Project Summary Presentation

Conversion of Biomass into Electrical Energy and Compost through Sequential Batch Anaerobic Composting

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Project Partners

Xcel Energy

UF UNIVERSITY of FLORIDA
The Foundation for The Gator Nation

American Crystal Sugar Company

ENTERPRISE MINNESOTA

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Project Focus

To convert biomass into electrical energy and compost with a highly improved anaerobic digestion technology.

- Feedstock: renewable biomass of sugarbeet tailings and other byproducts generated in the refining process at the American Crystal Sugar Company
- Technology: University of Florida anaerobic digestion technology (SEBAC II)originally developed for space applications

Project Goals

- To convert a renewable biomass of sugarbeet tailings and other sugar refining byproducts into usable electrical energy and compost by utilizing the SEBAC II technology.
- Conduct laboratory analysis on the quality and quantity of methane generated with expected conversion rates to electrical energy
- Design and construct a demonstration facility for processing 10 – 100 tons of tailings per

Project Goals

- Perform a study on the demonstration facility to determine the economic feasibility of bringing the system to full-scale commercial use at the American Crystal Sugar Company East Grand Forks Facility
- Develop a list of target companies in or near the Xcel Energy service area that are potential users of a SEBAC II system and introduce them to the technology. Offer an opportunity to visit the American Crystal Sugar Company facility to see a real-time demonstration.

Sugarbeet Tailings From American Crystal Sugar Company

Project Approach

- Laboratory scale analysis to determine:
  - biochemical methane potential of tailings and other byproducts
  - extent of degradation of these feedstocks
  - amount of residue remaining after anaerobic digestion
- Test the applicability of SEBAC II process to biogasify sugarbeet tailings in a laboratory scale system.
- Improve or modify process if required and validate it at the laboratory scale.
- Develop a process design for the demonstration facility.
- Construct, start up and operate the demonstration facility.

Project Results

- Project Goals have all been met
- Production Results
  - Tailings degraded very rapidly
  - 10 tons/week processed
  - Biogas yield was 2400 cu ft/ton wet weight of which 55% was methane
  - Energy equivalence of 1.32 MMBtu/ton wet weight
  - 80-90% of the dry weight of tailings was degraded

Project Results

- Technology Enhancements
  - New system design that is a Hybrid Two Stage entitled "**System for Semi-Continuously Fed Anaerobic Digestion of Solid and Soluble Organic Wastes by Products and Residues"**
  - System kinetics increased
    - Maximum biogas produced in shorter timeframe
    - Feedstock broken down in shorter timeframe (< 10 days)
  - Demonstration system can process 50% more than the design capacity
  - Compost/residue is free of plant pathogens and active weed seeds (collaboration with the University of Minnesota)
  - Commercial system will only require 2 tanks versus 20


TANK F
microTHERM

Project Results

- Economic Analysis for Full-Scale System at East Grand Forks
  - Biogas to power generation
  - 390 tons/day of tailings
  - Power potential: 2.1 MW (50,000 kWh/day)
  - Capital cost estimate: $4.9 M
  - Simple payback: 5.8 years
  - Power produced at 1.2 /kWh

Project Results

- Commercialization Potential
  - System can be scaled, ie. 10 tons per week to 400 tons per day
  - System footprint is small, even for large endeavors
  - System can handle multiple feedstocks at one time
  - Biogas can be used directly in boilers, cleaned for pipeline use, or converted to electrical energy
    - At full-scale estimate a 2MW system
  - System can be applied to a variety of industries producing biomass waste and/or by-products

Benefits to XCEL

- Viable renewable technology to convert biomass to electrical energy
- Technology can support a variety of feedstocks at the same time
- Technology is scalable and can support users at all levels
- Return on investment between 2 – 5 years, depending on system size
- Increased supply of electricity available to customer base
- Rural area economic development
  - Industry growth

Commercial Interest

- Many end-users interested in implementing technology
- Four entities have expressed interested in further discussions to potentially acquire the technology through a license agreement and/or partnership agreement
  - Equipment/System Manufacturers
  - Engineering Consulting Firms
  - Venture Capital

Technology Promotion

- News Media
  - Minnesota Public Radio (May 6, 2008)
  - Grand Forks Herald (June 8, 2008)
  - Biomass Magazine (August 2008)
- High Solids Anaerobic Digestion Workshop
  - Held in Fargo on December 11, 2008
  - 75 people in attendance
  - Technical sessions and tour of demonstration facility

Technology Promotion (cont)

- Students Participating on Project
  - 2 Ph.D.
  - 2 Master
  - 1 Undergraduate
- Conference Presentations/Papers
  - 5 Presentations at International Conferences
- Educational Seminars
  - Minnesota State Community & Technical College
  - Bemidji State University

Technology Promotion

- University Symposiums
  - 4 Symposiums give at the University of Florida
- Peer-Reviewed Papers and International Journals
  - 4 Published
  - 5 Pending
- One-on-one meetings with various groups
  - Industrial (16) -City (4) - County (4)
  - Federal (4) - University (4)

Additional Funded Contract Work

Entity	Description	Funding
American Crystal Sugar Company	Provide laboratory analysis on pressed sugarbeet pulp and CSB rafinate to determine biochemical methane potential and degradation time	$21,468
NASA – Johnson Space Center	Phase I: Provide laboratory analysis and preliminary designs for two systems, the first being an on-site system for Center municipal waste, and the second for a lunar base waste application	$225,000
American Crystal Sugar Company	Charge and operate the demonstration system with a new feedstock of pressed pulp and tailings combined, and analyze the results	$ 24,605
Nordic Sugar	Provide laboratory analysis on whole sugarbeets to determine biochemical methane potential and degradation time from anaerobic digestion	$27,588

Pending Projects

Entity	Description	Funding
Ottertail Ag Enterprises	Provide laboratory analysis on thin stillage to determine biochemical methane potential and degradation time from anaerobic digestion	$36,488
Ottertail Ag Enterprises	Analyze the thin stillage and anaerobic digestion effluent to determine if the fluids can be remediated for reuse applications within the facility, and determine the appropriate technology to do so	$92,500
Hennepin County	Provide laboratory analysis on municipal biomass feedstocks and an economic analysis for anaerobic digestion operations for different sized systems	TBD
American Crystal Sugar Company/Nordic Sugar	Charge and operate the demonstration system with whole sugarbeets and obtain analytical results.	TBD
American Crystal Sugar Company/Ottertail Ag Enterprises	Charge and operate the demonstration system with thin stillage as the feedstock and analyze the results.	TBD
NASA Johnson Space Center	Phase II: Provide final designs and construction estimates for both an on-site system and a lunar-based system.	TBD

Potential Opportunities/Collaborations

Entity	Description
University of Minnesota – Crookston	To customize and build an anaerobic digestion system for on-campus use to handle biomass waste products from municipal and agricultural sources, and to use the biogas for infrastructure support.
Hennepin County/Linden Hills Power and Light	To develop and build an anaerobic digestion system for neighborhood biomass waste and to use the biogas directly or convert it to electrical energy to support local area needs.
Hennepin/Ramsey/Washington Counties	To develop an anaerobic digestion demonstration system at one of the Minneapolis/St. Paul metro area composting sites to compliment the biomass collection and use program already in place and to generate energy.
Ryan Potato	To develop and build a full scale commercial system to handle potato culls from their facility operations. Two proposals already submitted.
American Crystal Sugar Company	To develop and build a 60 – 100 ton per day anaerobic digestion system based on and scaled up from the 10 ton per week demonstration system currently housed at their Moorhead facility.

Questions?

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