
Production	**Immediate production of enhanced CH_4**	Mining and separating of waste is needed before production
O&M	Advanced monitoring is required	**Monitoring is not as critical as RNG plant**

JSU JACKSON STATE UNIVERSITY

RESTORE

SWOT Analysis



JSU JACKSON STATE UNIVERSITY

RESTORE

SWOT Analysis

Recommendation for the County

- ReSTORE recommends building a new RNG plant with a landfill gas collection system, preferably a bioreactor
- The county can apply for a construction grant from the government to reduce initial investment
- Maintenance activities should be conducted carefully
- The cover should be less permeable than that of the liner for the bioreactor
- No leachate treatment will be required due to recirculation
- There should be concrete contingency plans if the amount of leachate is surplus or short
- Proper monitoring for temperature will be needed to avoid any fire incidence due to raised temperature

JSU JACKSON STATE UNIVERSITY

ReSTORE

Acknowledgment

Advising Faculty

Dr. Sadik Khan, P.E.
Associate Professor
Department of Civil and Environmental Engineering,
Jackson State University

Mentor

Mr. Matthew Lamb
Sr. Scientist
Smith Gardner, Inc

Ms. Mateja Vidovic Klanac, Project Professional, SCS Engineers
and
Ms. Hailey Tatum, Sustainability Business Analyst, WM Sustainability Rotation Program

Thank You

ReSTORE

JSU 1877 JACKSON STATE UNIVERSITY®