

## DEER CREEK

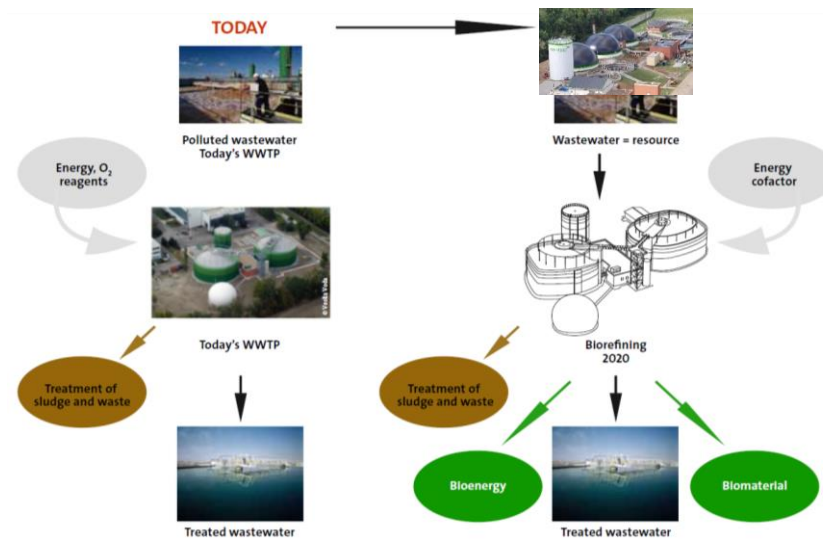
August 2015

# The Innovation of Transforming Wastewater Treatment Plants into Water Resource Recovery Facilities



## ANAEROBIC DIGESTION - WASTEWATER TREATMENT

Over the next 10 years, wastewater treatment plants (WWTP) will undergo profound changes






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

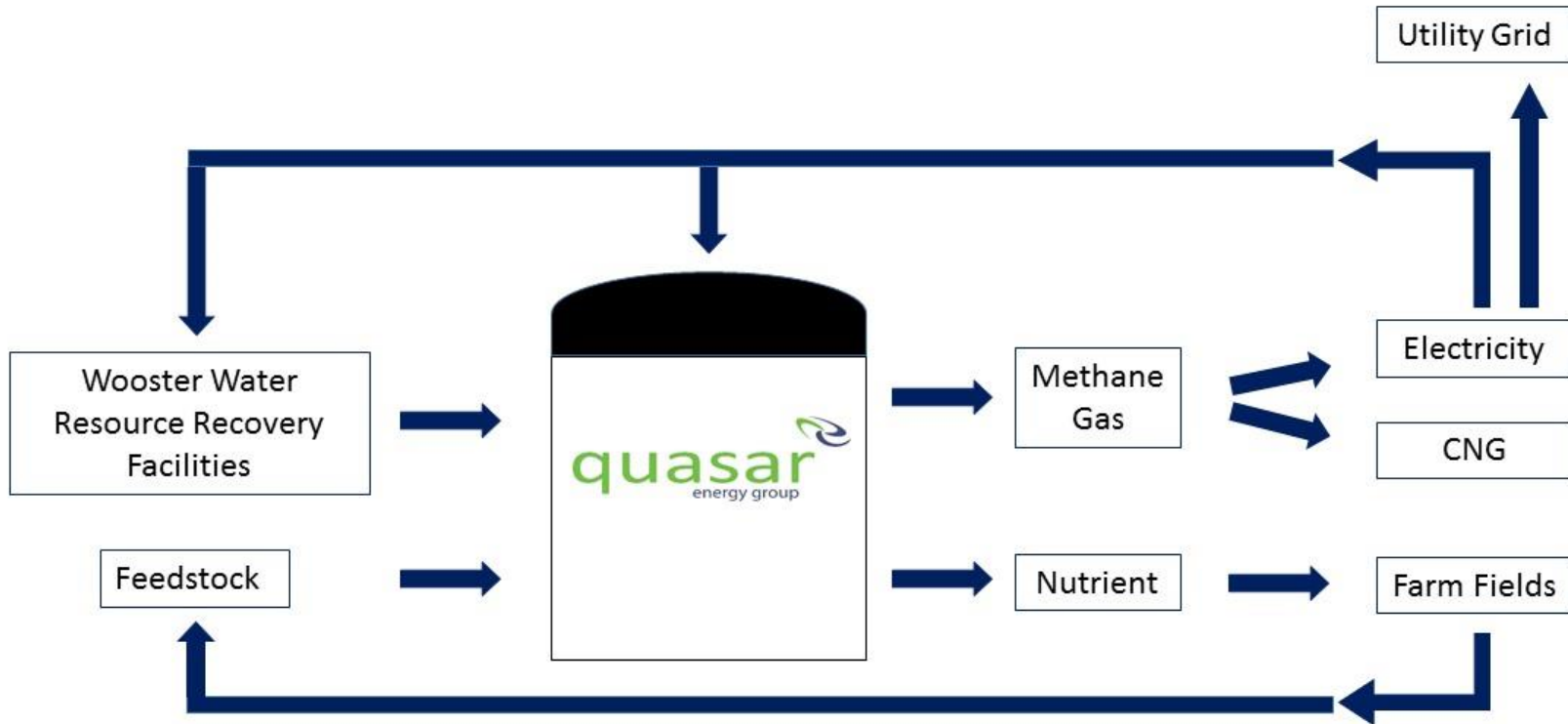
## The Value of the Resource

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



Source: Willy Verstraete (2008)

# Process Flow Chart



Welcome to the Future...





## 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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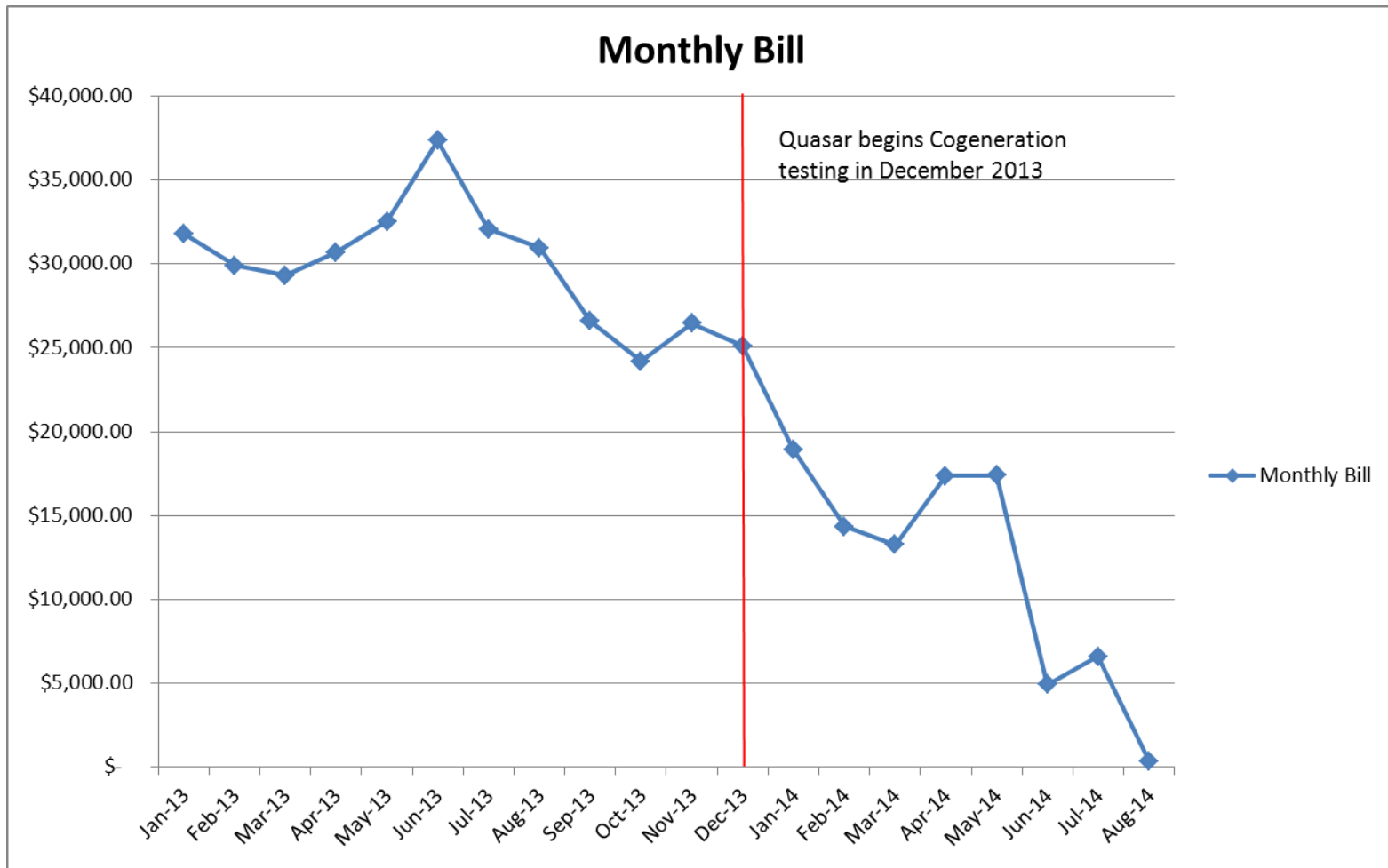
## Chevy CNG Vehicle





# How Quickly did the City benefit?

## Monthly Electric Bill City of Wooster (Ohio)



# Do you really see the savings?

## August 2013 Invoice

**AEP OHIO\***  
A unit of American Electric Power

Send Inquiries To:  
PO BOX 24001  
CANTON, OH 44701-4401  
R-07-UNMETERED  
29929-1

Account Number: 077-756-425-0-2  
Total Amount Due: **\$30,961.88**  
Amount Enclosed: \$

**Do Not Pay This Bill.**

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

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

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

00309618800311412101000000000077564250229082009002900005

Please tear on dotted line

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

Send Inquiries To:  
PO BOX 24001  
CANTON, OH 44701-4401  
R-07-UNMETERED  
24398-1

Account Number: 077-756-425-0-2  
Total Amount Due: **\$315.76**  
Amount Enclosed: \$

**Do Not Pay This Bill.**

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

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

WPCP CITY OF WOOSTER  
ANDREI DORDEA-FINANCE  
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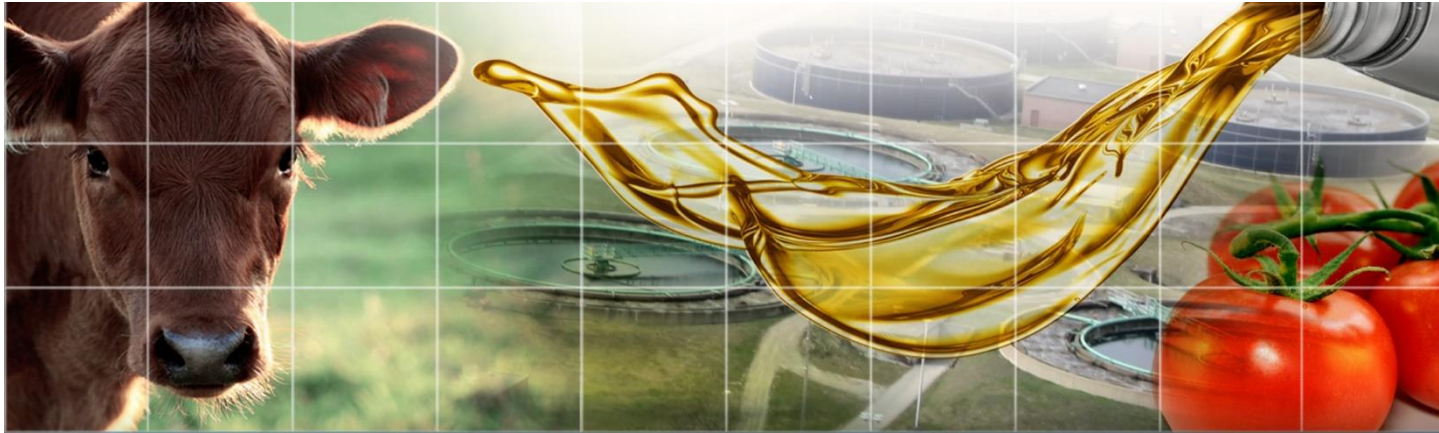
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Please tear on dotted line

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

## 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

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

- Cattle Manure =  $25\text{m}^3$  gas / ton
- Biosolids =  $120\text{m}^3$  gas / ton
- Food Waste =  $376\text{m}^3$  gas / ton







## 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.

15



## ANAEROBIC DIGESTION

## SOLUTIONS



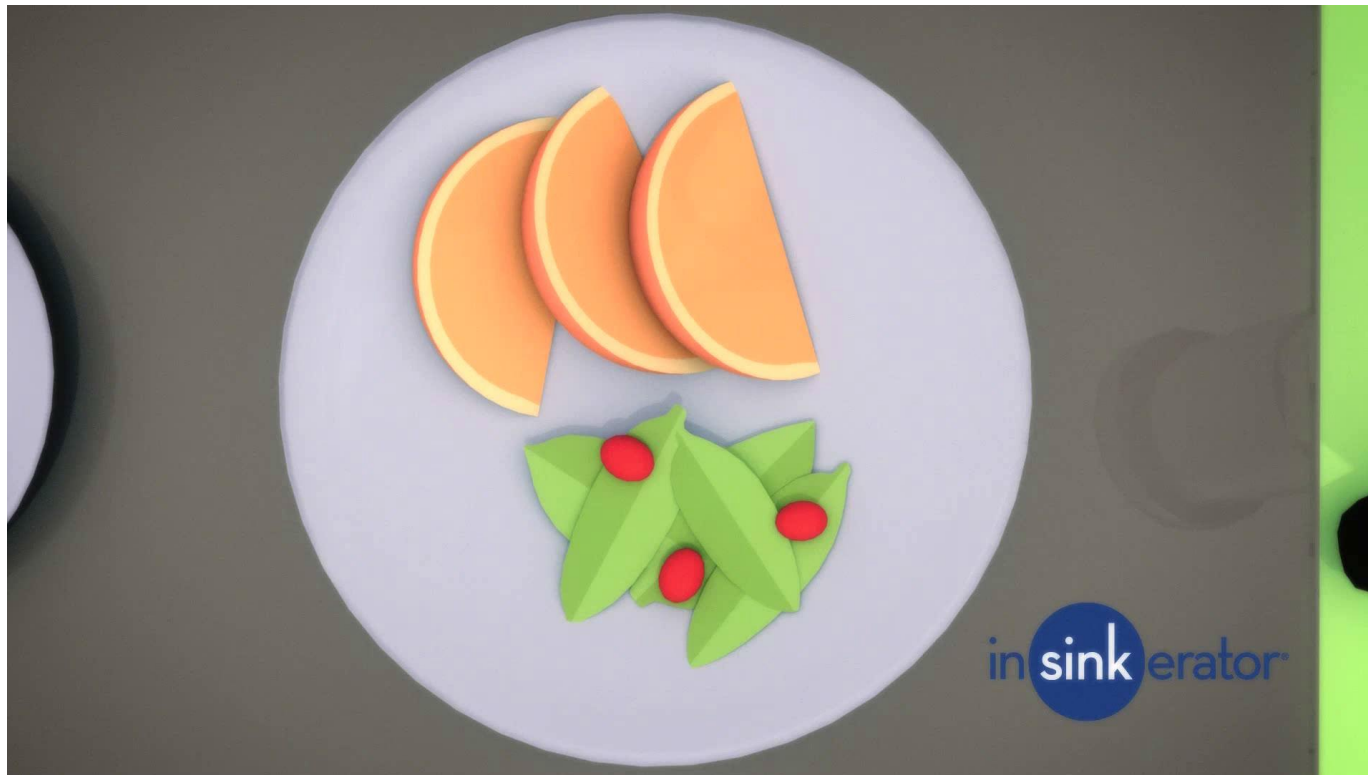
- **The Cleveland Indians** have cut the amount of waste going to the landfill in half over 4 years
- In 2012, the organization sent approximately 60 tons of food waste to a compost facility
- Going forward, it is estimated that they will be able to recycle **80 to 100 tons of food waste** through quasar's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

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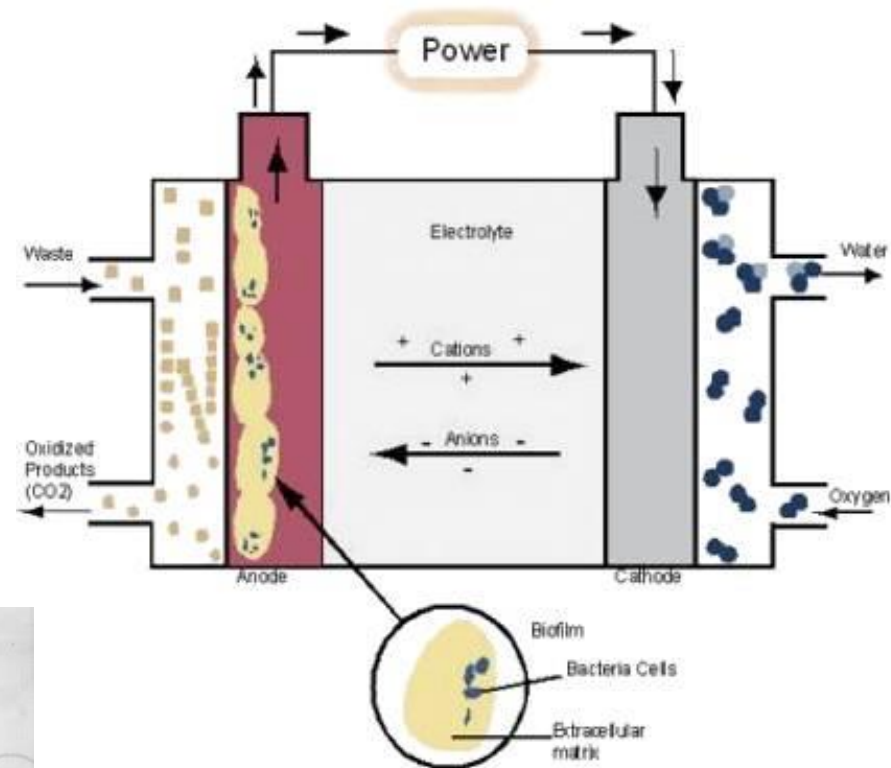
turning food scraps into renewable energy & nutrient-rich fertilizer

## Solutions - Food waste management





# Microbial Fuel Cell



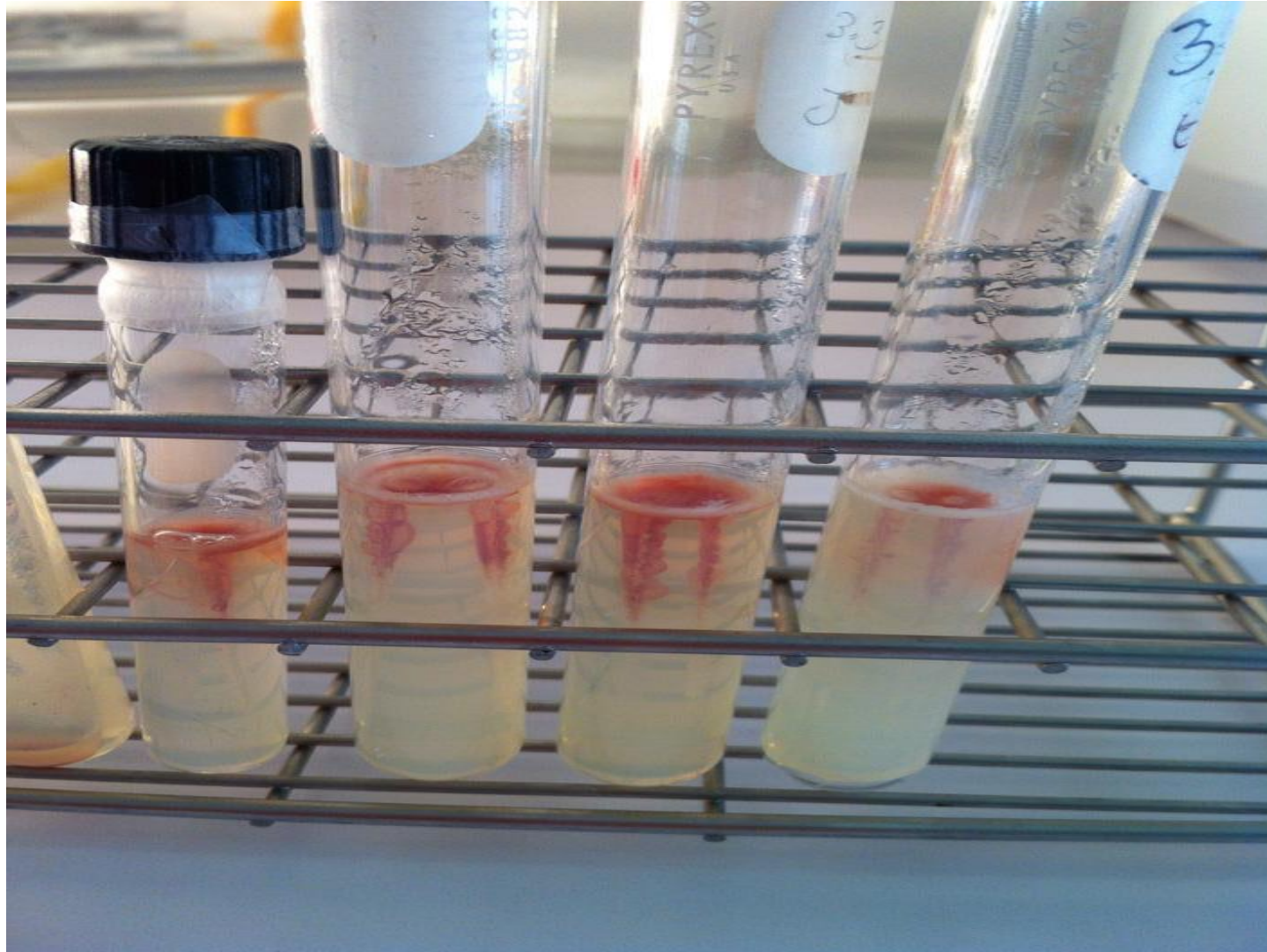


# 12 Tubular MFC Modules





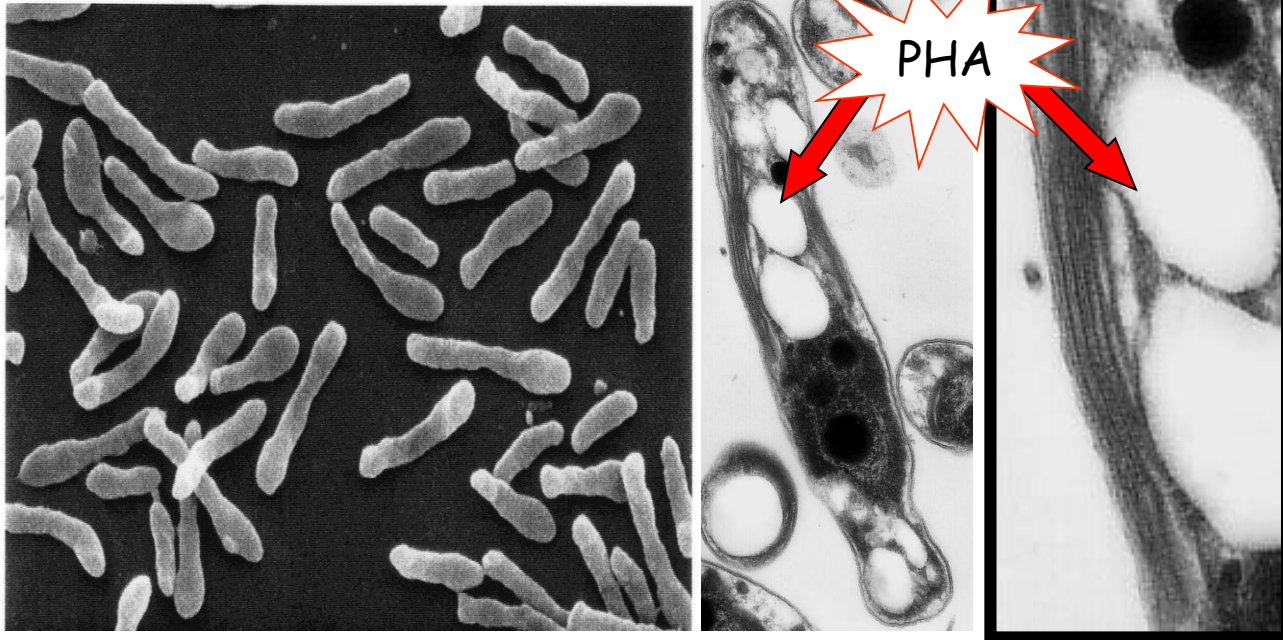






## TN1: the right microbe to do the job

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





PHA bottle biodegradation over a period of 2 months.

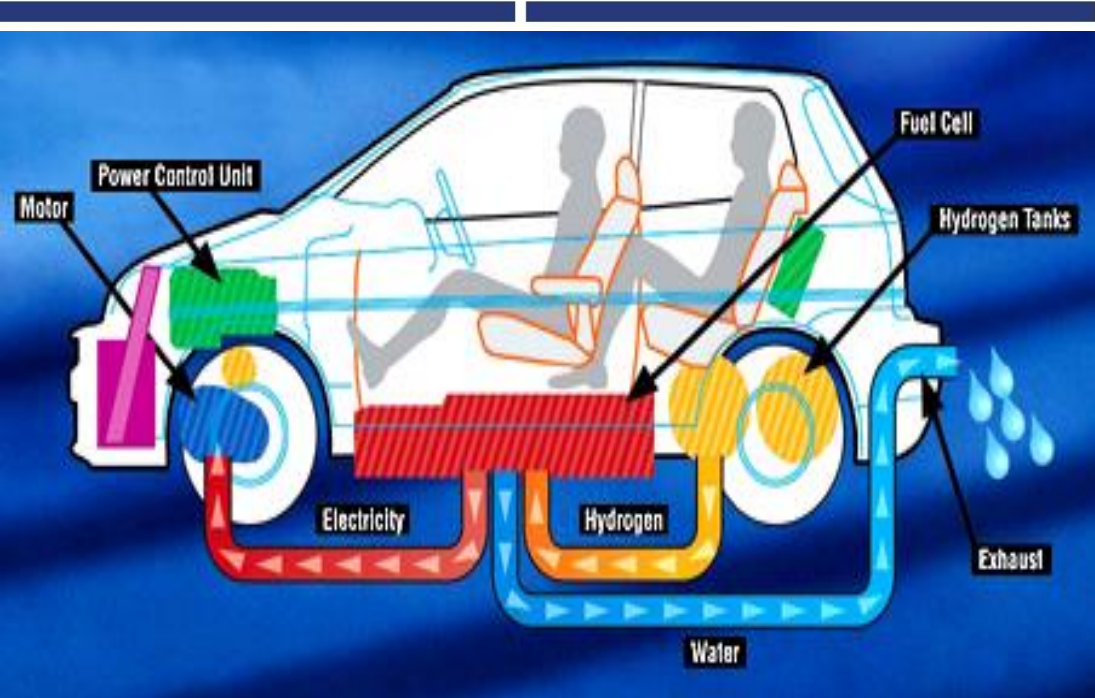
Mike, I would like to introduce you to Mr Kent Shields, CEO, E3 Clean technologies. Dr Botte, is a professor at OU, Athens. We got in touch with them, while we were looking to solve the problem of high concentration Ammonia water.

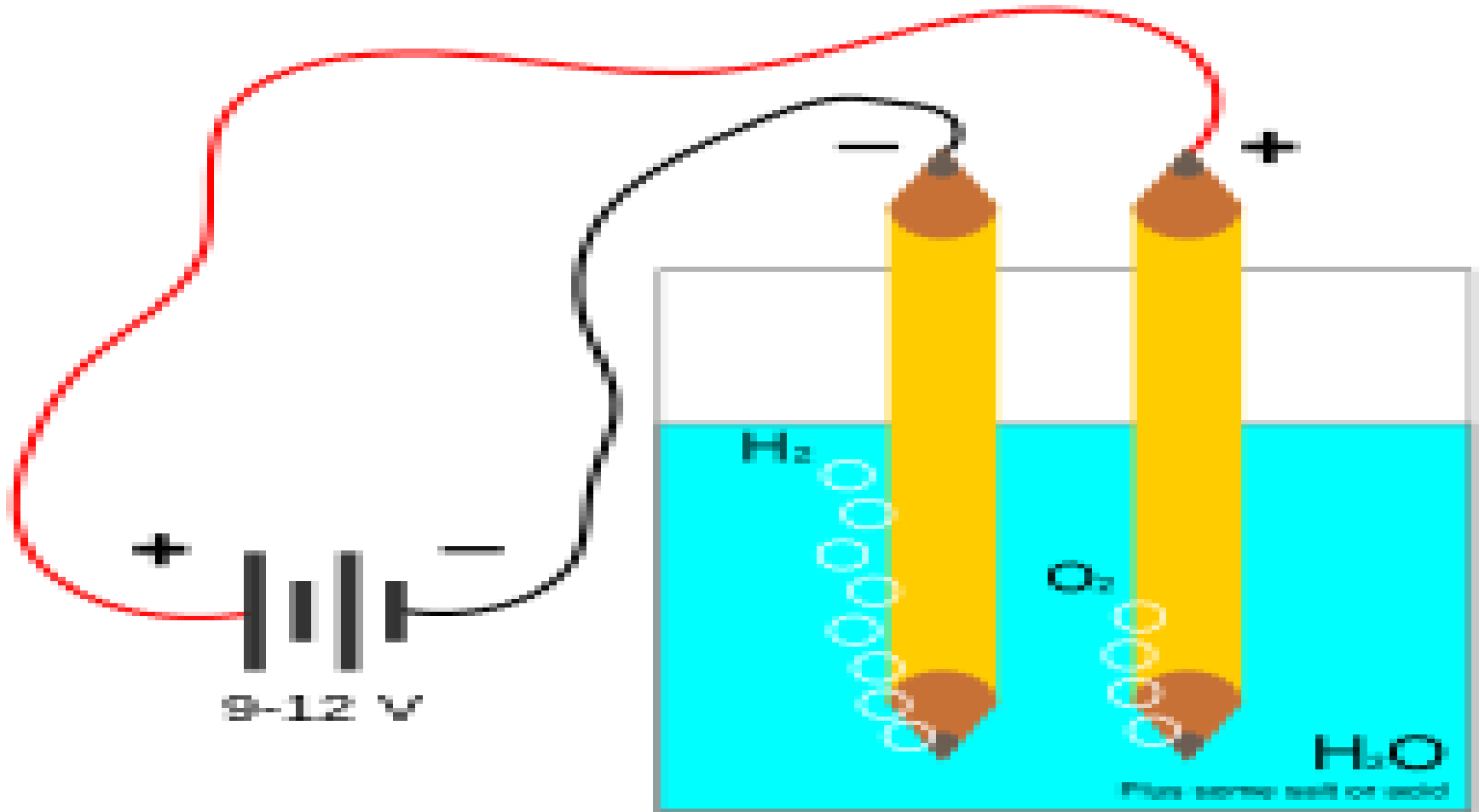
E3 clean technologies uses electrolysis of Ammonia water to produce hydrogen gas.

"Water will be the coal of the future  
confidence in 1874 Jules Verne

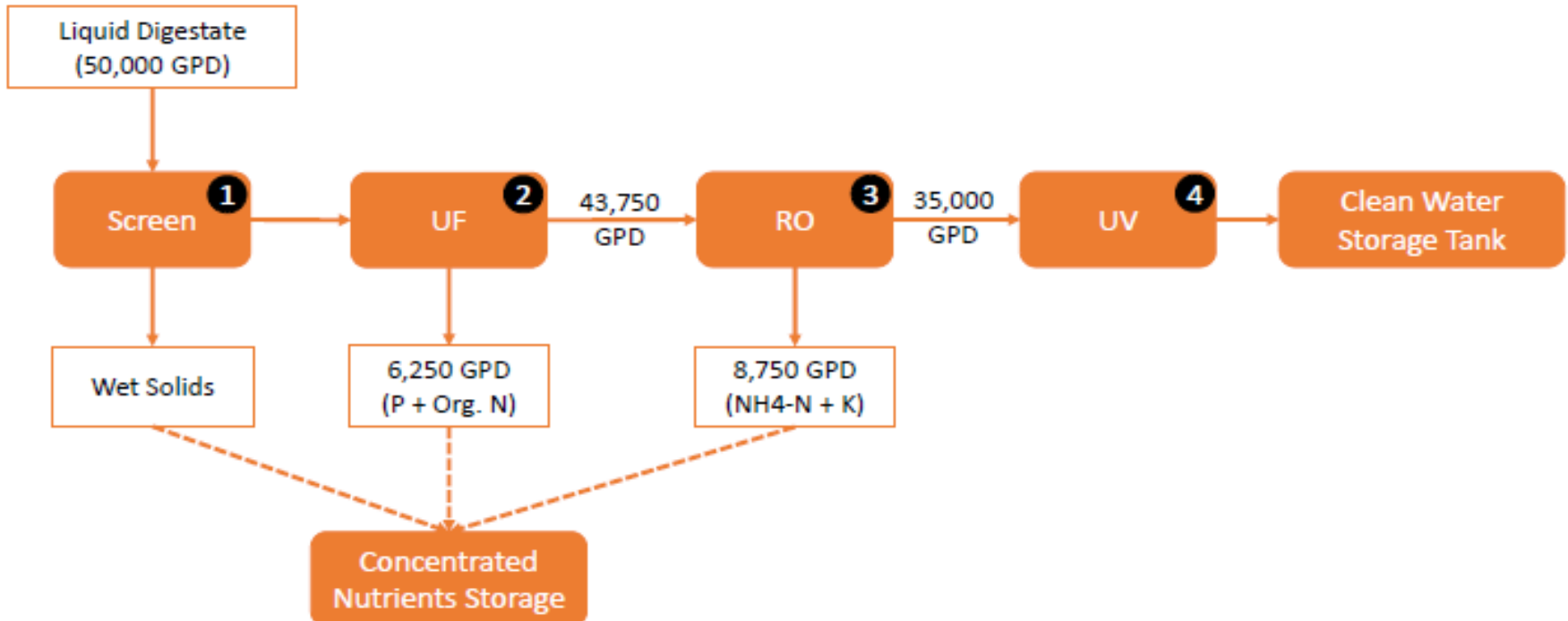




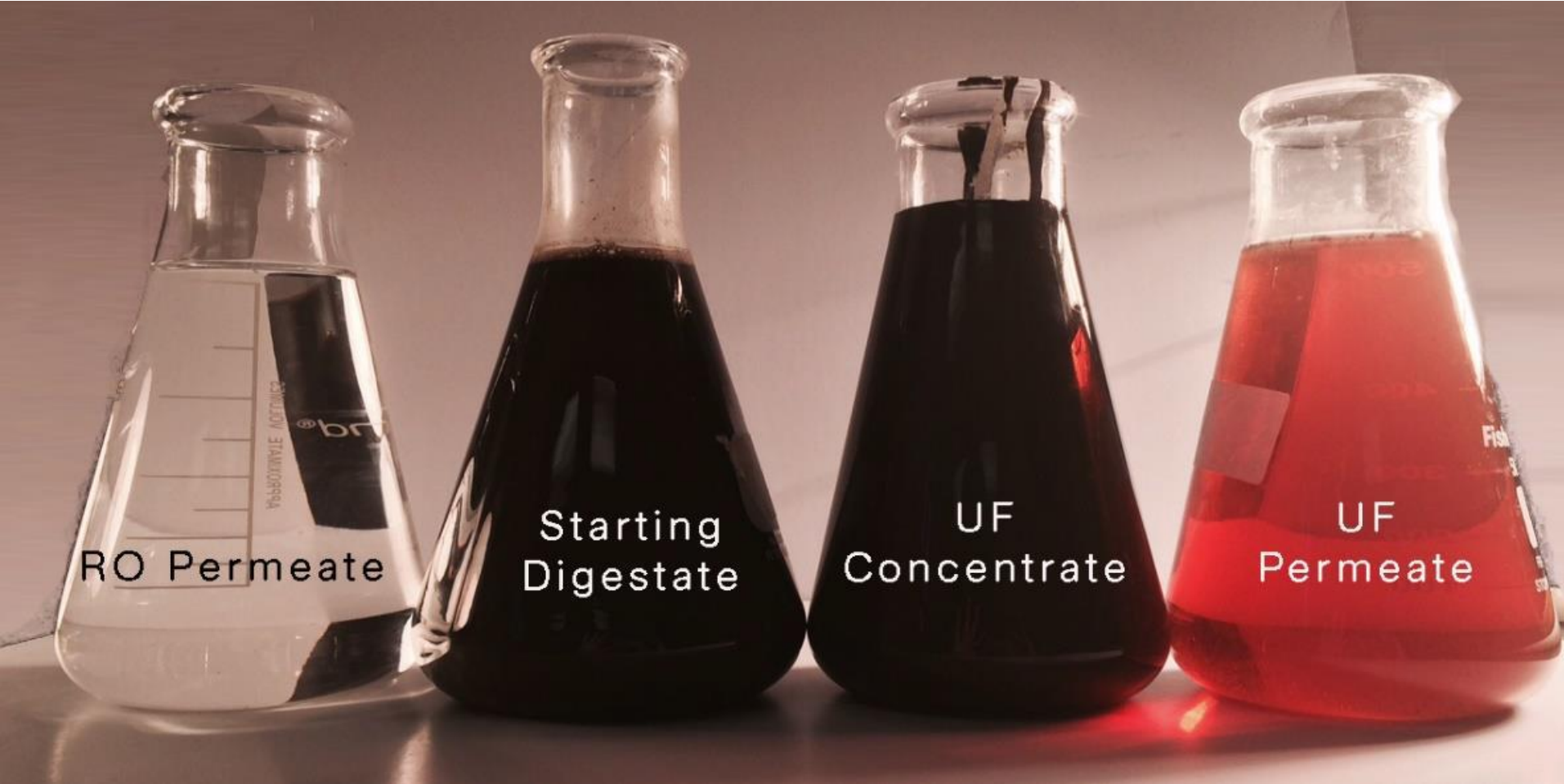




# Process overview for 50,000 GPD digestate







Samples from processing dairy manure digestate

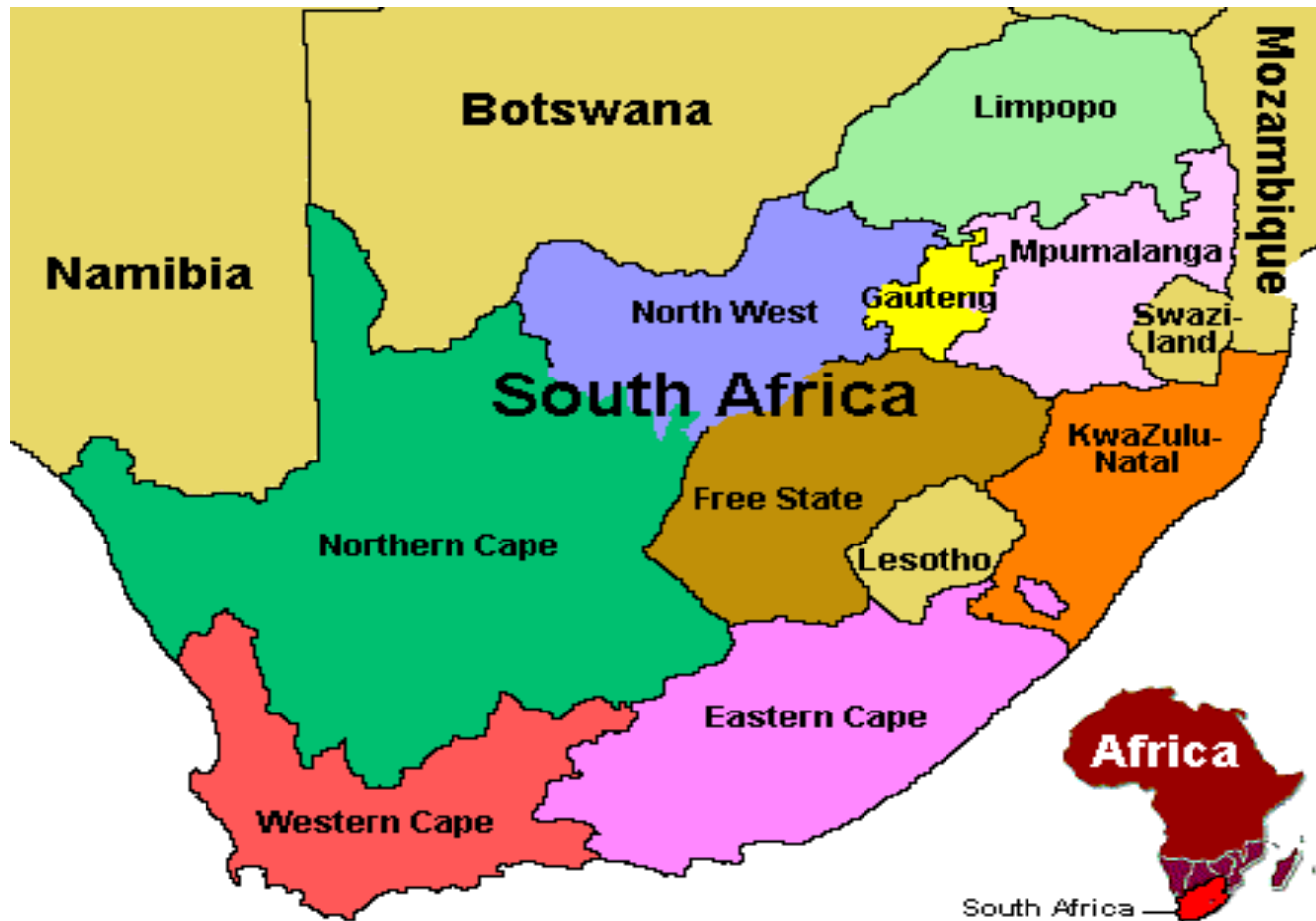




## California Drought: Orange County expands 'toilet to tap' water recycling

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.











<b>Description</b>	<b>Units</b>	<b>Design Value – Feed</b>	<b>Actual Feed</b>
<b>Na</b>	<b>mg/l</b>	<b>59</b>	<b>62.3</b>
<b>Ca</b>	<b>mg/l</b>	<b>486.4</b>	<b>521.1</b>
<b>Mg</b>	<b>mg/l</b>	<b>216.5</b>	<b>268.3</b>
<b>K</b>	<b>mg/l</b>	<b>9.8</b>	<b>16.7</b>
<b>Cl</b>	<b>mg/l</b>	<b>18</b>	<b>20.5</b>
<b>HCO<sub>3</sub></b>	<b>mg/l</b>	<b>0</b>	
<b>SO<sub>4</sub></b>	<b>mg/l</b>	<b>2379.5</b>	<b>2481.5</b>
<b>NO<sub>3</sub></b>	<b>mg/l</b>	<b>5</b>	
<b>Acidity</b>	<b>mg/l</b>	<b>256.7</b>	<b>233</b>
<b>Al</b>	<b>mg/l</b>	<b>23.2</b>	<b>17.5</b>
<b>F</b>	<b>mg/l</b>	<b>0.2</b>	<b>0.1</b>
<b>Fe</b>	<b>mg/l</b>	<b>13.1</b>	<b>20</b>
<b>Mn</b>	<b>mg/l</b>	<b>9.8</b>	<b>9.4</b>
<b>SiO<sub>2</sub></b>	<b>mg/l</b>	<b>10</b>	
<b>SS</b>	<b>mg/l</b>	<b>101</b>	<b>62.9</b>
<b>Temp.</b>	<b>°C</b>	<b>20</b>	
<b>pH</b>		<b>2.8</b>	<b>5.8</b>
<b>TDS</b>	<b>mg/l</b>	<b>3220.5</b>	<b>3727</b>



**667.37 FT<sup>2</sup>**



# Dunaliella salina algae



**PRODUCER OF BETA-CAROTENE  
AND GLYCEROL FEED ON BRINE**



## 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

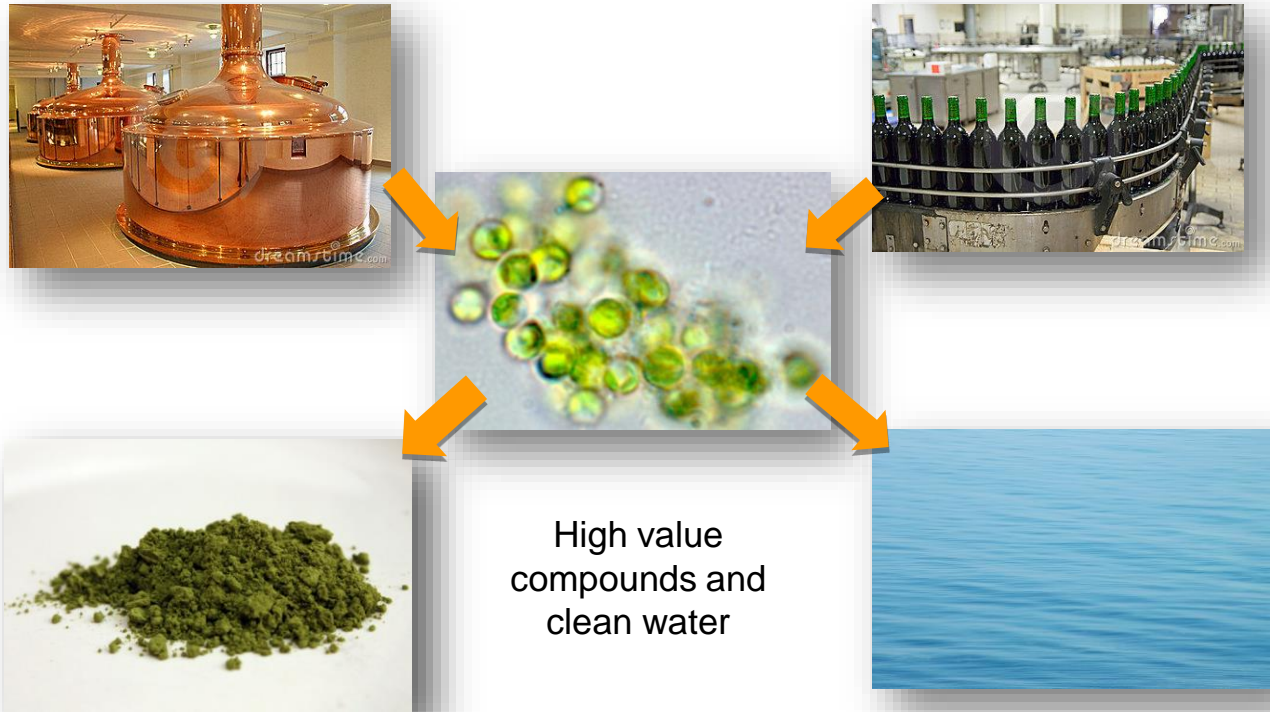


### Engineering Partners

- Alan Environmental – John Baker
- Tetra Tech



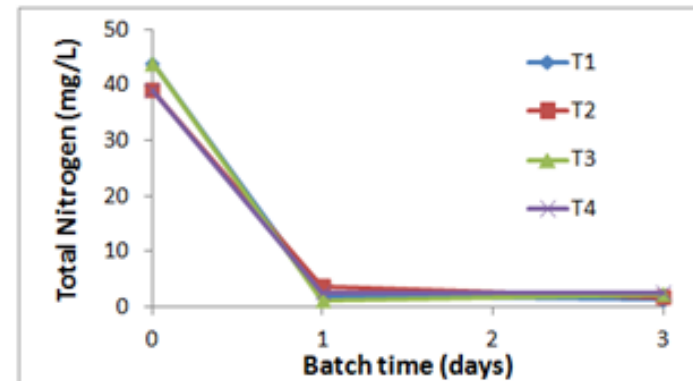
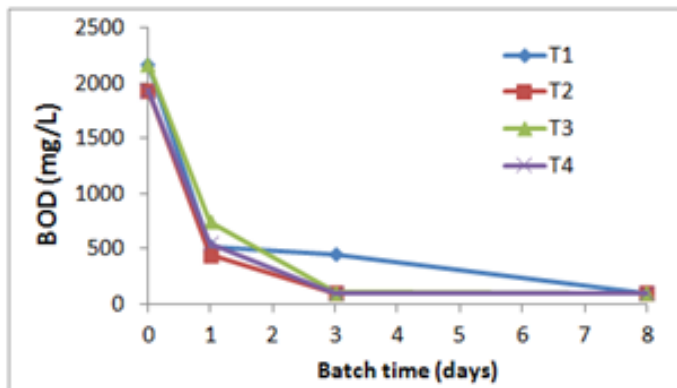
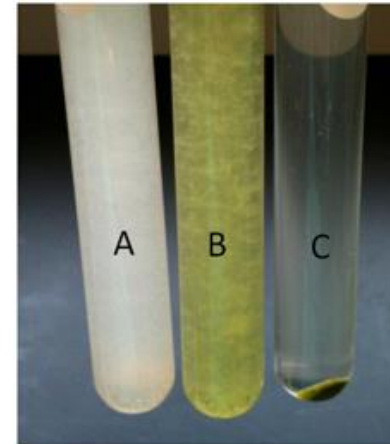
## Algal Scientific's Hypertrophic™ process produces Valuable biomass from Industrial byproducts

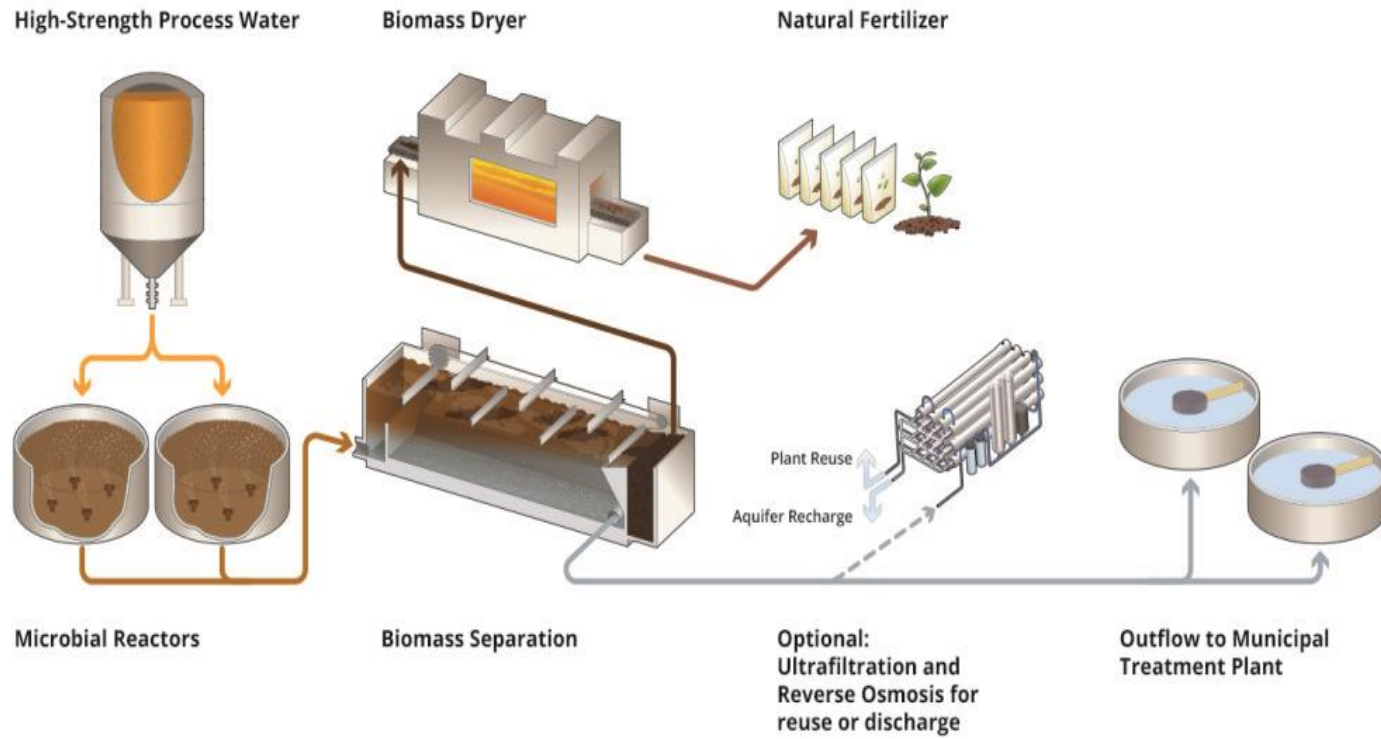


## Bench-top performance – Brewery process water

Parameter	Removal efficiency after:		
	1 day	3 days	8 days
COD	68%	83%	87%
TN	94%	95%	
TSS	85%		
BOD	73%	91%	95%

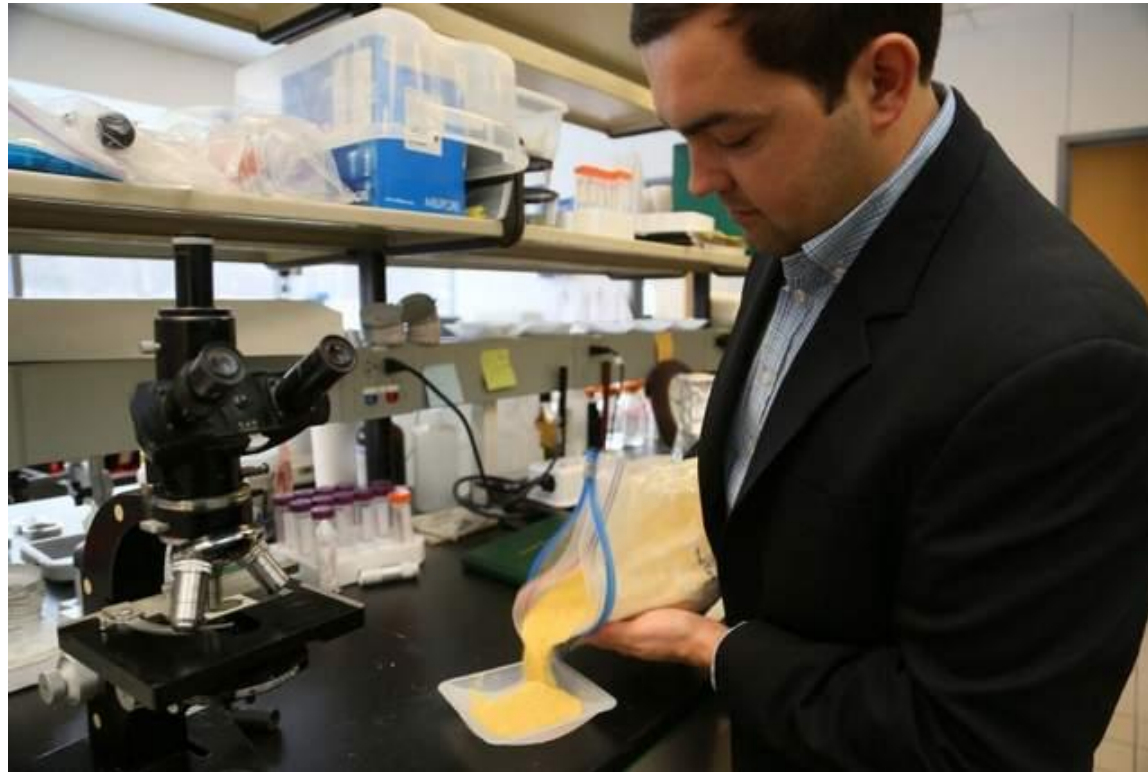
A) Untreated wastewater; B) Micro-organisms growing on wastewater; C) Centrifuged micro-organism pellet and supernatant for effluent.





## DETROIT FREE PRESS

February 11, 2015  
[Comments](#)  
**Tom Walsh: 'Survivability is key' for start-up animal feed  
maker**



# ALGAMUNE

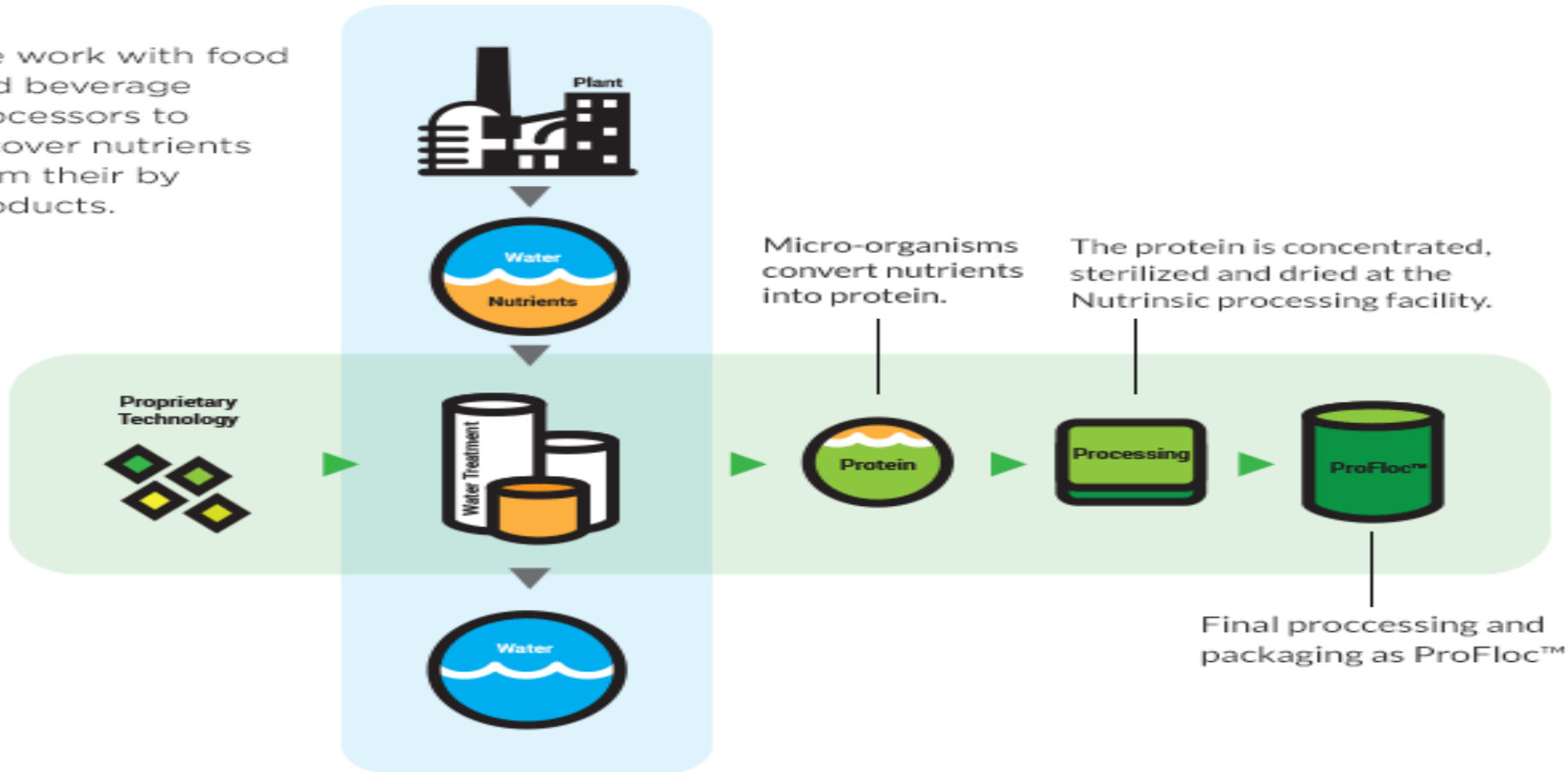
The screenshot shows the Algal Scientific website. At the top left is the Algal Scientific logo, which consists of a green circular icon with a globe-like pattern and the text "ALGAL SCIENTIFIC". To the right of the logo is a wide banner image of a blue ocean with white waves. Below the banner is a navigation menu with the following items: "COMPANY", "ALGAMUNE™ BETA GLUCAN", "WATER TECHNOLOGIES", "MEDIA NEWS", and "CONTACT US". The "ALGAMUNE™ BETA GLUCAN" item is highlighted. The main content area features a "Overview" section with a blue arrow pointing to the right. The text in this section reads: "Algal Scientific has two distinct business units that serve the animal feed, human nutrition, and wastewater treatment industries. One unit is focused on the production of our Algamune™ beta glucan products for animal feeds and human nutrition. The second unit is dedicated to the commercialization of our HyperAlgae™ wastewater treatment system, which we license to customers for use on-site. Please visit us to learn more about our businesses." Below this text is the heading "Algamune™ – The world's first beta glucan from algae". Underneath the heading is a paragraph: "Using stable fermenters and a proprietary strain of algae, we produce a dry biomass product that is rich in beta 1,3 glucan. Beta glucan is a polysaccharide, basically a long string of glucose-sugar molecules with a very specific form and functionality." At the bottom of the page is a chemical structure diagram of a beta-glucan chain, showing a series of glucose units linked together in a zig-zag pattern. Each glucose unit is represented by a six-membered ring with various hydroxyl groups (OH) and hydroxymethyl groups (CH2OH) attached to it.

<http://www.forbes.com/sites/michaelkanellos/2015/04/07/can-algae-help-the-meat-industry-cut-back-on-antibiotics/>



 NUTRINSIC

We work with food and beverage processors to recover nutrients from their by products.



THANK YOU  
WASTEWATER  
OPERATORS  
FROM  
MIKE MARINGER

**TEAMWORK**  
coming together is a beginning  
keeping together is progress  
working together is success  
- Henry Ford