Bio-methane and Bio-fertilizers Production from the Dry Thermophilic Anaerobic Co-Digestion of Poultry Litter and Crop Residues

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PRESENTATION SUMMARY

- Summary of the Company and its Mission
- Treatment of Wastes via Anaerobic Digestion
- Anaerobic Digestion Process and Technology
- Potential in the U.S. and Projects under Development
PART I

- Summary of the Company and its Mission
Commercialize the Development of Industrial Type Biogas Facilities across the U.S. by Converting Organic Wastes such as Agricultural Wastes into Bio-methane Fuel and Bio-fertilizers

Generate a continuous supply of Bio-methane fuel and Bio-fertilizers by utilizing poultry litter and crop residues

Improve the long-term economic viability of the poultry industry across the country (Mid-Atlantic Region, South-East, Upper Mid-West, West) by effectively utilizing the poultry litter in an environmentally sound and cost-saving manner

Improve air quality by reducing drastically emissions and water quality by eliminating discharges due to the advanced application of anaerobic digestion to the treatment of agricultural wastes; and Protect climate by reducing green house gas emissions

Promote a vibrant green economy in rural and underdeveloped areas by conserving and recycling resources, creating jobs and increasing business investments
PART II

- Treatment of Wastes via Anaerobic Digestion
ORGANIC WASTES AS RESOURCES

“Wastes” are unavoidable by-products of the economy, let alone of living (2nd Law of Thermodynamics)

“Wastes” also imply no economic or other value in a linear/ mechanistic view of the world

“Wastes” are in fact resources in a cyclical/ holistic view of the world - One’s “Waste” becomes Another’s “Resource”; Nature does it for us!

“Wastes” then viewed as “Resources” not only allow for the capture of an inherent economic value but also result in a more sustainable and efficient economy; We can learn from Nature and optimize the utilization of “Wastes”

Waste = Resource  →  Economic Opportunity: Energy, Fertilizers, Other Products
Wet wastes represent most of the available and/or potential resources.

- About 80% of available waste resources are wet, i.e., have a water content of 40% or more by weight.

Combustion and thermo-chemical processes produce only energy (and ash) and cannot be utilized for wet wastes.

Biological processes generate besides energy organic co-products that can be further recycled into the economy (e.g., fertilizer, animal feed, industrial gas, etc.).

Bio-Methane and Electricity are the most commonly generated forms of energy by any of the waste to energy processes.

Bio-Methane fuel production adds the most value in general in the waste to energy conversion process.

Anaerobic Digestion is the Technology of Choice for the Conversion of Organic Wastes into Bio-Energy and Other Bio-Products.
ANAEROBIC DIGESTION PROCESS
THREE DISTINCT STEPS - HYDROLYSIS, ACETOGENESIS, METHANOGENESIS

**STEP A - Hydrolyzing Microbes**

Hydrolysis of Polymers
(Proteins, Polysaccharides, Lipids, Organic Acids, Nucleic Acids)

**STEP B - Acetogenic Microbes**

Oxidation of Monomers and Oligomers
(Amino Acids, Sugars, Volatile Fatty Acids, Glycerol, Peptides, Purines and Pyrimidines)

**STEP C - Methanogenic Microbes**

Methanogenesis
(Methane, Carbon Dioxide)

Chemical reactions:

- Carbohydrates: \( \text{C}_{\text{n}}\text{H}_{\text{m}}\text{O}_{\text{p}} + \text{H}_2 \rightarrow 3\text{CH}_4 + 3\text{CO}_2 \)
- Oils and Fats (typical): \( \text{C}_{\text{n}}\text{H}_{\text{m}}\text{O}_\text{p} + 7 \text{H}_2 \text{O} \rightarrow 14\text{CH}_4 + 6\text{CO}_2 \)
- Proteins (average): \( \text{C}_{\text{n}}\text{H}_{\text{m}}\text{O}_\text{p}\text{N}_\text{q} + 12 \text{H}_2 \text{O} \rightarrow 11\text{CH}_4 + 9\text{CO}_2 + 5\text{N}_2 \)
PART III

- Anaerobic Digestion Process and Technology
DESIGN GOALS OF THE AD TECHNOLOGY

- Construct a standardized facility/modular processing plant unit that could be quickly and economically replicated across the country

- Co-digest 8,000 tpy of poultry litter with 3,000 tpy of crop residues (wheat straw, corn stover, rye), energy crops (such as switch grass), and other available waste products

- Produce commercial grade bio-fertilizers: solid phosphate with minerals; ammonium sulfate; and potassium solution - preserve the nutrients (N, P, K and minerals) without the pathogens and odor of poultry litter and tailor fertilizer composition to local farming needs

- Based on typical N-P-K application rates, produce ammonium sulfate and potassium for 2,000 acres of corn and phosphate for up to 2,000 acres of soybeans

- Effect minimal environmental impact in terms of odors, air emissions, storm water release, noise, dust and land disturbance

- Produce annually 150 million ft³ of biogas to either (a) generate 1.2 MW of electricity - sufficient to supply the annual electricity needs of 1,000 homes or (b) deliver 100 million ft³ of pipeline quality natural gas - sufficient to meet the fuel needs of 2,000 automobiles as CNG and 40 million ft³ of carbon dioxide to be used as an industrial gas
ECOCORP ANAEROBIC DIGESTION TECHNOLOGY

Anaerobic Digestion Process - Imitate and Improve upon Nature: Rumen of a Cow or Gut of a Termite

- Controlled Biological Process with Consistent Supply of Feedstock Materials (Organic Wastes), Adequate Pre-processing, Controlled Temperature, Controlled Retention Time and Sufficient Agitation
- Co-Digestion: Several different feedstock materials mixed together
- Processing Stages: Two - Aerobic and Anaerobic
- Pre-processing: Mechanical Maceration
- Process Water Content: Dry - Total Solids Content up to 35%
- Temperature: Thermophilic - 131°F (55°C)
- Hydraulic Retention Time: Aerobic 1-3 days; Anaerobic 16-21 days
- Agitation: Fully mixed digester
- Post-Processing: Liquid Digestate into N-P-K Bio-fertilizers; Gaseous Biogas (60% Methane, 40% Carbon Dioxide) into Power or Pipeline Quality Natural Gas and Carbon Dioxide
BIOGAS PRODUCING FACILITY ELEMENTS

- Substrate Receiving - Cleaning, Size Reduction, Homogenization
- Hydrolysis - Aerobic Break down of Substrates
- Anaerobic Digestion- Conversion of Substrates into Bio-methane
- Effluent Treatment - Bio Fertilizer Processing and Production
- Biogas Treatment - Upgrading to pipeline natural gas fuel and carbon dioxide capturing for industrial uses
- Facility Air Treatment - Biochemical or Biological
BIOGAS PROCESS SCHEMATIC

Feedstock Receiving/Pre-Processing - Size Reduction, Mixing, Homogenization

Hydrolysis (1 day) and Anaerobic Digestion (16-18 days)

Digester Effluent Post-Processing into Fertilizes - Separation via Centrifuge and Aeration

A. Solid Bio-Fertilizer
B. Liquid Bio-Fertilizer

Biogas Storage and Processing

Combined Heat and Power System (1.200 MWel) or Renewable Natural Gas (100 mil scf/yr)
ANAEROBIC DIGESTER PROCESS PARAMETERS

Bio-Reactor Type
- Plug Flow with integrated Membrane Roof for Biogas Storage
- Total Volume 48,000 ft³ - Liquid 41,000 ft³; Biogas 7,000 ft³

Process Parameters
- Thermophilic Temperature 131°F
- Dry Digestion at Total Solids of up to 35%
- Retention Time 16-18 Days
STANDARDIZED BIOGAS FACILITY

ISOMETRIC VIEW AND ELEMENTS

- Wastes Receiving/Size Reduction/Pre-Mixing
- Homogenization/Hydrolysis/Acidification
- Anaerobic Digestion/Bioreactor
- Effluent Treatment/Solid and Liquid Fertilizers
- Biogas Treatment: Combined Heat and Power Generation (or Upgrading to pipeline natural gas fuel and carbon dioxide capturing for industrial uses)
- Facility Indoor Air Treatment
TYPICAL BIOGAS PLANT PROCESS
Potential in the U.S. and Projects under Development
POTENTIAL IN THE U.S. FOR THE DRY THERMOPHILIC CO-DIGESTION OF POULTRY LITTER

  - Broilers 10,260,000 tons
  - Turkeys 3,040,000 tons

- Regional Distribution of Poultry Litter Production
  - Mid-Atlantic Region (MD, VA, WV, DE, PA) 1,700,000 tons
  - South East (GA, MS, AL, AR, NC, FL) 7,430,000 tons
  - Upper Mid-West (MN, WI, IA, MO, KY) 2,300,000 tons
  - West (TX, OK, UT, CA) 1,350,000 tons

- Crop Residues are abundant in all areas where poultry litter is generated
  - 5,000,000 ton per year of corn stover, wheat straw

- The available poultry litter combined with the requisite amount of crop residue can support over 1,650 standardized digesters for a generation of either
  - 2,000 MW of power
  - 150 Billion scf / yr of bio-methane production (equivalent to 1.3 billion GGE)
THE BIO-METHANE CYCLE IN THE TRANSPORTATION SECTOR OF THE U.S.
ECOCORP PROJECTS UNDER DEVELOPMENT

**ECI BIOGAS**
- 1.06 MW power generation
- Westover, MD
- Under Development, permits and design complete

**CRISFIELD BIOGAS**
- 10 MW power generation
- Crisfield, MD
- Under Development

**SLEEPY EYE BIOGAS**
- 1.2 Billion Scf per year Bio-methane production
- Sleepy Eye, MN
- Under Development