# Anaerobic Digestion and Biogas

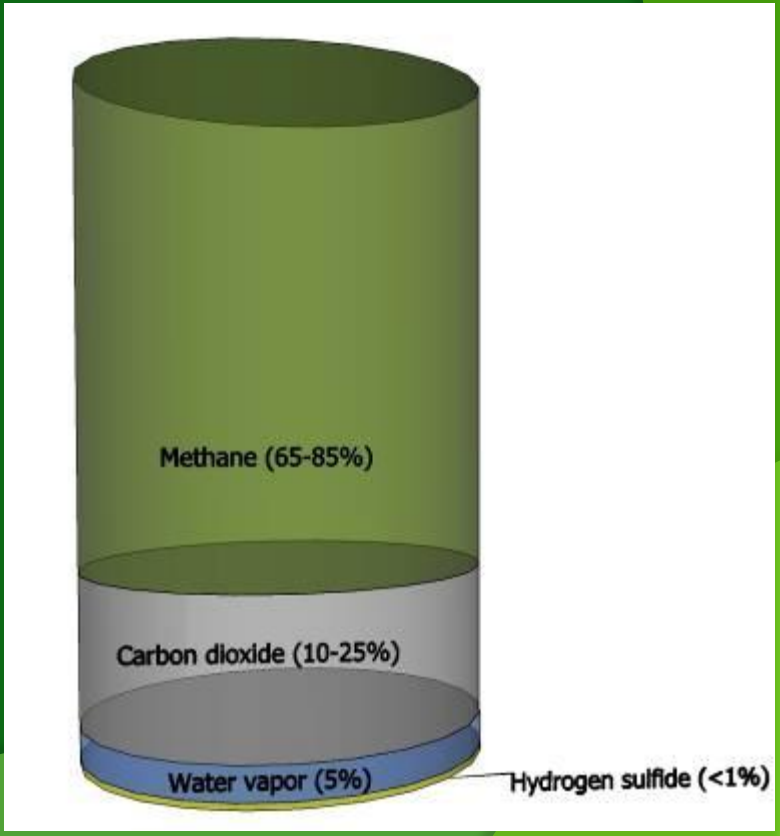
Overview and benefits

# What is anaerobic digestion?

- Bacterial degradation of organic waste under anaerobic conditions
- Ubiquitous, naturally-occurring process
- Anaerobic digesters harness the power these microbes

# What is biogas?

- Gaseous by-product of anaerobic digestion
- After clean-up, used as sustainable alternative for natural gas



# Biogas clean-up

- Clean-up may be necessary based on use
- $CO_2$ – decreased BTU
- $H_2S$ – corrosion problems
- Many clean-up options (iron sponge, water, screens, activated carbon, algae?)

# Biogas Cycle

Solar energy

Photosynthesis

Animal husbandry

Biofuel production

Crop harvesting

Industrial processing

Human consumption

$CO_2$

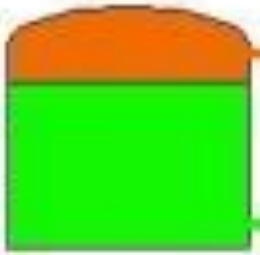
$H_2O$

Energy crops

Biofertilizer

Electrical and/or thermal energy

Organic wastes



Anaerobic digestion

Biogas

Natural gas pipeline

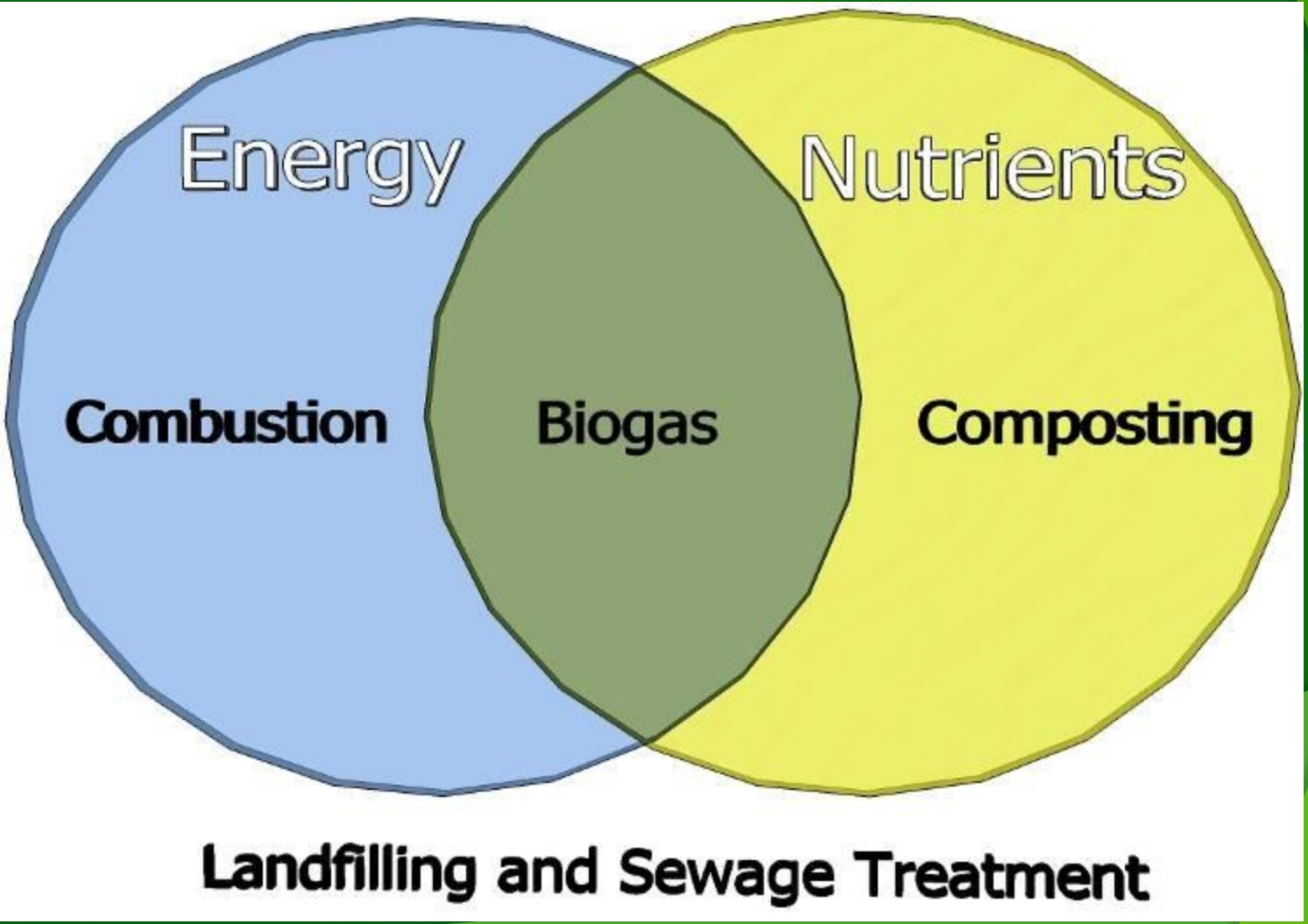
# Feedstocks for biogas

- Manure
- Sewage
- Food waste
- Crops, crop residues
- Glycerol from biodiesel
- Algae biomass

# Benefits of biogas

- Sustainable energy
- Sustainable nutrients
- Scalable and local
- Reduces pathogens
- Diverts waste from aerobic treatment plants and landfills

# Benefits of Biogas



# Sustainable energy

- Carbon neutral
  - Combats global warming
- Captures energy from waste
  - No need for energy crops
- Offsets fossil fuel use
  - Stretches energy reserves

# Sustainable energy

- Uses of biogas
  - Cooking
  - Heating (water/air)
  - Electricity
  - Gas lighting
  - Vehicle fuel
  - Hydrogen fuel cells

# Sustainable nutrients

- Effluent is a nutrient-rich organic fertilizer
- Nutrients mineralized for better plant availability
- Content depends on feedstock

  (e.g. high protein=high N)

# Sustainable nutrients

- Reduces use of synthetics
  - Synthetics= fossil fuel derived
- Reduces cost of organic fertilizer
- Increased organic production
- Keeps nutrients within productive cycle
- Reduces runoff/ eutrophication

# Scalable and local

- Applicable to small farm or large city
- Biogas produced on-site or at centralized digester
- Sustainable energy in developing nations

# Reduces pathogens

- Anaerobic bacteria out-compete pathogens
- Huge benefit for human waste and manure

*Escherichia coli*

*Salmonella typhimurium*

# Diverting waste from aerobic treatment

- Problems with aerobic treatment
  - High aeration energy input
  - Loss of nutrients
  - Transportation of biosolids

# Diverting waste from landfills

- Problems with organics in landfills
  - Take up space
  - Increased leachate
  - Release of methane
  - Lock-up nutrients
  - Cause odor and vermin problems
  - Transportation

# Landfill gas vs. biogas

- Landfill gas
  - Slow, passive process
  - Gas contaminated with many pollutants
  - Transportation of waste to landfill
  - Feasible option for existing landfill

- Biogas
  - Fast, active process
  - Gas significantly cleaner
  - Energy and nutrients
  - Can be produced throughout community
  - Saves space in landfill

# Food waste in Florida

- 1.7 million tons in 2006
- 6% of the state's solid waste
- ~9800 food stores= ~625,000 tons/year
- Other sources
  - Restaurants
  - Schools
  - Prisons
  - Households

# Questions?