Water Resources Utility of the Future

By

Mike Maringer

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According to calculations by the environmental biotechnologist Willy Verstraete, every 1000 gallons of waste water contains the equivalent of $1.88 worth of fertilisers, organic matter, energy-producing gases and more.

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For Every 1,000 gallons of sludge
@ 3% solids and 68% volatility

There is $3.06 in biogas($5.00/1,000Ft3)
and
$8.97 in electricity($0.05/KWH)

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Following a groundbreaking ceremony on March 26, 2014, Stanford is moving forward on the construction of the William and Cloy Codiga Resource Recovery Center, "CR2C" for short, whose main purpose will be to testbed and demonstrate scalability of promising wastewater treatment technologies and essentially serve as an innovation accelerator. One of the first key projects will be a test of resource recovery technology at pilot-scale, extracting clean water, nutrients, energy and chemical feedstocks from wastewater

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William and Cloy Codiga Resource Recovery Center

ACCELERATOR TESTBED SCALING FACILITY FOR WATER & ENERGY RESOURCE RECOVERY TECHNOLOGIES

Value Creation from Waste

R2C

Stanford University

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The Value of the Resource

Resource	Per m^3	US $ per m^3
Organic Soil Conditioner (kg)	0.10	0.03
Methane (m^3)	0.14	0.07
Nitrogen (kg)	0.05	0.07
Phosphorus (kg)	0.01	0.01
Water (1 m^3)	1.00	0.33

Source: Willy Verstraete (2008)

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Stanford engineers use rocket science to make wastewater treatment sustainable

Researchers encourage bacteria that produce nitrous oxide and methane in sewage sludge. The gases can then be cleanly burned to produce energy to run the plant.

Nitrosomonas europaea appears to produce N_2O by more than one mechanism. Moderate amounts are released under full aeration, but the release increases sharply in response to oxygen limitation. Poth and Focht showed that *N. europaea* denitrified with NO_2^- as the electron acceptor and that the labelling pattern observed (with either $^{15}NH_4^+$ or $^{15}NO_2^-$) indicated that N_2O was primarily a product of NO_2^- reduction, rather than a by-product of NH_3 oxidation. The presence of nitrite reductase in*N. europaea* has been demonstrated in several investigations and it is probably involved in the production of N_2O by this organism under oxygen-limiting conditions

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NITROUS STORAGE

- For racing purposes, nitrous oxide is usually contained in an aluminium cylinder; available in a variety of sizes ranging from 2.5 lbs to 20 lbs. While retained in the cylinder the nitrous is in a liquid form and held under high pressure. When it is released from the cylinder into the intake tract its physical state changes from a liquid to a gas. This transformation occurs as the nitrous is released from an area of extreme pressure (the aluminium cylinders are pressurized to approximately 1000 P.S.I.) into the vacuum of the intake manifold. This change in state is usually referred to as the nitrous 'boiling'.

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Gas Cleaning Technology

quasar has collaborated with **Air Products** to develop proprietary gas cleaning technology.

- Now biogas can be affordably upgraded to biomethane exceeding pipeline quality.
- **Ohio organic residuals represent the equivalent of 1,000,000,000 gallons of renewable fuel annually.**


Gas Cleaning


Gas Drying & Compression


Gas Separation
Air Products Prism® Membranes

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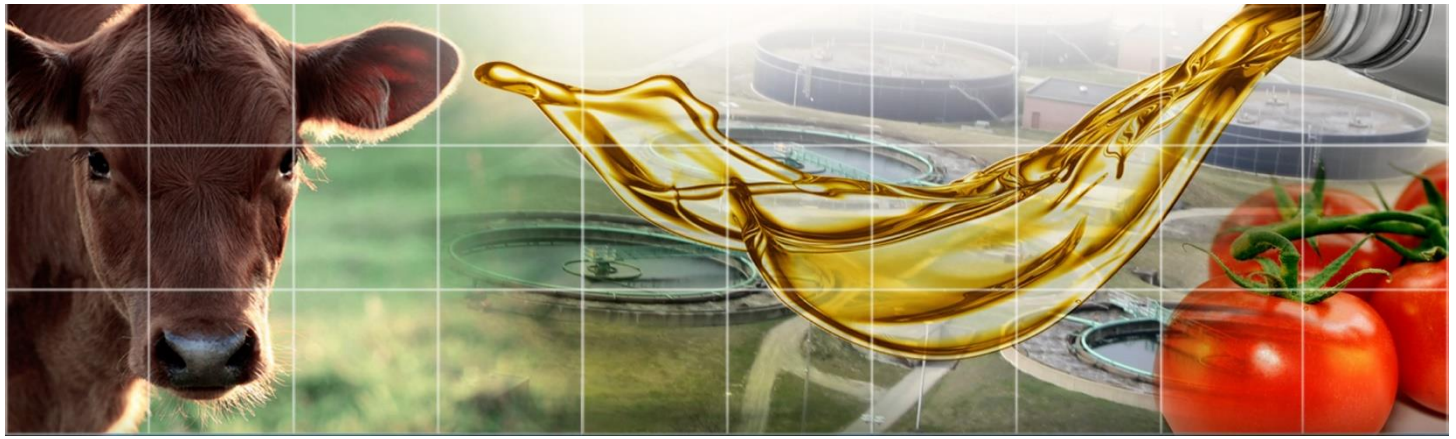
INPUTS



TYPES OF ORGANIC RESIDUALS:

- Food Processing Residuals
- Manure
- Energy Crops & Spent Grains
- Biobased Oils & Lubricants
- FOG (fats, oils & grease)
- Waste Water Treatment Sludge
- Personal Care Products
- Ethanol and Biodiesel processing residuals
- Dissolved Air Flotation (DAF)
- Expired, damaged or off-spec consumer goods
- Packaged Organics (depackaging technology)
- Crop Residuals
- Glycerin & Stillage
- Whey
- Sugar Water

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Food Waste Has Three (3) Times the Methane Production Potential As Biosolids

- Cattle Manure = 25m^3 gas / ton
- Biosolids = 120m^3 gas / ton
- Food Waste = 376m^3 gas / ton

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The Cleveland Indians

- The Cleveland Indians have cut the amount of waste going to the landfill in half over 4 years.
- In 2012, the organization sent approximately 60 tons of food waste to a compost facility.
- They will be able to recycle **80 to 100 tons of food waste** with macerating technology and AD.

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ANAEROBIC DIGESTION SOLUTIONS

- **The Cleveland Indians** have cut the amount of waste going to the landfill in half over 4 years
- In 2012, the organization sent approximately 60 tons of food waste to a compost facility
- Going forward, it is estimated that they will be able to recycle **80 to 100 tons of food waste** through quasar's more efficient waste management and transportation system and InSinkErator's macerating technology

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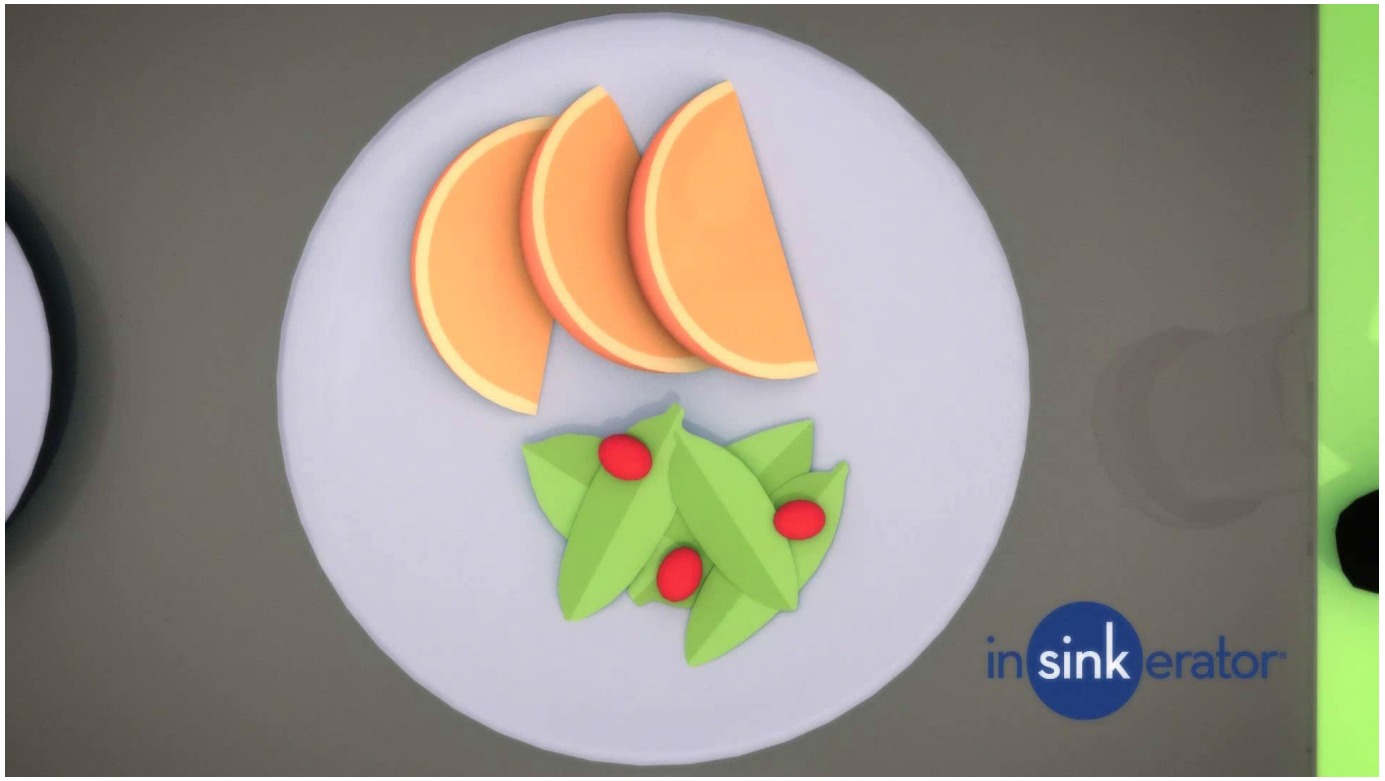
Solutions - Food waste management



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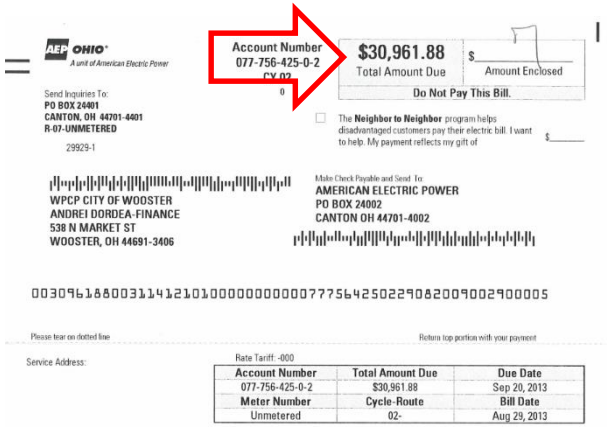
Do you really see the savings?

August 2013 Invoice


AEP OHIO
A unit of American Electric Power

Account Number
077-756-425-0-2
CY 02
0

$30,961.88
Total Amount Due

$ _____
Amount Enclosed

Do Not Pay This Bill.

Send Inquiries To:
PO BOX 24401
CANTON, OH 44701-4401
R-07-UNMETERED
29929-1

The Neighbor to Neighbor program helps disadvantaged customers pay their electric bill. I want to help. My payment reflects my gift of $_____

WPCP CITY OF WOOSTER
ANDREI DORDEA-FINANCE
538 N MARKET ST
WOOSTER, OH 44691-3406

Make Check Payable and Send To:
AMERICAN ELECTRIC POWER
PO BOX 24002
CANTON OH 44701-4002

00309618800311141210100000000000777564250229082009002900005

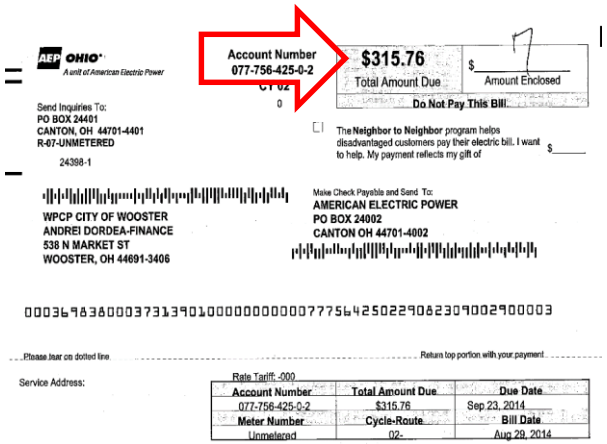
Please tear on dotted line — Return top portion with your payment

Service Address:

Rate Tariff: -000

Account Number	Total Amount Due	Due Date
077-756-425-0-2	$30,961.88	Sep 20, 2013
Meter Number	Cycle-Route	Bill Date
Unmetered	02-	Aug 29, 2013

August 2014 Invoice


AEP OHIO
A unit of American Electric Power

Account Number
077-756-425-0-2
CY 02
0

$315.76
Total Amount Due

$ _____
Amount Enclosed

Do Not Pay This Bill.

Send Inquiries To:
PO BOX 24401
CANTON, OH 44701-4401
R-07-UNMETERED
24398-1

The Neighbor to Neighbor program helps disadvantaged customers pay their electric bill. I want to help. My payment reflects my gift of $_____

WPCP CITY OF WOOSTER
ANDREI DORDEA-FINANCE
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Make Check Payable and Send To:
AMERICAN ELECTRIC POWER
PO BOX 24002
CANTON OH 44701-4002

00036983800037313901000000000007775645025229082309002900003

Please tear on dotted line — Return top portion with your payment

Service Address:

Rate Tariff: -000

Account Number	Total Amount Due	Due Date
077-756-425-0-2	$315.76	Sep 23, 2014
Meter Number	Cycle-Route	Bill Date
Unmetered	02-	Aug 29, 2014

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Foster's: Australian for Electricity
Drunk scientists play with fuel cells and biogas

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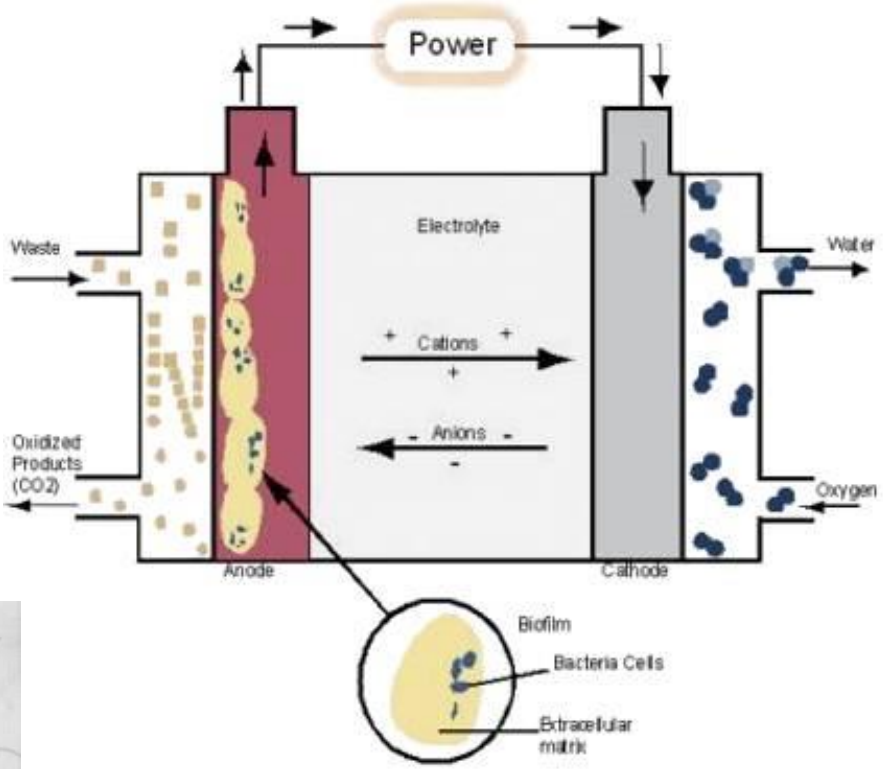
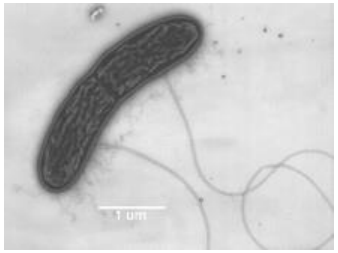
Microbial Fuel Cell





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12 Tubular MFC Modules

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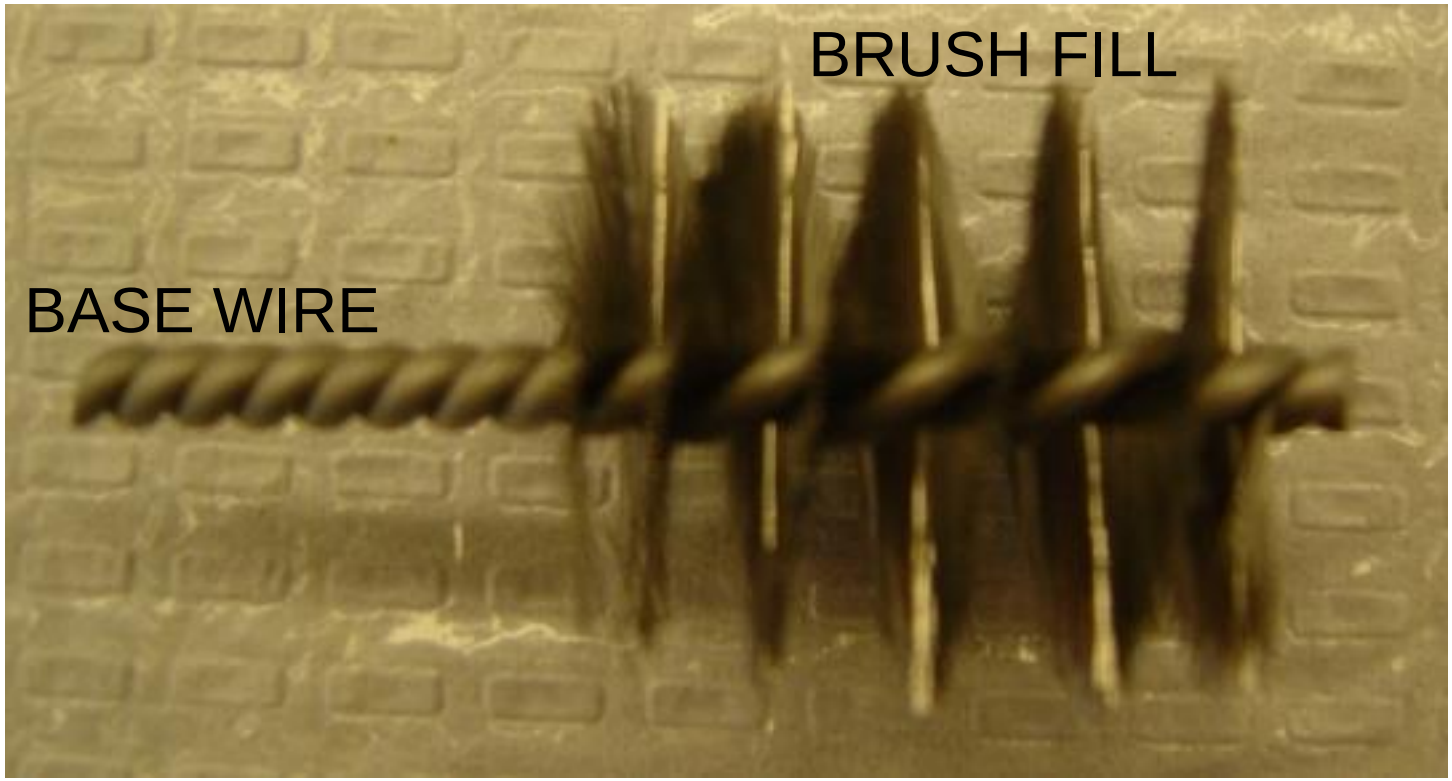
Stainless Steel Media Electrode



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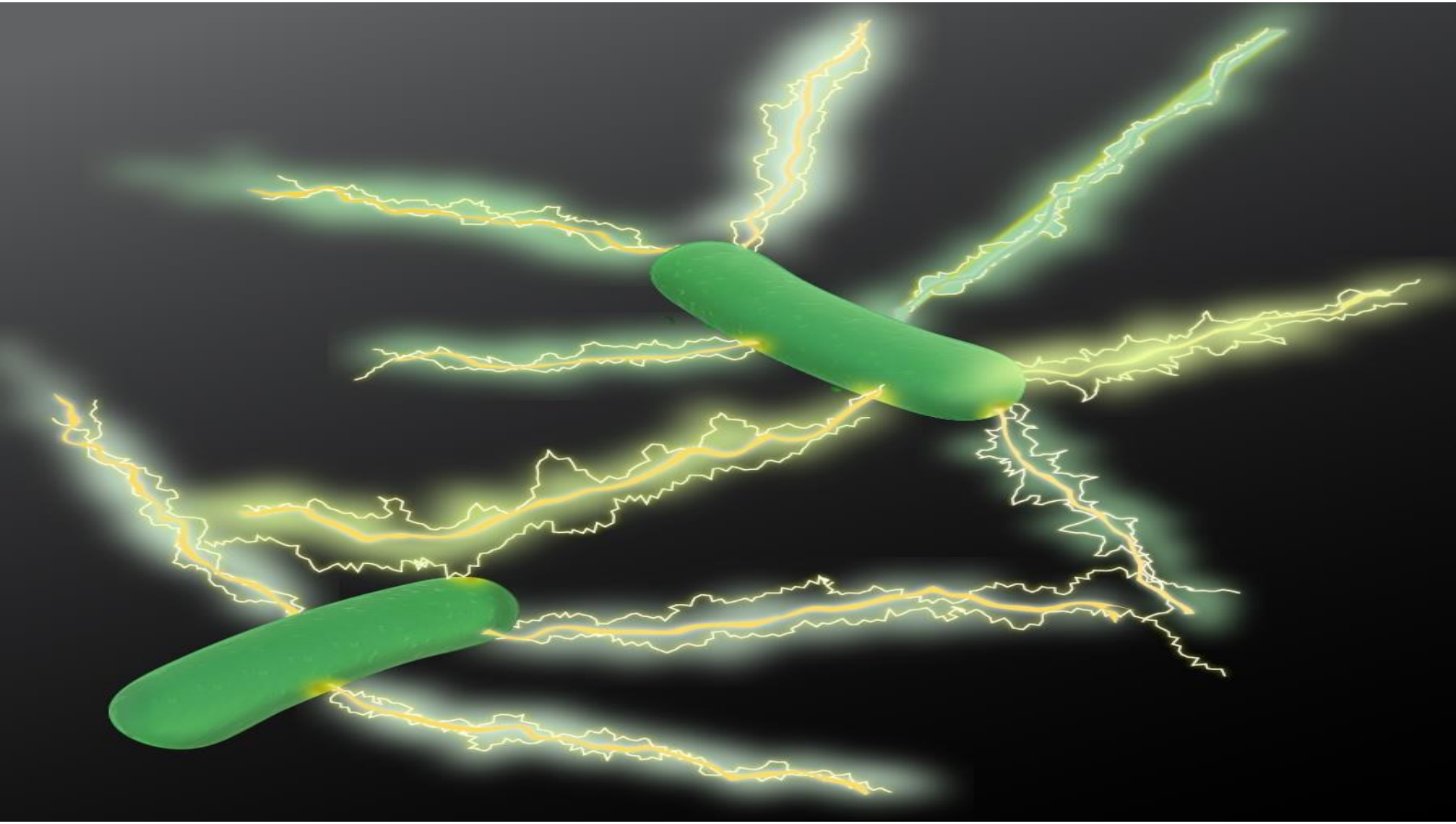

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MANGO MATERIALS

Realizing the Value of Biogas System By-Products

Anne Schauer-Gimenez VP of Methane Marketing
Anne@mangomaterials.com

@MangoMaterials

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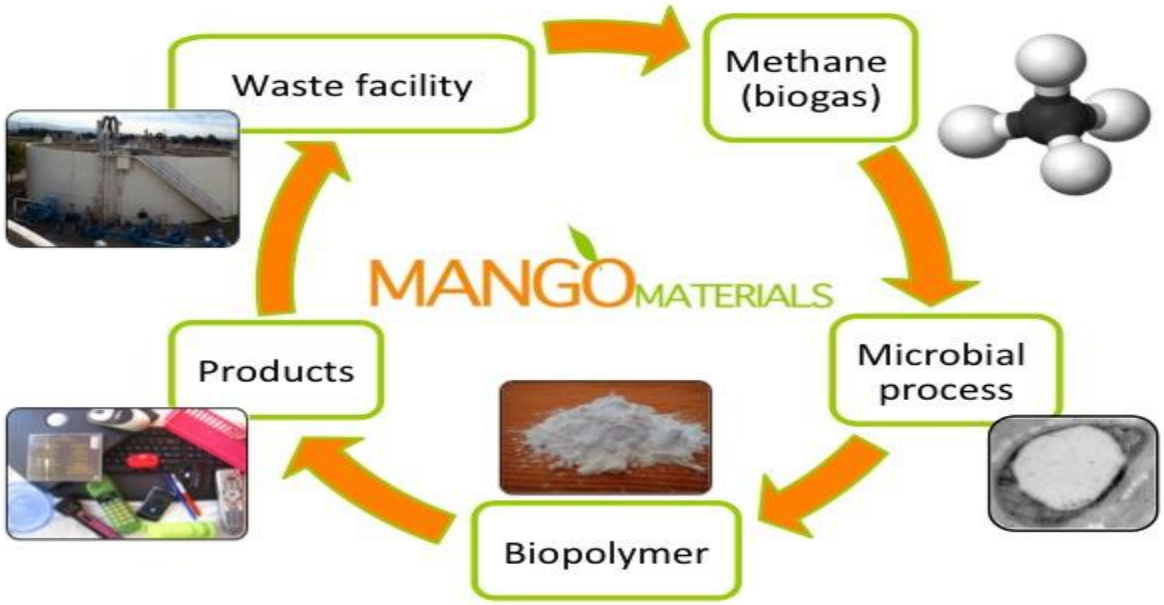

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Waste methane **Bioreactor** **Bioplastic**

Patent-protected by IP licensed from Stanford University

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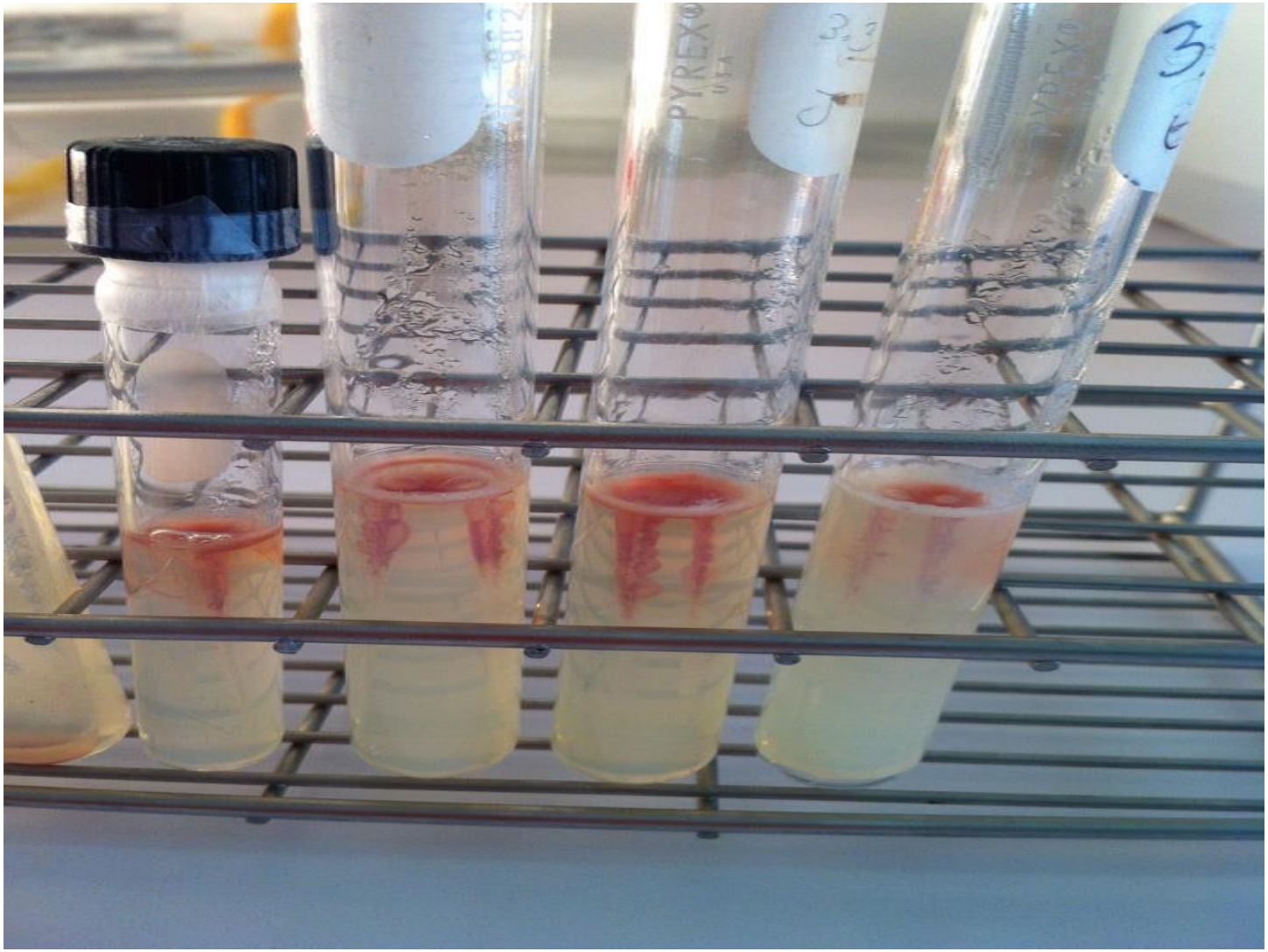

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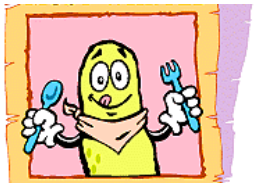
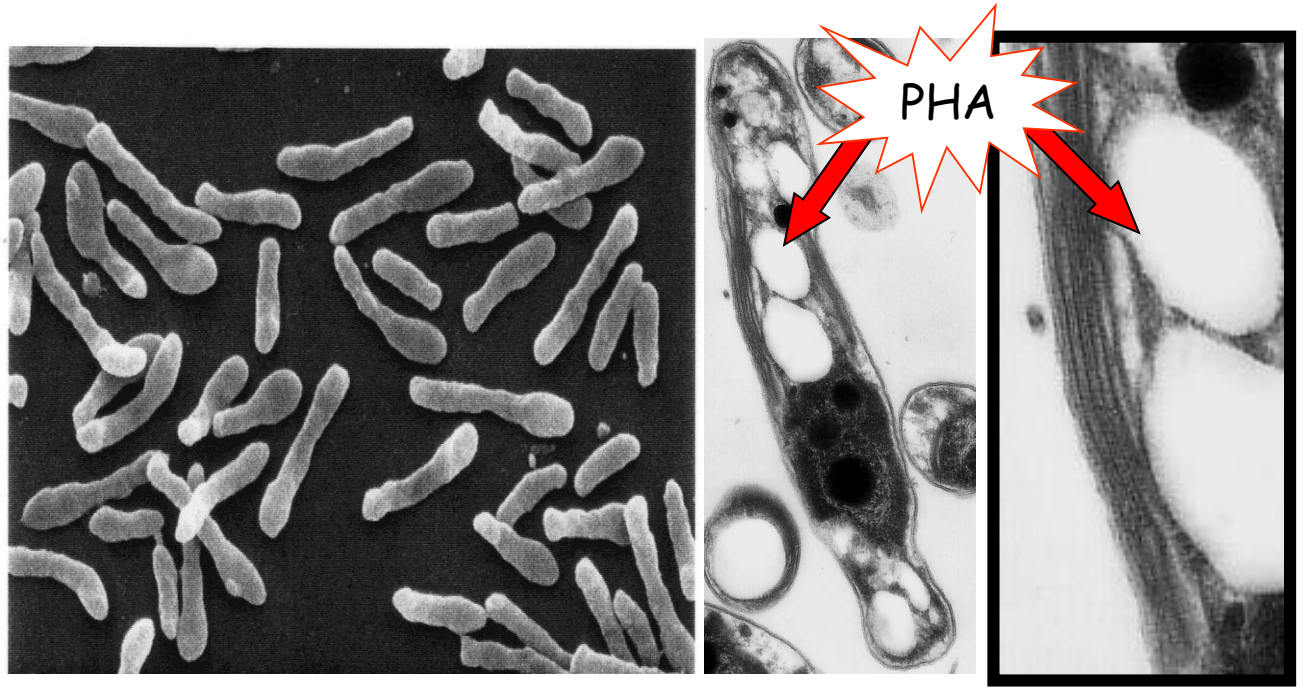


TN1: the right microbe to do the job

- Can use VFAs as food.
- Makes LOTS of hydrogen and PHA.
- Can grow aerobically and anaerobically.



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PHA bottle biodegradation over a period of 2 months.

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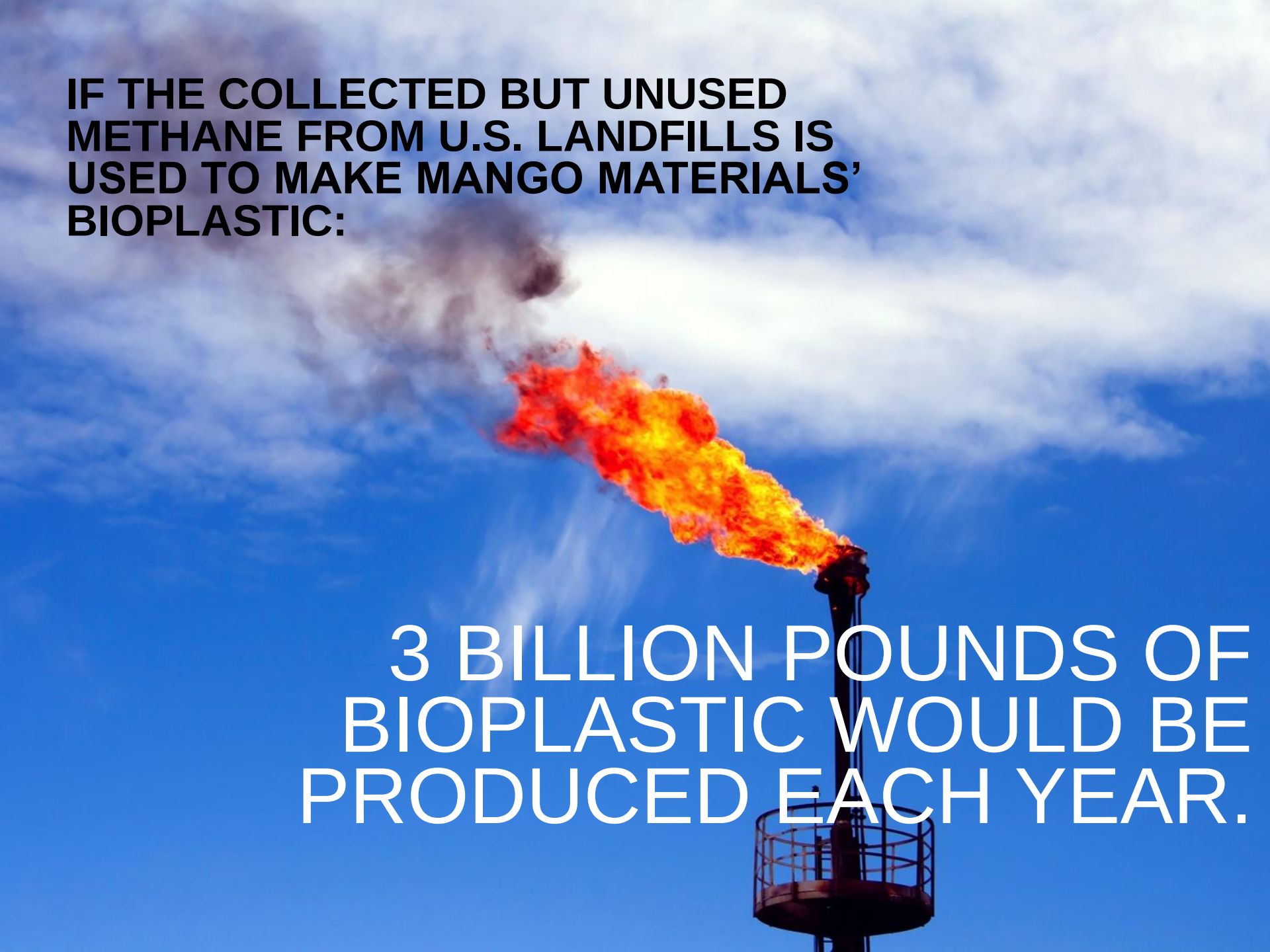
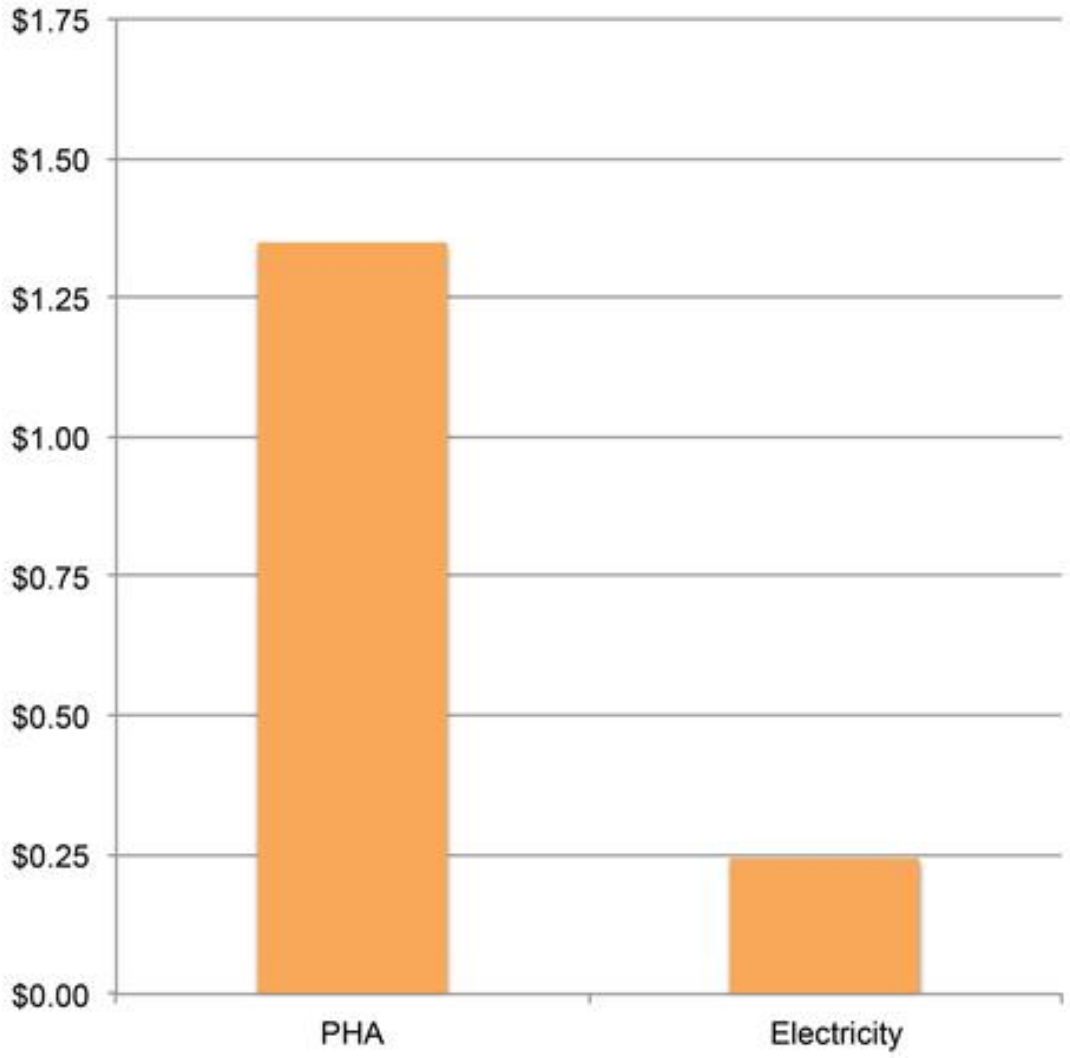
IF THE METHANE FROM U.S. WATER RESOURCE RECOVERY FACILTIES IS USED TO MAKE MANGO MATERIALS' BIOPLASTIC:
MORE THAN 250 MILLION POUNDS OF BIOPLASTIC WOULD BE PRODUCED EACH YEAR.


IF THE COLLECTED BUT UNUSED METHANE FROM U.S. LANDFILLS IS USED TO MAKE MANGO MATERIALS' BIOPLASTIC:
3 BILLION POUNDS OF BIOPLASTIC WOULD BE PRODUCED EACH YEAR.

Total Sales Per Pound of Methane



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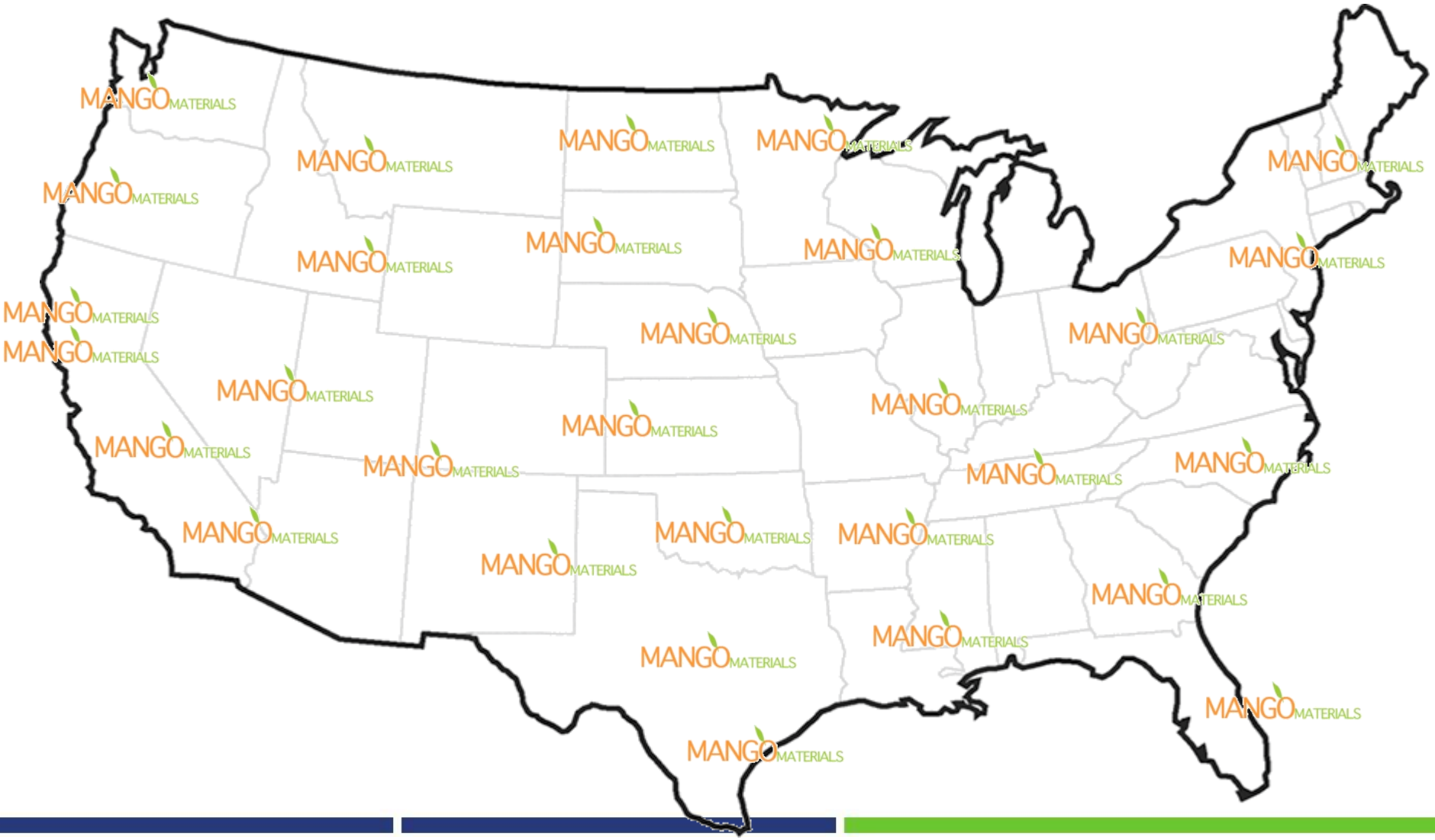
Decentralized Production



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The pilot plant is chugging along. We are currently running it to produce customer samples and are focused on producing as much product as possible right now. We are actively fundraising for the next scale, a demonstration facility (to be located at the same WWTP) that will produce thousands of pounds of polymer per week. This increased volume will greatly accelerate our customer and product development. Depending on our financing situation, we anticipate having this unit up and running by the end of the year. That unit will also allow us to bring downstream equipment on-site for trials in order to verify the needs of the full-scale unit.

Once the demo unit is operational and these pieces of equipment have been verified, we will then be ready for commercial scale. Right now we are on track for 18-24 months for commercial deployment. I love the idea of the Utility of the Future! Do you know what the new capacity of the Lucas County plant (wastewater flow and methane production)? Anne Schauer-Gimenez, Ph.D. - VP of Methane Marketing - Mango Materials

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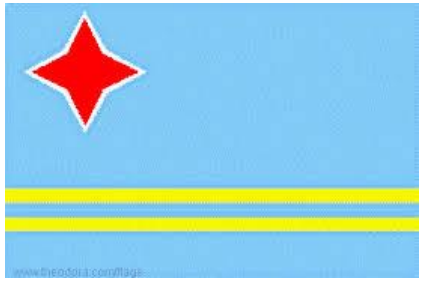

We live on a small island called Aruba with a population of approx 120.000 and our economy depends allot on tourist. Our government just had pass a law and banned the use of plastic bags in supermarkets.
Mike had enlightened us about Mango's Project that is really amazing and we think it will be the future in such products.

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A CLOSED LOOP
PLASTIC ECONOMY
IS NOW POSSIBLE
– LET'S BUILD IT!

Urine turned into hydrogen fuel

US researchers have developed an efficient way of producing hydrogen from urine - a feat that could not only fuel the cars of the future, but could also help clean up municipal wastewater.

Using hydrogen to power cars has become an increasingly attractive transportation fuel, as the only emission produced is water - but a major stumbling block is the lack of a cheap, renewable source of the fuel.

Gerardine Botte of Ohio University may now have found the answer, using an electrolytic approach to produce hydrogen from urine - the most abundant waste on Earth *- at a fraction of the cost of producing hydrogen from water.*

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Imagine powering your home with waste bi-products. You could essentially power your home with pee. Adult human being produces 1-2 liters of urine per day. 1 liter is enough to power a small generator for 6 hours. How do we know this? A 14 year old girl and her friends from Nigeria, Africa created a system that separates the hydrogen and oxygen in urine, purifies the hydrogen and uses it to power a generator.

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The system works like this:

Urine is put into an electrolytic cell, which separates out the hydrogen.

The hydrogen goes into a water filter for purification, which then gets pushed into the gas cylinder.

The gas cylinder pushes hydrogen into a cylinder of liquid borax, which is used to remove the moisture from the hydrogen gas.

This purified hydrogen gas is pushed into the generator

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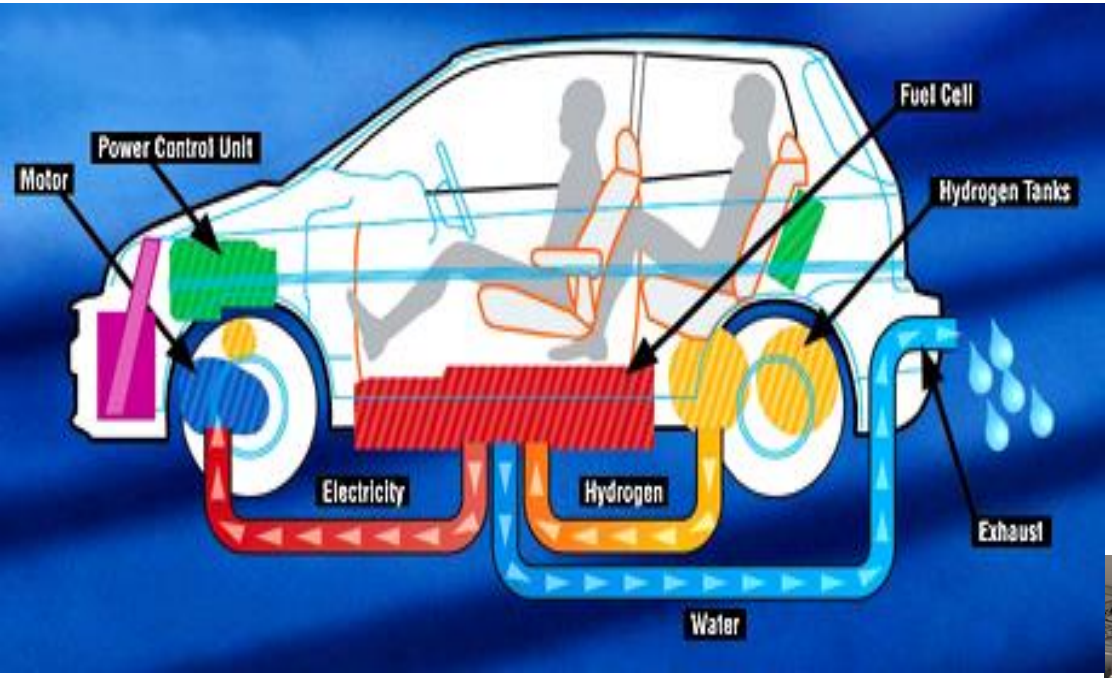

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California Drought: Orange County expands 'toilet to tap' water recycling

The process works by re-routing a proportion of the 1.3 billion gallons of waste water generated in Southern California each day into a three-step treatment. The first is microfiltration of the treated waste water to remove solids, oils and bacteria, before the resulting liquid goes through reverse osmosis, pushing it through a fine plastic membrane that filters out viruses and pharmaceuticals. The water is then treated with UV light to remove any remaining organic compounds, before joining the main groundwater supply, which must pass strict quality controls to meet legal standards, and distribution to households.

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Wastewater Reuse Policy

- DEP has developed interim guidance
- Allowable uses:
  - Golf course irrigation
  - Landscape irrigation
  - Toilet flushing
  - Aquifer recharge
- Treated to a high quality to meet reuse standards

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Reclaimed water hydrant (purple pipes)

Evanston, Illinois (home of Northwestern U.)
Everything there is purple

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ALGAGLUCAN NUTRINSIC

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Management Team

Paul Horst (CEO). Jim Fahrner (CFO)

- Founded industrial computer company, 9x cash over cash exit in 3 years, later spun off as NASDAQ company
- Grew alternative energy subsidiary of DTE Energy to over $40M

Geoff Horst (CSO), Robert Levine (CTO)

- Developed Algal's patent-pending treatment process
- PhD candidates in biology and chemical engineering

Mike Maringer, James Bleyer (operations, engineering)

- Managed Campbell Soup's largest wastewater treatment plant (10 million gallons per day), highest certification
- Designed and built bio-fuel plants

Notable Advisors: Joh Kang, Walter Weber

- PhD, VP & Director of water at Tetra Tech
- PhD, Professor Emeritus, U. Michigan

Engineering Partners

- Alan Environmental – John Baker
- Tetra Tech

45

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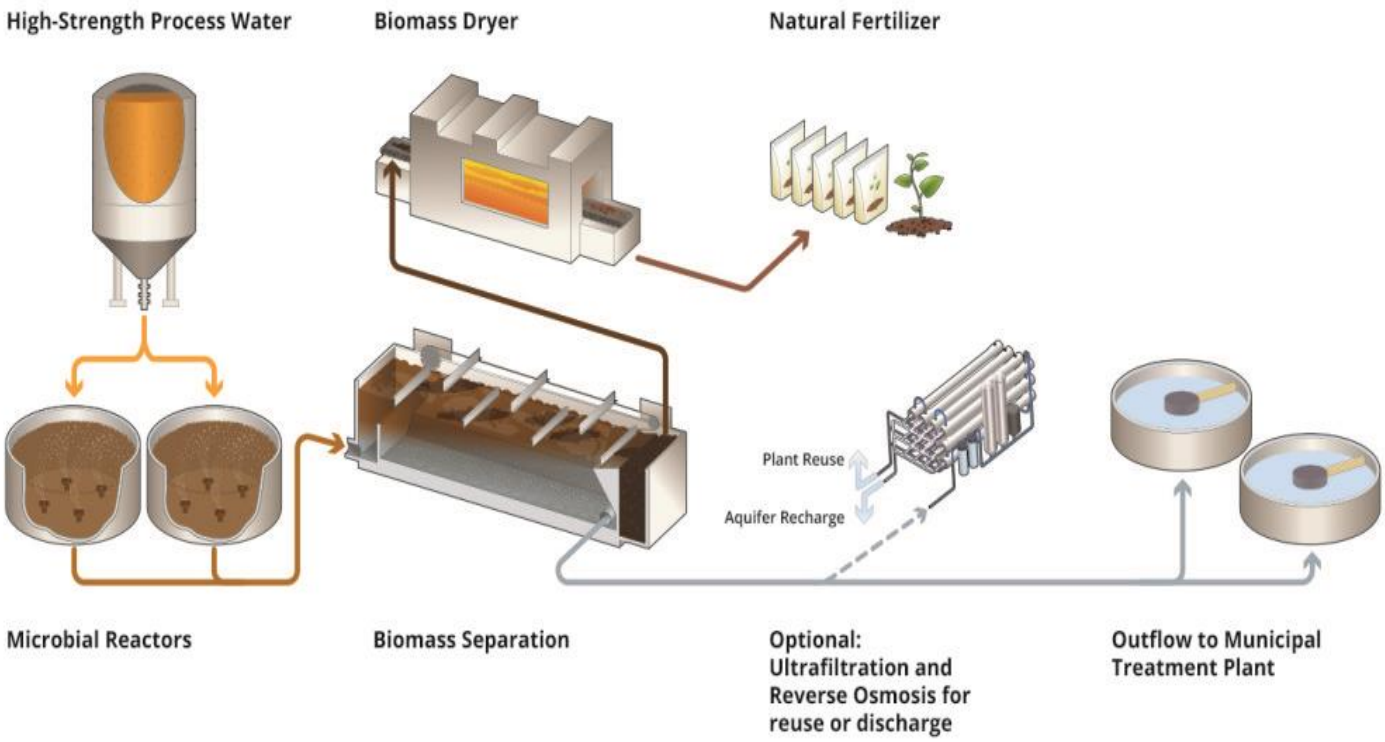

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ALGAMUNE

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For those of you not familiar with supercritical water oxidation, the basic premise is that once water goes above 370 Deg C and 220 Bar of pressure(3,190 psi), it enters a fourth state, referred to as supercritical. If you introduce oxygen into supercritical water, you can completely oxidise organic material. This releases energy which can be used in a CHP plant and produces an inert ash-like material and water (supernatant) with a COD of less than 5mg/l.

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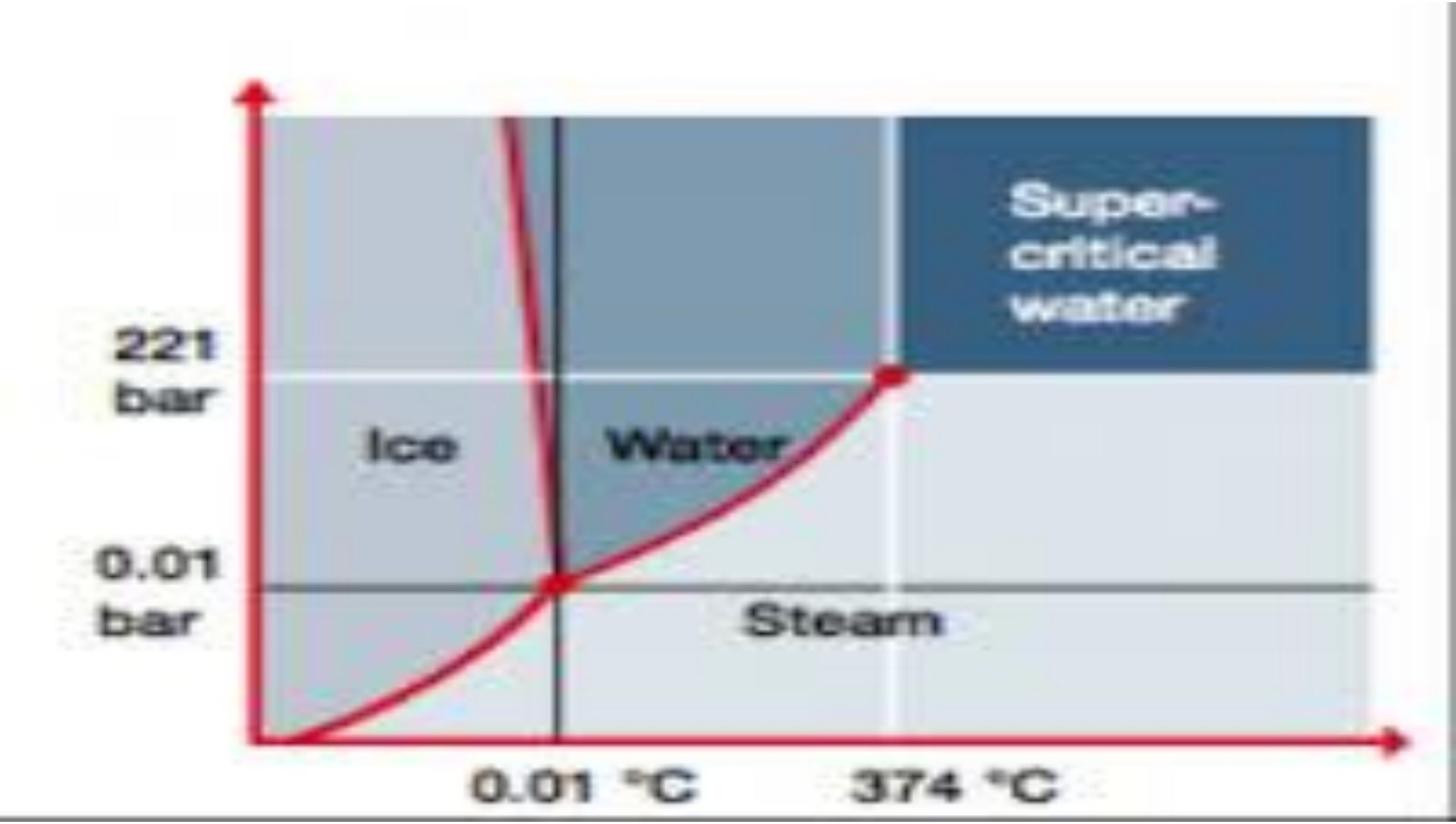

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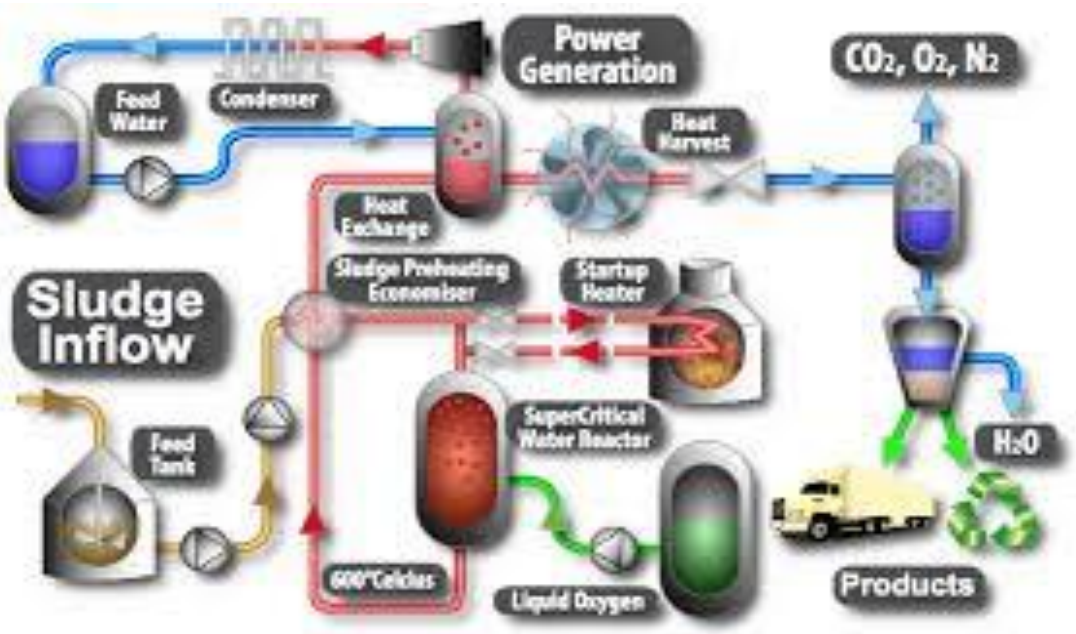

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What is SCWO?

- Supercritical Water Oxidation uses high pressure and temperature water to treat sludge
- Organic material dissolves in supercritical water. In the presence of oxygen, organic material will chemically combust (burn without flame) at SCWO temperatures and pressures.
- End result is inert ash, metal salts, water, carbon dioxide and heat
- The heat energy is captured through heat exchangers and will be used to power a steam turbine

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SCWO upsides

- Technology results in complete destruction of organic material in sludge
- Provides the highest level of treatment recognized by regulatory agencies
- Produces excess energy and usable by-products (CO_2, phosphorus and hot water)
- Provides all weather solution and is not dependent on land application

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Supercritical Water Oxidation (SCWO) is an innovative and effective destruction method for organics in sewage sludge. The SCWO process leaves a slurry of inorganic ash in a pure water phase free from organic contaminants, which opens possibilities for a simple process to recover components like phosphates from the sewage sludge. In a continuous pilot plant for the SCWO process digested sludge has been treated. The ash has been extracted in lab scale with both caustic and acids in order to recover phosphates. By leaching the ash with caustic, 90% of the phosphorus could be separated as a sodium phosphate solution. By treating the sodium phosphate solution with lime, calcium phosphate was precipitated and caustic recovered and circulated back to the leaching process

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Ca PO4

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Long Term Financial Considerations

	Capital Cost at 35 dry tons per day	Operating cost/ D.T.	Annual operating cost
Land Application	$32,850,000 (2190 acres at $15,000)	$257	$3,283,175
SCWO	$33,698,000	$268	$3,423,700
Gasification	$38,682,000	$286	$3,653,650
Pelletization	$30,381,000	$429	$5,480,475
Incinerator	$53,496,000	$647	$8,265,425

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Thank-you

you're creating the future

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