



# Maracanaú Landfill Gas Project

## **Community-Based Landfill Gas & Biogas Development To Address Social Needs**

by

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# Appalachian State University

- Boone, North Carolina
- 17,800 Students
- Leader In
  - Business & Economics
  - Technology
  - Public Administration
  - Geography & Planning
  - International Studies
  - Sustainable Development
  - Education





# Appalachian State University Energy Center (Est. 2001)

Mission - Committed to research, development, policy analysis and demonstrations in all areas of energy, including...

- Energy efficiency
- Wind
- Small hydro
- Biofuels
- Solar
- Biogas and landfill gas





# Landfill Gas

- Created by decomposing garbage
- 50% CH<sub>4</sub>, 40% CO<sub>2</sub>
- Pollutant
- Explosive
- Greenhouse Gas, 21X CO<sub>2</sub>
- High gas combustion







# Community-Based Landfill Gas Models



North Carolina models of Community-based landfill gas projects

- EnergyXchange
- Catawba Eco-Complex
- Jackson County Green Energy Park





# Landfill Gas Fueled Glass Furnace







# Landfill Gas Fueled Ceramic Kiln





# Landfill Gas Fired Boilers – Provides Heat for Buildings and Greenhouses







# Landfill Gas Heated Greenhouses





# SECC Micro-Propagation







# Watauga County, NC Landfill Gas Combined Heat and Power

## ASU/Watauga Research Center

- Accessible
- Simple Technology
- Ease of Maintenance
- Small-Scale Generator







# Sweet Potato Production

- Dehydration – Dietary Supplements, Pet Food
- Sweet Potato Fries





# ASU Landfill Gas Assistance In North Carolina

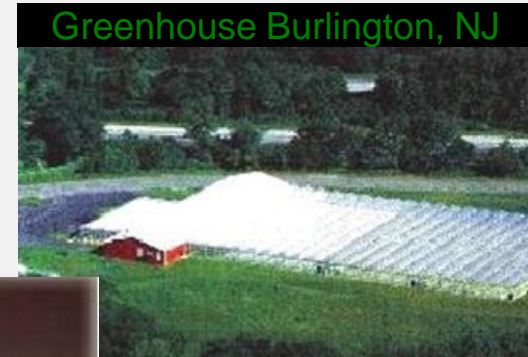
34 Landfills - Small to medium sized

Rural economically challenged communities

Dehydrated sweet potato processing, heat for ethanol production, chicken manure to fertilizer processing, electricity generation (200-1,000 kW), ceramics and glass, wood drying, greenhouses for food crops and herbs, native medicinal rare plant production, and poultry processing.



- Direct landfill gas use projects are growing
  - Heating technology for industry - to replace petroleum products
  - Dryers (food and feed processing)
  - Ovens and furnaces - bricks and tile
  - Natural gas injection
    - Medium and high BTU
  - Greenhouse heating
  - Leachate evaporation
  - Automobile fuel (LNG, CNG)
  - Pottery studio
  - Hydroponics/Aquaculture







# State of Ceará, Brazil

- 8.5 Million People
- 3.2 Million in Fortaleza
- Poor & Rural
- Semi-arid
- Solid Waste Industry Transition
- No Landfill Gas Projects



**Universal problem  
Universal resource  
Most of the trash in North Carolina  
and Ceará goes to a landfill. The  
underground decomposition of waste  
produces landfill gas, and the  
availability of other recyclable  
products.**







# Appalachian State University

- International programs in 35 countries on all continents
- Exchange programs focused on 4 countries –India, China, Brazil, South Africa
- Global Methane Initiative has awarded research grants, in 2009 & 2011, to the Appalachian Energy Center to work in Ceará







# Global Methane Initiative



- The GMI program was launched in November 2004, as an international initiative that has approximately 40 member countries.
- The goal of the GMI is to advance the benefits of methane recovery in the short term and its use as a clean energy source.





# Initial Trip to Brazil

- Visited 7 Landfills, 8 State & Local Government Offices, and 3 University Offices.
- Contact with State Congressman
- Excellent guide
- Brazilian translators
- Coordinated by Chris Godlove, U.S. Environmental Protection Agency



# Maracanaú Landfill

- Opened - 1999
- 1.7 million metric tons waste in place.
- Political support
- Well qualified engineer & good management
- Industrial center







# Energy, Environment and Social Problems





# Importance of the Social Aspect

- Expansion of benefits from using landfill gas
- Participation / community engagement
- More sources of project funding
- Inclusion of partnerships - Government institutions, NGOs, universities, community Members







# Ceará Landfill Gas Task Force Visits North Carolina

- Visits to community projects
- 8 visitors
  - Mayor of Maracanaú
  - Director of Social Services
  - Landfill Engineer /  
Professor of Engineering
  - Engineer representative  
from SEINFRA

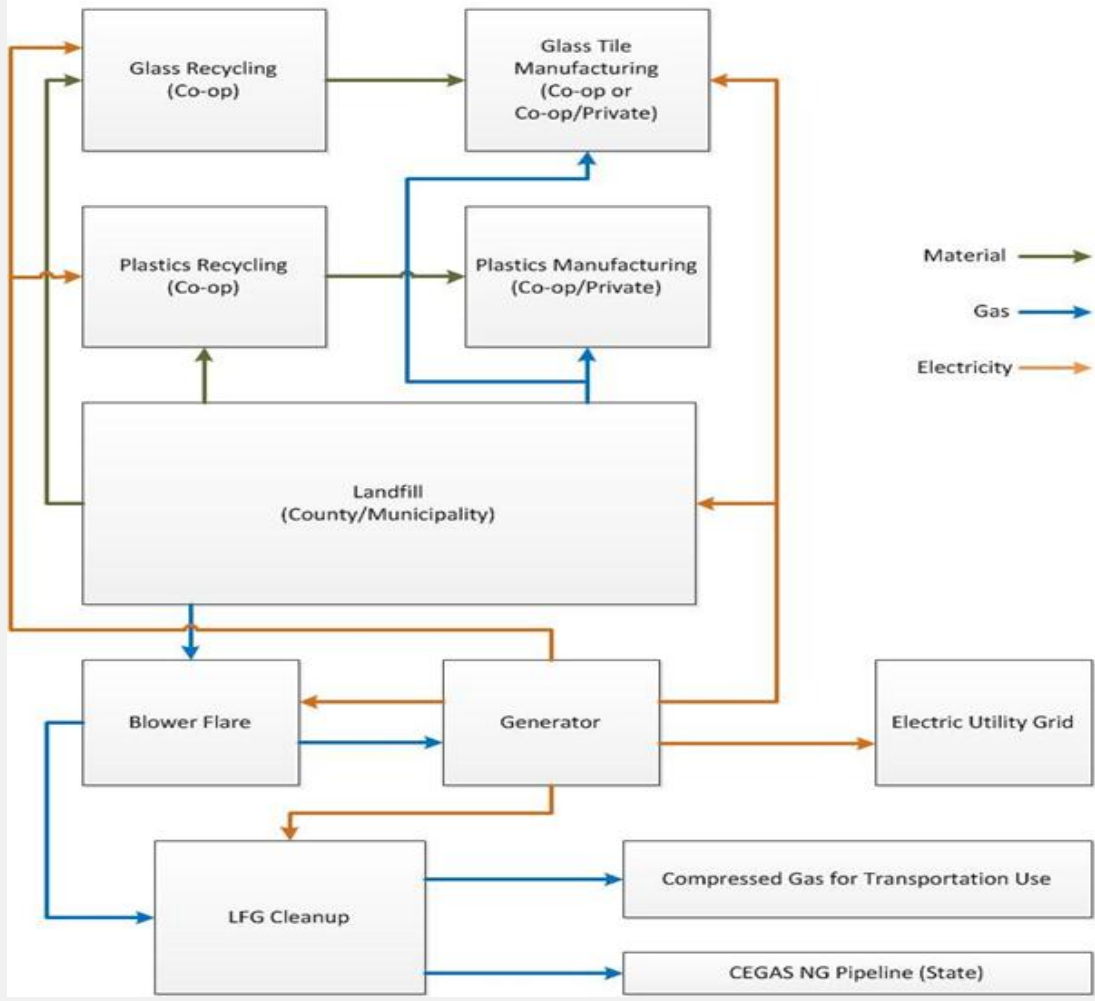






# Original Conceptual Plan for Maracanaú

Maracanaú Landfill Material Processing Design



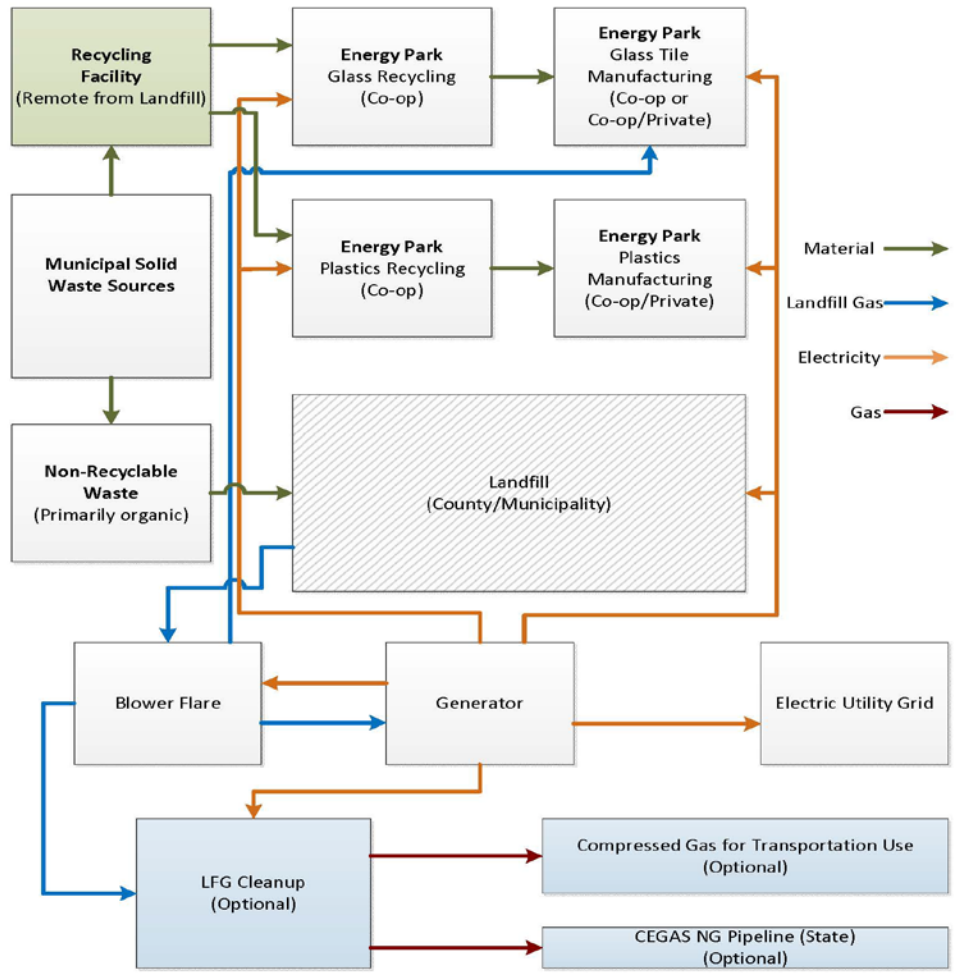
The original conceptual plan. Developed during the Ceará Landfill Gas Task Force's visit to North Carolina in June, 2010.





# Updated Conceptual Plan for Maracanaú

Current Maracanaú Landfill Material Processing Design



Updated conceptual plan – 2013. This is a conceptual plan only. Actual use may vary according to the needs and plans of the community.





# Recyclable Sorting Facility







# Plastics Processing





# Plastics Recycling - Energy Use



The unit we saw during one visit to Ceará was completely electric, including motors, controls, and resistance heating extrusion equipment. Recycling plastic is an energy intensive process that could be made more profitable by using landfill gas.







# Plastic Panels for Construction







# Value-Added Glass Model

STUDIO Xaquixe



# Building Equipment





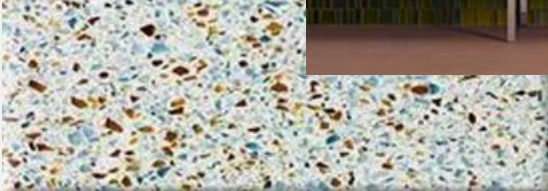
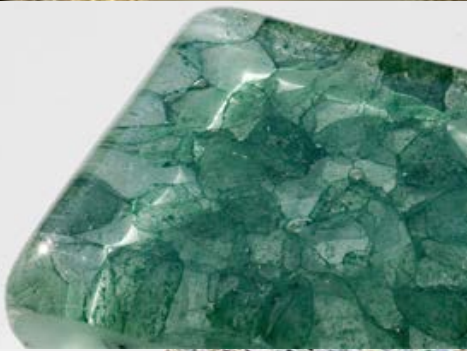
# Glass Injection Molding Process





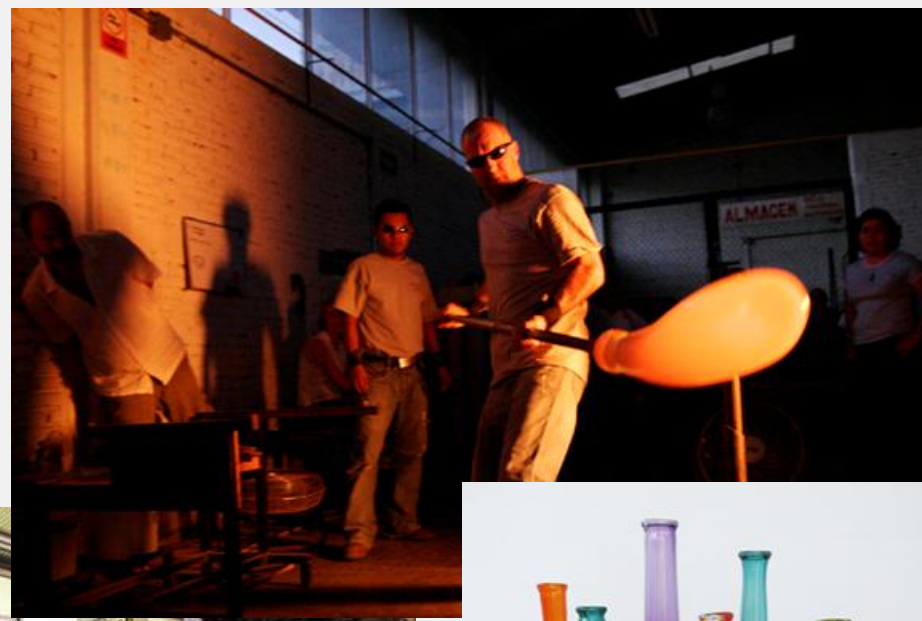


# Recycled Content Glass Tile





# Handcrafted Glass by Community







# Maracanaú Pilot Project Significance

- A goal of the Maracanaú landfill gas Pilot Project is to become a model for future projects in community energy - projects where the community and local government work together to improve the environmental, energy, and social conditions of the community.
- Landfill gas is produced in all landfills where organic matter is buried. Generally, the recovery of landfill gas produced in small and medium sized landfills is not of interest to large investors, however it is an efficient, viable and economical solution for communities fighting for environmental improvement and to provide better working conditions their catadores.







# Impact for Catadores

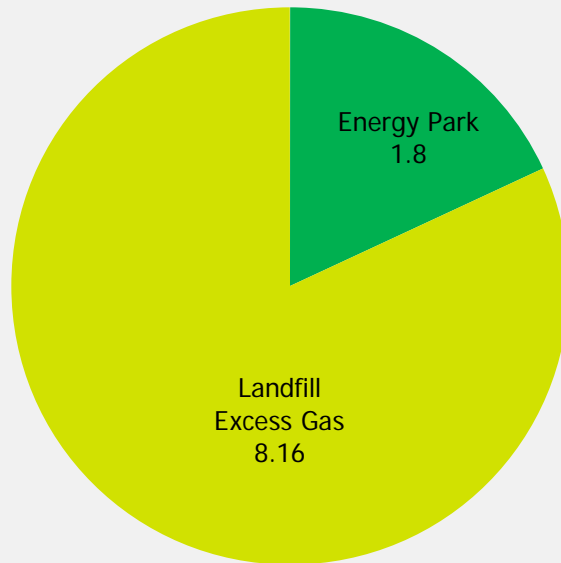
- Safer and healthier working conditions
- More income
- Opportunity for professional improvement
- More power to local catadores association
- More opportunities for the children of catadores
- Source of income for social programs



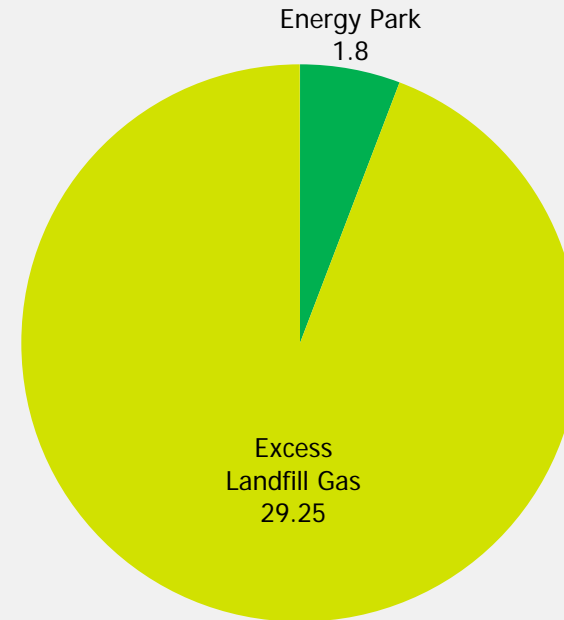


# Landfill Gas Needed for Value-added Processing

2012



2041



Calculated Landfill Gas Quantities in Millions of BTUs





# Maracanaú Industrial District

- 200 Industries that need plenty of energy
- Interest in the use of landfill gas from various industries
- 12 km – Probably too distant for constructing a pipeline
- Source of support for the project







# Commercial Uses in Maracanaú

- Landfill gas converted to electricity can be used for commercial purposes
  - Reciprocating engines
  - Gas turbines
  - Microturbines
  - Systems for combined heat and electric



Caterpillar 3516 800 kW Genset  
Short Mountain LF  
Eugene, OR



Solar 3 MW Gas Turbine  
Milwaukee, WI





# Other Potential Uses of Landfill Gas





# Remaining Tasks

- Financing for landfill gas collection unit, waste separation, and Energy Park
  - International resources
  - Private business and industry engagement
  - Foundations / private partnerships to build.
- Identify and recruit potential partners.
- Continue Energy Park planning and feasibility study of commercial energy uses.
- Involve government agencies. Request federal and state political support.







# Continuation of the Project

- Transfer the responsibility of the project to the Brazilian partners
- Appalachian State trading the project lead for a consulting role
- Ensure the project continues under new management
- Assign responsibility for tasks
- Complete the landfill gas system
- Complete the design of the Energy Park
- Involvement of government agencies at the state and federal level







# ASU

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