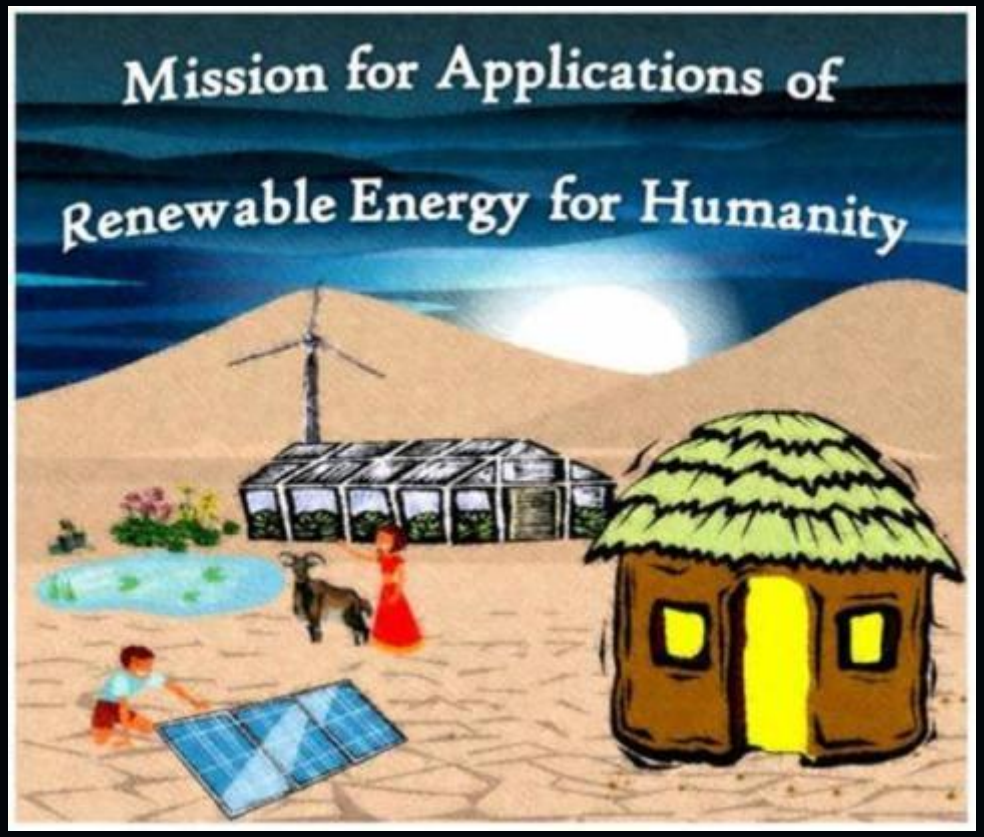

Municipal Solid Waste to Biogas Renewable Power Technologies Overview

MAREH / 361 Southwest Drive, #153, Jonesboro, AR 72401 / (870) 206-0160 / www.mareh.org

Bio-Mass to Biogas
Renewable Energy Technologies

A Public Service Presentation

prepared for

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New Mexico State University, Cooperative Extension Services, Zuni Office

and the

Pueblo of Zuni, McKinley County, New Mexico

12/02/2015

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Energy Efficiency Management For a Cleaner and Brighter World

Mission for Applications of Renewable Energy for Humanity

Municipal Solid Waste to Biogas Renewable Power Technologies

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Introduction

Todays municipalities face a variety of waste problems from house hold garbage, trash, and sewage to industrial, commercial, and agricultural wastes.

American's Produce over 251 Million Tons of Municipal Solid Wastes Every Year (MSW).

MSW, is comprised of

- Paper/Organic Packaging
- Food/Agricultural waste
- Residential Yard and Tree clippings
- Furniture and other equipment
- Plastics, Metals, and other non-organics
- Computers, Tires, Refrigerators

MSW does not include industrial, hazardous, or construction waste

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Municipal Solid Waste to Biogas Renewable Power Technologies

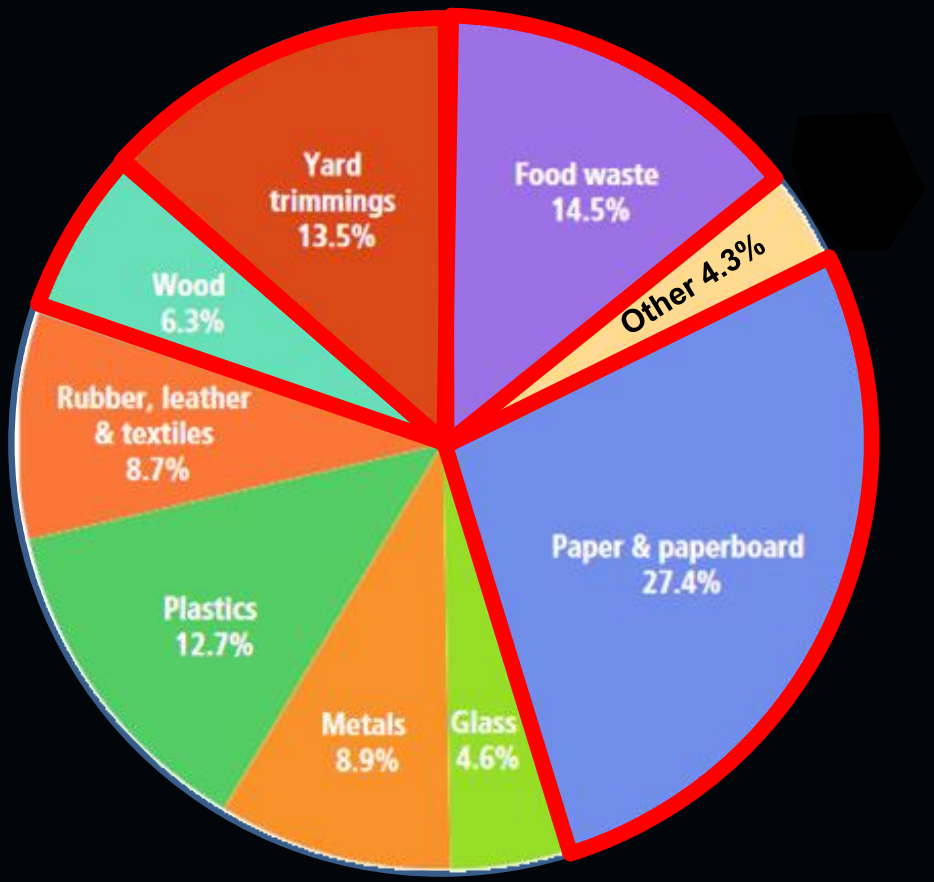
The Problem

Municipal Waste is a problem for communities that is growing in complexity of materials to be handled and costs to safely handle the waste.

- Volume of waste is Increasing
- Types of waste products is diversifying
- Costs of safe treatment is skyrocketing
- Environmental regulations are stricter
- Tax revenues are decreasing
- Fee increases are harder to implement
- The public and environmental organizations are demanding municipalities to fix the problem now!

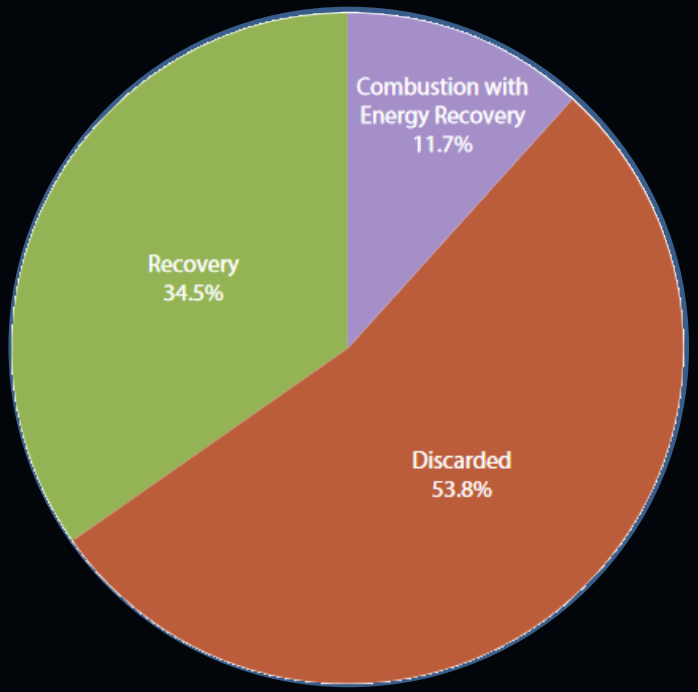
The Problem (Cont.)

- Organic materials such as paper and paperboard, yard trimmings, and food waste continue to be the largest component of MSW, over 138 million tons annually.
- This does not include construction or agricultural and industrial waste products



The Problem (Cont.)

- Organic MSW represents the larges single component of materials entering our land fills.
- Over 53% of all organic MSW is deposited into land fills
- Only about 12% is utilized for environmentally and economically friendly fuel



The BioMass Catastrophy

- Handling of organic Municipal Solid Waste (MSW) has become a more complex and increasingly costly endeavor for many small communities.
- Traditional methods like burning and land filling of organic MSW has become unacceptable
- Other commercial processing into wood chips or compost is not always cost effective

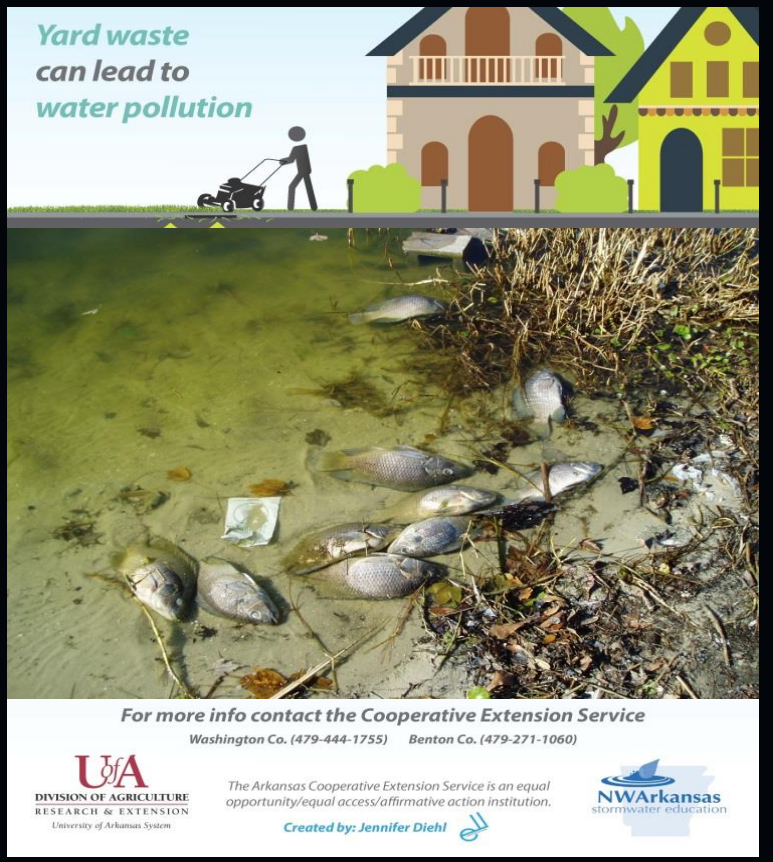
The BioMass Catastrophy (Cont.)

Community generated biomass materials are comprised of biodegradable wastes such as:

- Food waste from homes and businesses
- Yard wastes like grass clippings, leaves, and trees
- Construction wastes such as wood and cardboard
- Paper waste from homes, restaurants and businesses
- And is often contaminated with medical, plastic, and other hazards.

The BioMass Catastrophy (Cont.)

- Traditional MSW solutions are little more then dumping grounds where dense accumulations of various biomass elements can be found.
- Traditional MSW dumping areas are a costly drain on tax revenues to build, operate, and maintain.
- Traditional MSW dumps can produce anoxic leachate rich in lignins and tannins, as well as, other hazardous materials that can contaminate ground waters through soil leaching and surface waters through runoff.



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There is a better environmentally safe and economical solution!

Video curtesy of Clark Energy https://www.clarke-energy.com/biogas/

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Municipal Solid Waste to Biogas
Renewable Power Technologies

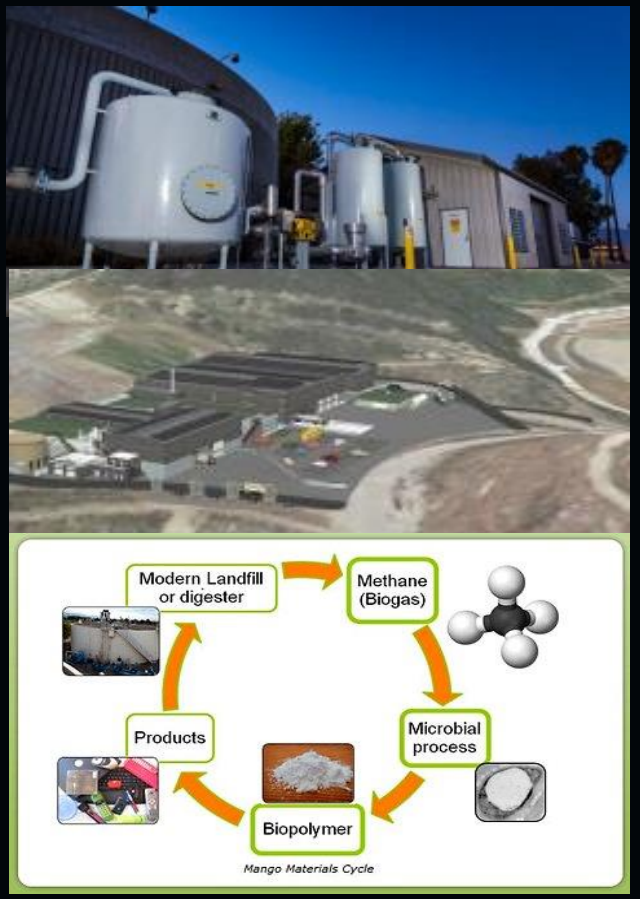
Waste to Environmentally Sustainable Biogas and Cash

- Today municipalities are abandoning their obsolete and potentially damaging practices of putting MSW into landfills and using it to environmentally friendly and profitable biogas.
- Biogas generating waste treatment facilities can solid biomass waste, and plastics into:
  - Environmentally safe biogas that can be used to operate municipal electrical plants
  - Safe reusable compost materials
  - Materials for making environmentally safe biodegradable plastics for consumer use

Waste to Biogas Technologies

Two solid waste to biogas technologies can alleviate the primary solid waste management problems for many municipalities.

1. Solid biomass wastes such as, grass and leaves, manure, waste food products, and wood products such as chips, mulch, construction wood residues, etc. ,can be converted to biogas, vehicle fuels, and raw ingredients for new biodegradable plastic
2. Plastics of virtually all types, even those not normally considered recyclable can also be converted to biogas



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Municipal Solid Waste to Biogas Renewable Power Technologies

Solid Biomass (MSW) to Biogas Facilities

Modern State-of-the-Art solid waste digester plants can cleaning and safely convert municipal, commercial, and agricultural Biomass into clean biogas and compost.

Tajiguas CA, Biogas facility, by Bekon, will process 75,000 tons of biomass a year.

Ready to use organic compost

Fuel-Cells turn solid waste into clean energy

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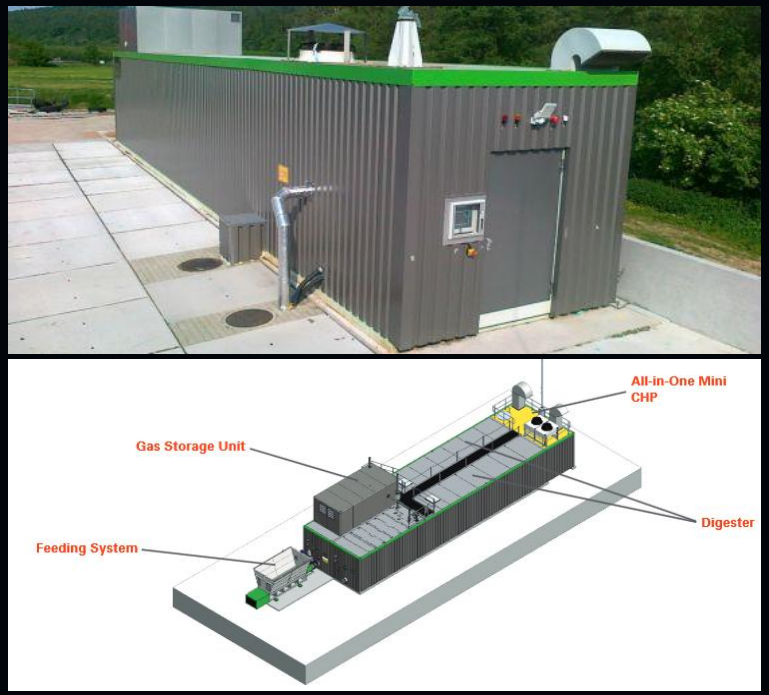
Solid Biomass to Biogas Facilities (cont.)

While solid biomass to biogas generators come in sizes from individual home size, to farm size, to municipal size treatment plants, whole communities can benefit from the economies of scale associated with continuous operations of a municipal size biomass to biogas facility

The Community benefits from a Municipal Biomass to Biogas Plant



Scalable Small-Scale self contained Biomass Digester and Combined Heat and Power Units (CHP) by EUCOlino

Solid WastBiogas Plants (cont.)

- **A Solid Waste Biogas Digester is a Cost Effective Replacement for existing dumping and/or composting attempts of MSW**
- These Energy efficient systems have been shown to be so cost effective, replacing even recently acquired older technology has proven to:
  - Reduce MSW handling cost enough to pay for the system in just a few years
  - Turn cost centers into revenue generation centers
  - Generate new spin-off revenue streams
  - Reduce environmental protection costs
  - Reduce municipal facilities utility costs

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Municipal Solid Waste to Biogas Renewable Power Technologies

The MSW to Biogas Cycle

Biogas raw materials come from a variety of waste generated in most municipalities including food wastes, grass clippings, leaves, tree clippings, and paper board products.

Diagram Courtesy of Bekon AG
http://www.bekon.eu/en/sustainable-cycle/

The MSW to Biogas Process

In the simplest of systems, like this one produced by Beken AG of Germany , solid waste is dumped at a enclosed tipping station to await entry into the percolate chamber via a conveyor belt or loader. The solids left over after digestion is complete are ready to dried and bagged or applied in bulk to fields and gardens.

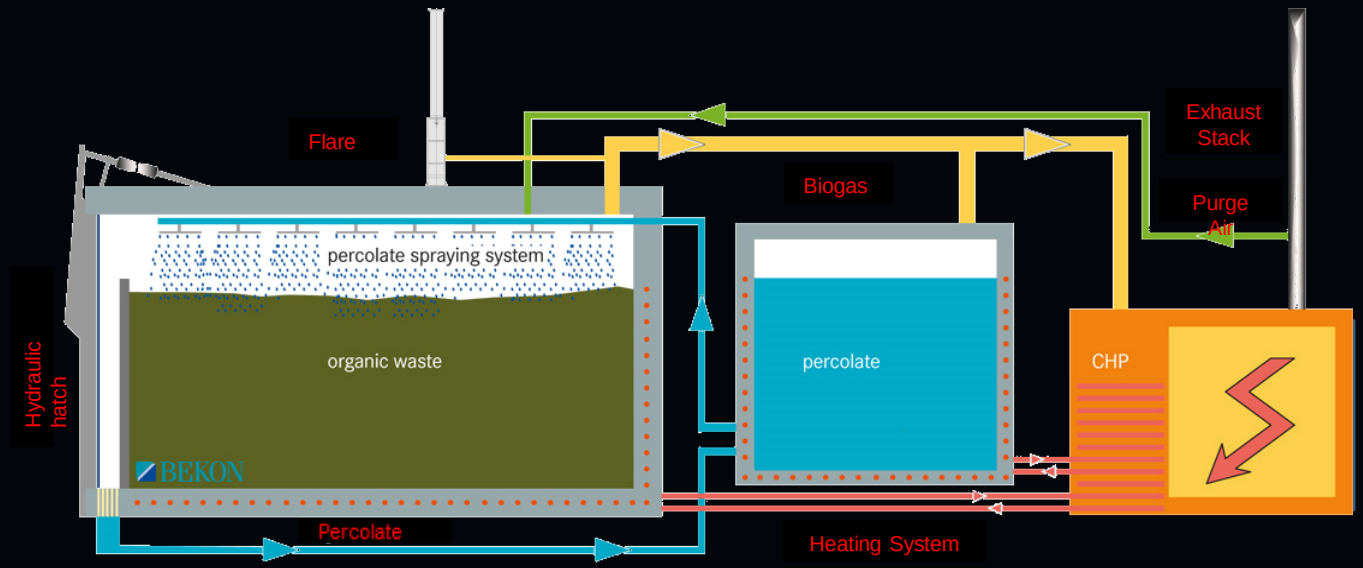

Diagram Courtesy of Bekon AG
http://www.bekon.eu/en/technology/

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Municipal Solid Waste to Biogas Renewable Power Technologies

Biogas Fuel from Solid Biomass

Biogas from municipal solid waste can be easily and cheaply processed onsite to Bio-Methane a product that can be directly injected into the commercial natural gas grid making it easily distributable to the community through existing gas line network or use locally to power agricultural, personal, or commercial vehicles.

Locally produced Biogas helps to make a community an independent energy island.

Bio-methane from biogas can be injected into the gas grid or used for vehicle fuel as Compressed Natural Gas (CNG) and Liquefied Natural Gas (LNG). - Carbotech

Traditional Recycling MSW Harms the Enviroment

While it is intended to be environmentally friendly traditional recycling is harmful to the environment and the economy.

- From gamma radiation poisoning of buildings built from contaminated recycled steel, to lead from recycle aluminum spray paint cans, to toxic chemicals in recycled paper.
- Recycling requires doubling the fleet of pick-up vehicles to well over 179,000 trash/recycling vehicles operating in the USA alone. With each vehicle contributing more environmental pollutants in its life time than it can haul as recyclables.

Traditional Recycling MSW Actually Harms the Enviroment (cont.)

- Recycling requires more waste pick-up vehicles, almost twice as many
- Well over 179,000 trash/recycling vehicles operating in the USA alone.
- With each vehicle and the associate handling of recycled materials contributing more environmental pollutants then making new products from raw materials
- Early studies like the often cited 1996 by Sound Resource Management Group, Inc., used flawed calculation methods that did not account for Total Life Cycle Costs in terms of BTUs and environmental damage.

Timothy Gutowski, professor of Mechanical Engineering at MIT, and his colleagues…has found that remanufacturing or recycling certain products actually uses more energy than simply using new products."

Traditional Recycling MSW Harms the Enviroment

- Paper (an organic solid) requires 100s of millions of gallons of clean water annually, while putting out the same about of polluted water that must be cleaned in energy guzzling cleaning process,
- Produces millions of tons of polluted sludge that is dumped in landfills or leaked into water ways.

- Inks, dyes, and other contaminates from paper recycling are dumped into landfills rather than being processed and neutralized.
- Paper can only be reprocessed a limited number of time before the fibers break down and must be discarded completely

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Municipal Solid Waste to Biogas
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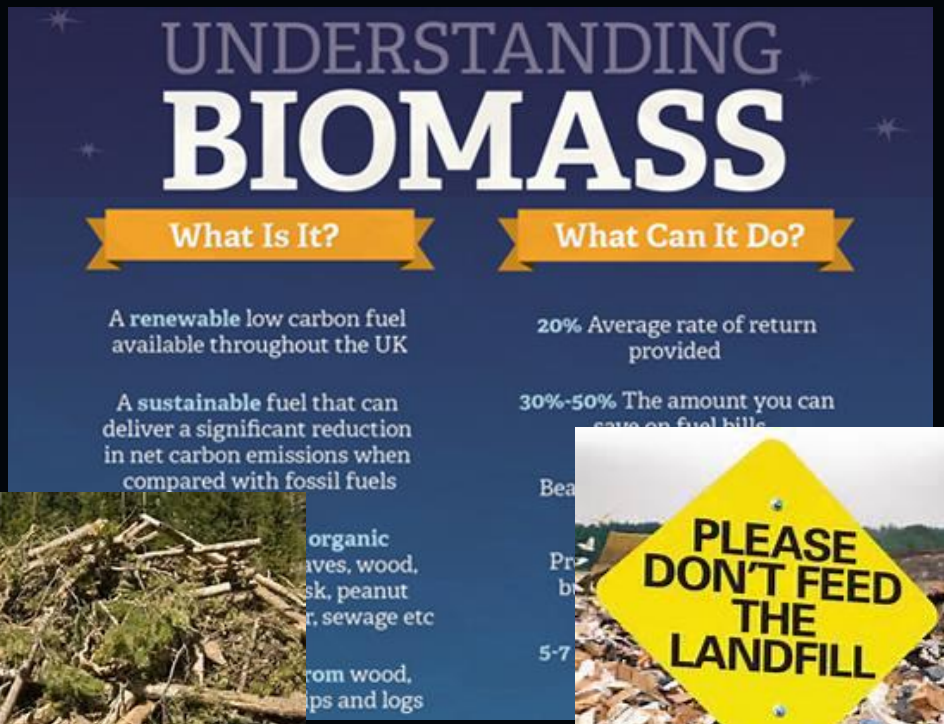
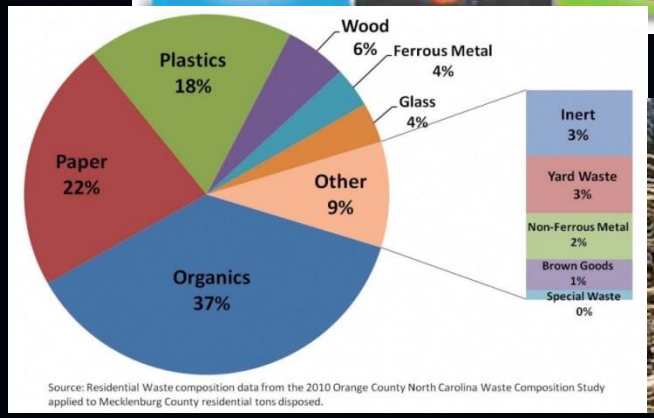
Traditional Recycling MSW Harms the Enviroment

Traditional recycling is very costly, more dangerous to the environment then dumping, a logistical nightmare that isn't working, and is literally killing us with radiation and obesity.





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Municipal Solid Waste to Biogas
Renewable Power Technologies

How Biogas can be used in your Community

Biogas to Electricity

- The most common use of biogas is the local generation of electricity
- Biogas from the digester is piped a short distance to a turbine or reciprocating engine that then turns an electrical generator
- Smaller biogas generation facilities benefit from this less complex and less costly model
- Heat from the plant is captured and used for domestic water and facility heating

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Municipal Solid Waste to Biogas
Renewable Power Technologies

How Biogas can be used in your Community

Compressed Biogas and Propane

- The second most common use of biogas is liquefied bio gas for cars, trucks, and farm vehicles
- Some biogas is converted to propane and bottle in high pressure tanks for use to heat homes and make domestic hot water
- Whether used directly as liquefied biogas or processed into more common compressed propane biogas powers our homes and our vehicles, cleaner , cheaper, and safer then any other form of natural fuel or biofuel

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Municipal Solid Waste to Biogas
Renewable Power Technologies

How Biogas can be used in your Community

How Wood and Paper can cleanly power our cars and trucks!

- Gasoline that virtually sulfur free can be economically synthesized from biogas (bio-methane)
- Because biogas is compatible with natural methane, synthesis of gasoline can be supplemented from commercial pipeline sources of methane
- Synthesized gasoline burns cleaner and more efficiently to power vehicles with less environmental impacts
- Cost to synthesize one gallon of gasoline - about **$0.53** per gallon

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Municipal Solid Waste to Biogas Renewable Power Technologies

How Biogas can be used in your Community

Wood and Paper powers tractors to produce food and fuel…

- Diesel fuel is essential to power our modern agricultural production process
- Inefficient biomass to directly to fuel process are environmentally insensitive and economically questionable
- Biogas a form of methane can be cleanly and economically converted to clean affordable burning diesel fuels with virtually now Sulphur or other dangerous pollutants
- Left over solids are field ready compost and tail water is ready for irrigation purposes

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Municipal Solid Waste to Biogas Renewable Power Technologies

Costs

526 kW Biodigester and Generator		
Civil Works	$0.00	$0.00
Preparation of Site on site	on site	
Fence and Gate	on site	
Street Works	on site	
Civil Works in general	on site	
Reception Tank for Liquid Input	$105,082.60	$110,826.00
Concrete Tank, diameter 17.00 m, height cyl. 6.00 m, volume 1,360 m³	$55,895.00	
2 mixers, submerged, 11 kWe each	$22,358.00	
Cage Ladder with Platform	$4,471.60	
Cover (simple roof)	$16,768.50	
Flanges	$5,589.50	
	$0.00	
Pasteurisation Unit	$0.00	
no Pasteurisation included	$0.00	
Digester	$632,731.40	$667,314.00
Foundation, concrete, diameter 18.00 m	$31,301.20	
Leakage Control for Foundation	$3,353.70	
Steel Tank, glass coated, diameter 17,50 m, height cyl. 17,50 m, volume 4,210 m³	$503,055.00	
Leak-/Over-/Underpressuretest	$0.00	
1 mixer, top mounted, 15 kW	$78,253.00	
Insulation	included	
Cage Ladder, Platform, Viewing Glass	included	
Over-/Under pressure Valve and Safety Equipment	included	
Freight, Assembly, Documentation	included	
Flanges	$16,768.50	

Secondary Digester	$201,222.00	$212,220.00
Concrete Tank, diameter 20.00 m, height cyl. 6.00 m, volume 1,885 m³	$72,663.50	
Leakage Control for Foundation	$4,471.60	
2 mixers, side-mounted, 11 kWe each	$39,126.50	
Double Membrane Gas Holder Roof, volume about 640 m³	$36,890.70	
Insulation	$31,301.20	
Cage Ladder, Platform, Viewing Glass	$6,707.40	
Over-/Underpressure Valve	$3,353.70	
Flanges	$6,707.40	
	$0.00	
Storage Tank	$0.00	
according to local regulations, may be lagoon	$0.00	
Gas System	$184,453.50	$194,535.00
Emergency Flare, 250 m³/h	$27,947.50	
Gas Blower	$11,179.00	
Gas Cooler	$55,895.00	
Gas desulphurisation	$89,432.00	
Gas Engine	$402,444.00	$424,440.00
Gas Engine, Jenbacher, 526 kW el. Power	$391,265.00	
completely equipped to be installed in a building	included	
incl. heat distribution, safety devices, control cabinet	included	
Heat for start-up operation	$11,179.00	
Building	$72,663.50	$76,635.00
Pumping Room between digesters and secondary digester	$33,537.00	
1 Building for electrical devices	$11,179.00	
Building for Gas Engines	$27,947.50	
Reception Hall	$0.00	
Biofilter	$0.00	
Toilet, shower, office	$0.00	
Office Building	$0.00	

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Municipal Solid Waste to Biogas Renewable Power Technologies

Cost (Cont.)

Building	$72,663.50	$76,635.00
Pumping Room between digesters and secondary digester	$33,537.00	
1 Building for electrical devices	$11,179.00	
Building for Gas Engines	$27,947.50	
Reception Hall	$0.00	
Biofilter	$0.00	
Toilet, shower, office	$0.00	
Office Building	$0.00	
Equipment	$159,300.75	$168,007.50
Pumps	$25,152.75	
Grinder	$0.00	
Heat Exchanger	$67,074.00	
Pipes	$67,074.00	
Weigh Bridge	$0.00	
Gas-, Electric-, Heating System Installations	$122,969.00	$129,690.00
Electrical Equipment	$89,432.00	
Process Control Equipment	$22,358.00	
Measurement Devices	$11,179.00	
Lightning Protection	Included	
Transformer	on site	
Connection to Transformer	on site	
Engineering	$335,370.00	$353,700.00
Subtotal, net, without VAT		$2,337,367.50
Onsite Preparation activities	$200,000.00	$200,000.00
Estimated Total for a 525kW ssystem		**$2,537,367.50**

A complete 526kW biomass to electric plant installed for about $3,000,000

4,607,760 kWh /year @ $0.1246
$574,126 per year revenue
Simple pay back period ~8.5 years

https://energypedia.info/wiki/File:Cost_Assessment_of_Biogas_Plant_Components_Tupandi.pdf

Financing

Direct Financing:

- Municipalities can issue bonds to finance projects

Grants:

- Municipalities can obtain state and/or federal grant funding to finance projects

Energy Savings Performance Contracting (ESPC & EPC):

- **A financing model to fund upgrading facilities, fleets, water infrastructure and renewable energy by using energy cost savings to offset project costs .**

Power Purchase Agreements (PPAs)

- A Municipality can enter into long-term power purchase agreements who will finance, build, and operate the facilities
- The municipality agrees to buy back the power from the facility at a pre-arranged price per energy unit, over the life of the agreement.

What Next?

Renewable Energy Efficiency Audit

- A renewable energy efficiency audit should be commissioned.
  - Looks at current energy demands and provides low/no cost efficiency measures the community can implement now.
  - Addresses energy efficiency measures that should be implemented along with any waste-to-energy projects, such as, cool roofs, equipment upgrades, lighting upgrades, other renewable projects
  - Outlines an overall architecture for a comprehensive integrated technology Waste-to-Energy plan for the community that is both modular and scalable so that it can adapt to the needs of the community over time.
- Create a committee of key players from the local government and community advocates to review potential solutions and present a formal plan to the local government for action.
- Obtain funding via the approved financing plan to begin building the new waste processing facility.

What about Existing Facilities?

- Current structural facilities can either be incorporated into the new system design or operated until the new system comes on line and then decommissioned.
- 200 acres of municipal land now tied up in waste water treatment lagoons will be made available for other community use.
  - Some lagoons may be maintained to conduct final filtration/holding of treated water for use in agriculture or other community approved uses.
  - Lagoons no-longer required for water treatment can be cleaned and sanitized for other aquatic uses.
    - Aquaponics - various wetland plants and other plants for resale can be raised by a community owned and operated not-for-profit company.
    - Aquaculture - Lagoon based aquiculture is an ideal configuration for many easy to grow, highly-profitable boutique aquodic species, such as, fresh water prawns, fresh water lobsters, fresh water clams, oysters, mussels, and other select species. Excess heat from the waste treatment facility and passive solar covers can be used to maintain temperatures during the cooler seasons. Project can be operated by a a community owned and operated not-for-profit company. (Municipal Wastewater Aquaculture_EPA600/2-78-110 and Aquaculture Systems for Wastewater Treatement_EPA430-9-80-007)
    - Other Public use – sufficient clean water for recreational and fishing usage should be available from the treatment system to support adapting some lagoons for this purpose.

Summary and Conclusion

Problem:

- Many communities are continuing to employ outdated and costly solid waste programs for solid biomass waste.
- Environmental and economic costs are being borne by taxpayers and are burdening already stretched municipal budgets.

Solution:

- State of the art gasification technologies and other energy reclamation technologies are available and affordable today.
- Reclaimed energy from a variety of waste products can pay for treatment facilities in a few years and provide significant positive cash flows over the life of the system.

Conclusion:

- Replacing even newly constructed obsolete-technology-systems now, with positive cash flows to the community, can be significantly cheaper then continued operation of current systems.

How MAREH Can Help

Requirements/Conception:

- MAREH can identify and codify your requirements into a set of Proposal Ready specifications and produce an effective Statement of Work

Project Oversight:

- MAREH can serve as the "Clerk of the Works" we represent your communities interests in monitoring the various contractors involved in making your biogas system a reality

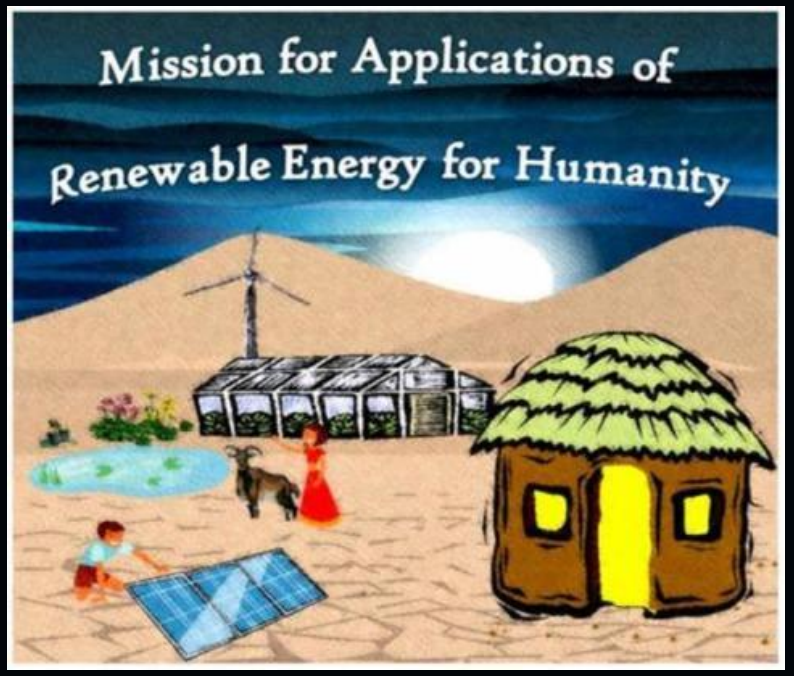
Verification and Commissioning:

- MAREH can serve as your verification and Commissioning agent to ensure you get what you paid for in your Biogas Plant and that it works as designed.

Lower Costs:

- As a non-profit MAREH is a cost affordable alternative to high priced commercial engineering and management firms.

The End



Contact Information

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