Biogas and Renewable Carbon

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**Biogas Cycle**

Electrical and/or thermal energy

Biofertilizer

Organic wastes

Anaerobic digestion

Energy crops

Biofertilizer

H$_2$O

CO$_2$

Solar energy

Photosynthesis

Animal husbandry

Crop harvesting

Industrial processing

Human consumption

Energy crops

Biogas

Electrical and/or thermal energy
Fossil Fuel Cycle
Anaerobic Digestion

The microbial degradation of organic compounds, in the absence of oxygen, to biogas – a mixture of:

- Methane (50 to 70%)
- CO₂ (30 to 50%)
- trace amounts of H₂, NH₃, and H₂S.
COMPLEX ORGANIC MATTER → LIQUEFACTION PHASE → SIMPLE ORGANICS → ACETATE H₂ / CO₂ → GASIFICATION PHASE

ACIDOGENS → METHANE and CARBON DIOXIDEx

METHANOGENS

LOW ODOR EFFLUENT

METHANE and CARBON DIOXIDE
Feedstocks

• Animal manures
• Agro-Industrial wastewaters
• Municipal wastewaters
• Municipal solid wastes
• Biofuels by-products
• Energy crops / crop residues
Benefits of Anaerobic Digestion

- Renewable energy
- BOD/COD reduction
- Odor reduction
- Pathogen reduction
- Nutrient conservation
- Greenhouse gas reduction
Biogas – A Bioenergy Vector

• Direct Utilization (Heat / Steam)
• Conversion to Bioelectricity (CHP)
• Natural Gas Pipeline
• Vehicular fuel
• Fuel Cells
• Methanol
• Biodiesel
Biogas as fuel
GatorGas
UF-IFAS Anaerobic Digester
(80-90% CH₄)
Water heater at UF-IFAS Dairy powered by manure biogas
Natural Gas Bus - Brisbane
Bioethanol Production

• Up to 20 liters stillage per liter ethanol

• Increased ethanol production requires effective stillage treatment

• Anaerobic digestion provides a sustainable solution, reducing pollution potential and producing biogas for use as an in-plant fuel
Biodiesel Production

• Crude bottoms
  – Crude glycerol

• Anaerobic digestion offers a sustainable solution
  – In-house energy / export
  – Reduced process complexity
  – Capital cost savings
  – Avoid non-energy markets
Biodiesel from Algae
Biomass Energy Crop
Green Grass to Green Gas

SUNLIGHT
WATER
CO₂

Energy Crops

Biogas Plant

Methane

CO₂
WATER

Biofertilizer
Biogas is a sustainable energy solution that is:

- Renewable
- Carbon dioxide neutral
- Locally based

thereby protecting the environment, creating jobs and strengthening local economies.
Biogas power provides …

• Energy independence
  – Renewable natural gas

• Energy reliability
  – Based on locally based feedstocks
2005
18 million
2060
36 million
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