Use of Algae Appliance for Harvesting and Microbiological Control of Algal Biomass

By Jose Sanchez Piña, General Manager Algae Division, OriginOil Inc

NAA Workshop, The Woodlands TX, April 11th. 2013.

A BREAKTHROUGH ENERGY PRODUCTION PROCESS
FOR THE OIL & GAS AND ALGAE INDUSTRIES

OriginOil: In a few words...

- OriginOil develops & licenses breakthrough technologies that solve ruinous problems in expanding multi-billion-dollar energy industries
- Proprietary technologies boost yields, slash cost, and return profits in:
  - Algae harvesting and shelf life
  - 98% decontamination of oil & gas frack water
- Independent tests and trials in US government and commercial labs, Pacific Rim and European partner sites verify breakthrough results
- Technology protected by 29 patents pending; Australia grants the first
- Income streams from scale-up and deployment partners
- Creating and receiving enthusiastic media coverage
- Loyal following of large and small stockholders
- Proven management team with bull's-eye industry experience

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Important Disclaimer

Matters discussed in this presentation contain forward-looking statements within the meaning of the Private Securities Litigation Reform Act of 1995. When used in this presentation, the words "anticipate," "believe," "estimate," "may," "intend," "expect," “poised,” and similar expressions identify such forward-looking statements. Actual results, performance or achievements could differ materially from those contemplated, expressed or implied by the forward-looking statements contained herein. These forward-looking statements are based largely on our expectations and are subject to a number of risks and uncertainties. These include, but are not limited to, risks and uncertainties associated with our history of losses and our need to raise additional financing, the acceptance of our products and technology in the marketplace, our ability to demonstrate the commercial viability of our products and technology and our need to increase the size of our organization.

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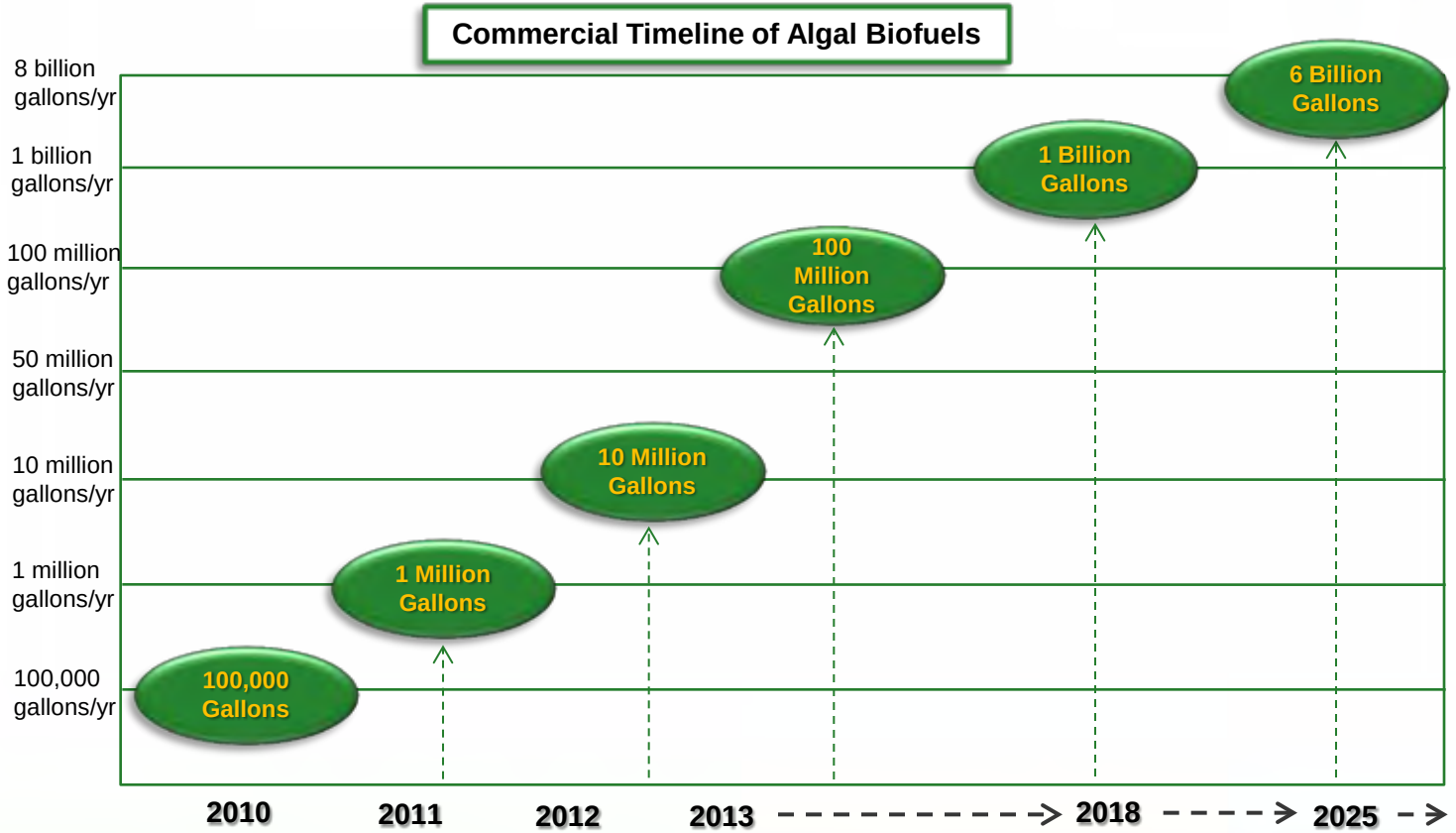
From R&D to Commercialization

THE ALGAE MARKET TAKES OFF

Algal Biofuels: An Engine of Growth

- World biofuels market is expected to grow at a CAGR of 12%+ through 2017
- $105.4 billion annual revenue forecast for 2018



Sources: Algae 2020, Emerging Markets Online Consulting Services, Biofuel Digest

ALGAE

Large Markets

- In 2010, algae biofuels markets were $217 million
- By 2015, they are forecast to reach $1.6 billion
- One-third of this market will be advanced technologies—such as ours

What Is Our Industry's Greatest Challenge? (Other Algae Companies)

- Extracting algae from the water it grows in
- At harvest, algae is highly dilute—up to 1000:1 water to algae!
- Other harvesting solutions are slow, costly, energy-intensive, and toxic

Algae as a Commodity

- 2013: Algae fuel producers receive $1.01/gallon tax credit on output
- Emerging markets for green commodities: fuels, chemicals, feed, fertilizer
- Mounting global pressure for renewables (France's Green Buildings law)
- China and India pushing for clean energy technology
- Opportunities for green chemicals and other high-value end products

Source: Algae Biofuels Production Technologies Worldwide Market Research Report

The OriginOil Algae Harvesting Solution

- OriginOil's breakthrough algae harvesting system:
  - Lower capital and operating costs than *any* other de-watering process
  - High speed
  - Energy efficient
  - Chemical free
  - Completely scalable
  - Integrates upstream and down
  - Now a standardized, selling product line: The Algae Appliance™

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The Algae Appliance, Model 4 (AA4)

- Fully integrated algae harvester
  - Dewaters more thoroughly
  - Decontaminates to extend shelf life
- Model 4 delivers up to 4 LPM
  - In commercial production and sales
  - Entry-level, low-cost
  - Testing, R&D, process improvement
  - Will process 20% of daily harvest at 30,000-liter/day facility
  - Options: Decontamination, pre-harvest stimulation, capacity upgrade
  - Operator training, literature and support included
- 200 LPM (50 GPM) model available

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Versatile, Adaptable, Rugged

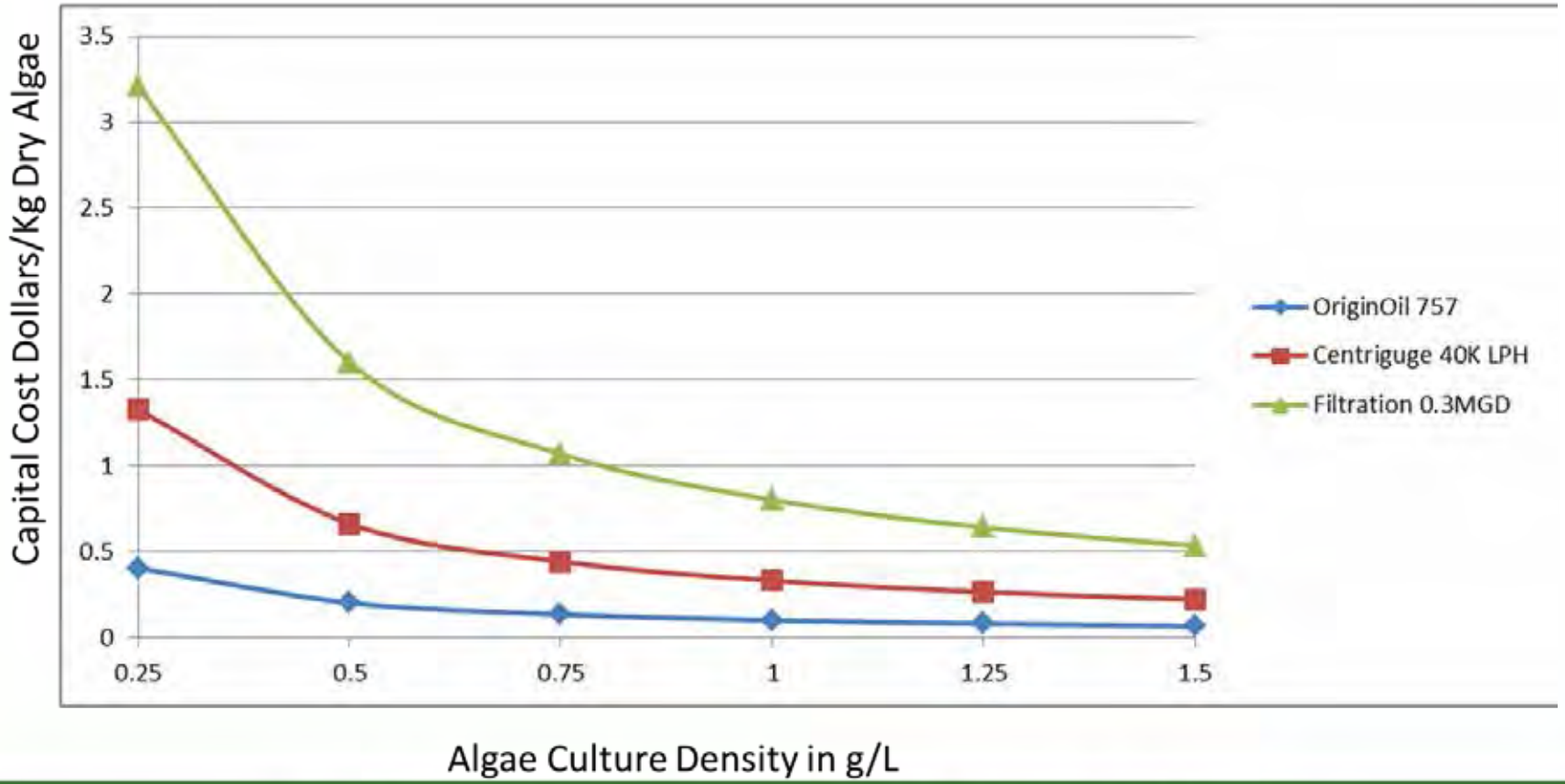
- Operates with all algae types and conditions: Any strain, salinity, degree of contamination, temperature, grown in light or dark

Harvesting algae grown in light

Harvesting algae grown in dark

Savings Over Other Methods

Capital Cost of Harvesting in USD per Kilogram of dry Algae at different culture densities in USA



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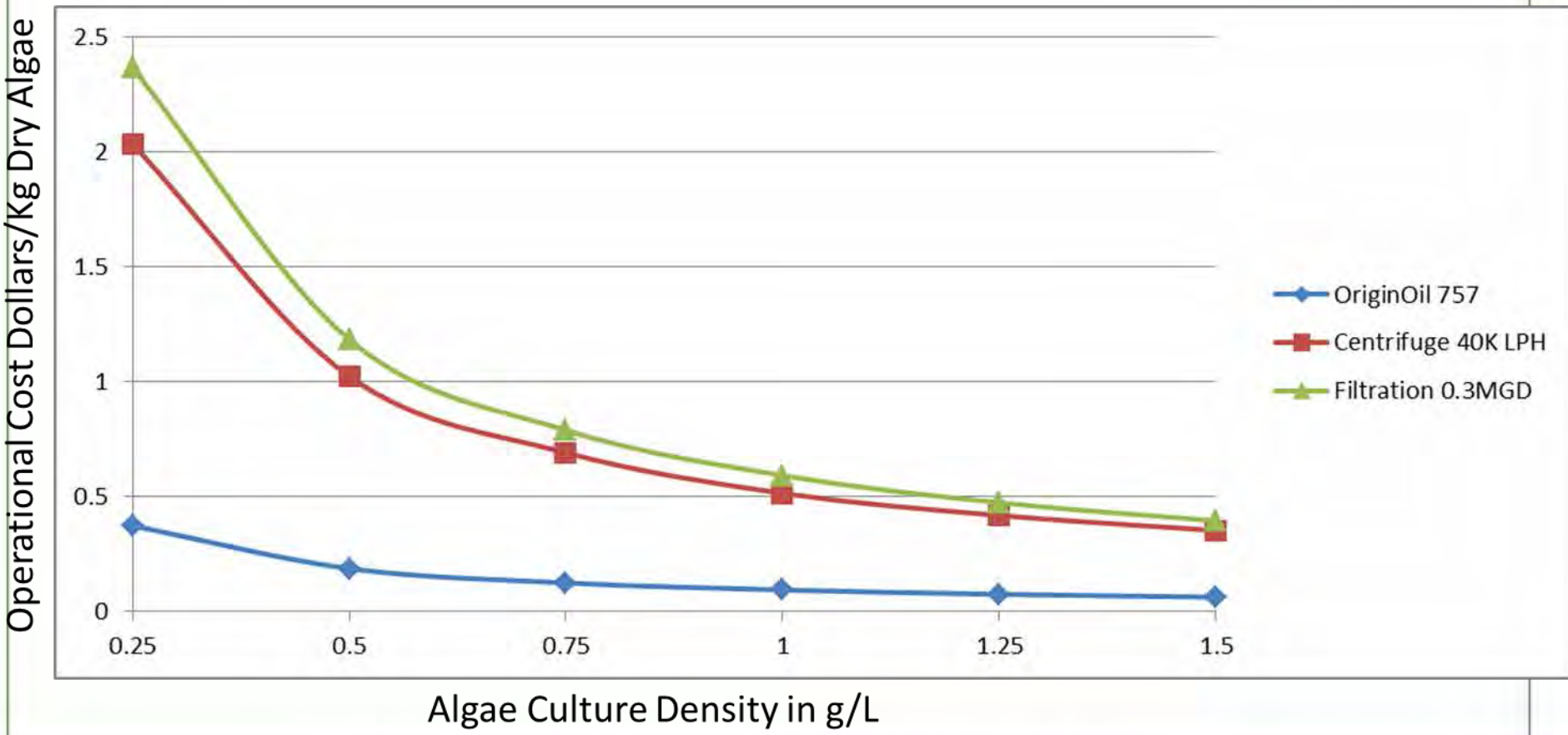
Savings Over Other Methods

Operational Cost of Harvesting in USD per Kilogram of dry Algae at different culture densities in USA



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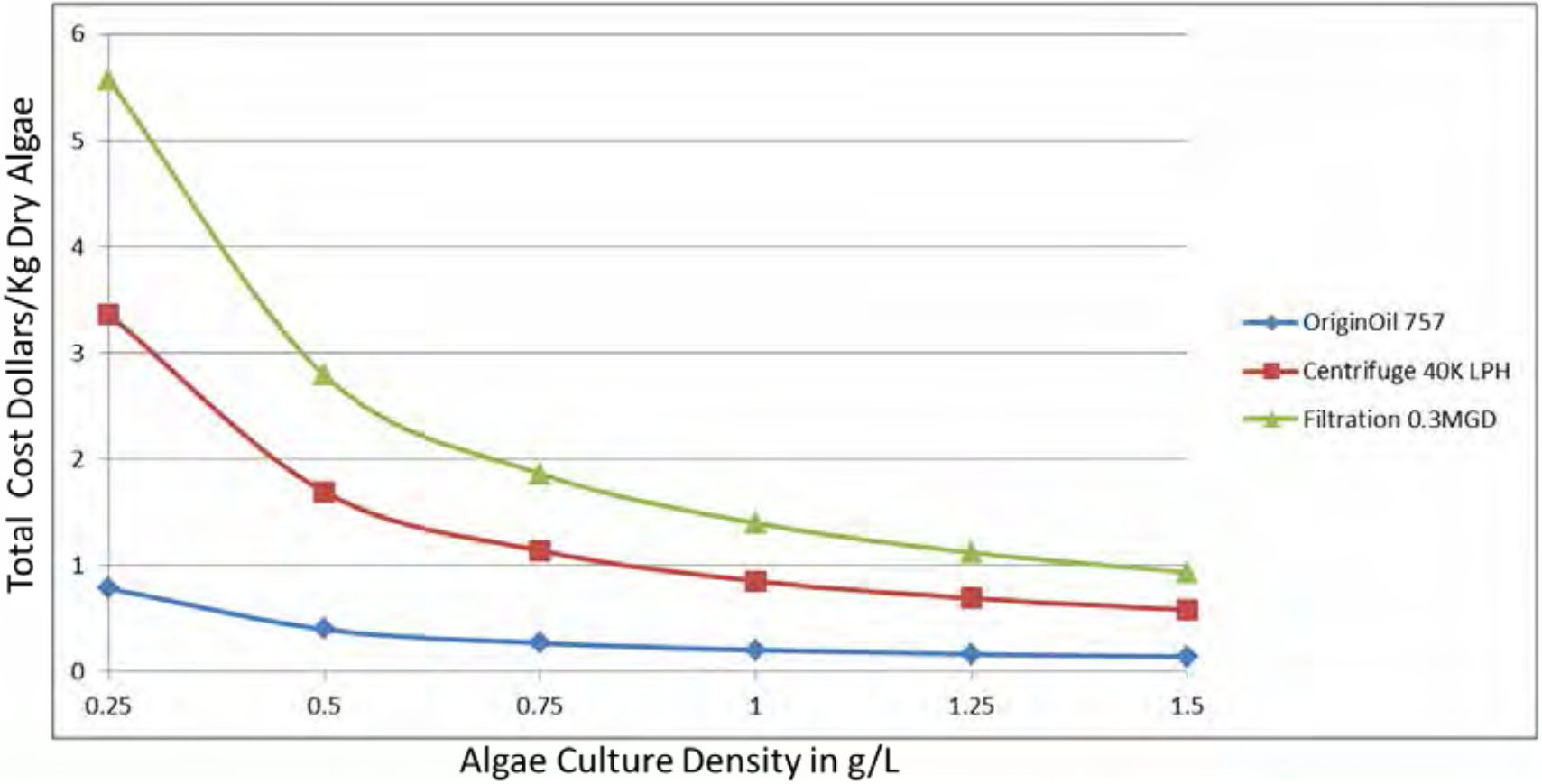
Savings Over Other Methods

Total Cost of Harvesting in USD per Kilogram of dry Algae at varying culture densities in the USA (Including Labor and Consumables)



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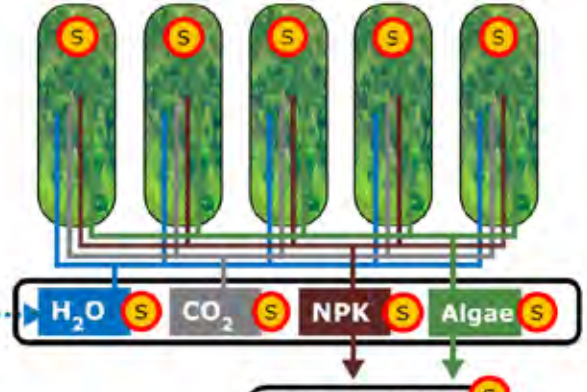
OriginOil®

HIGH-SPEED ALGAE HARVESTING

Algae Growth System



Real-Time Control Network*

Water Recycling

Optional Boost Phase

Algae Appliance™

Post-Processing

Direct Distillates

- Jet Fuel
- Diesel
- Marine Distillate
- Gasoline

Biocrude
Biogas
Biochar

Fertilizers

Animal Feed

Existing Refinery or Integrated Biorefinery

Optional Chemical Fractionation

High-Value Products from Proteins and Lipids

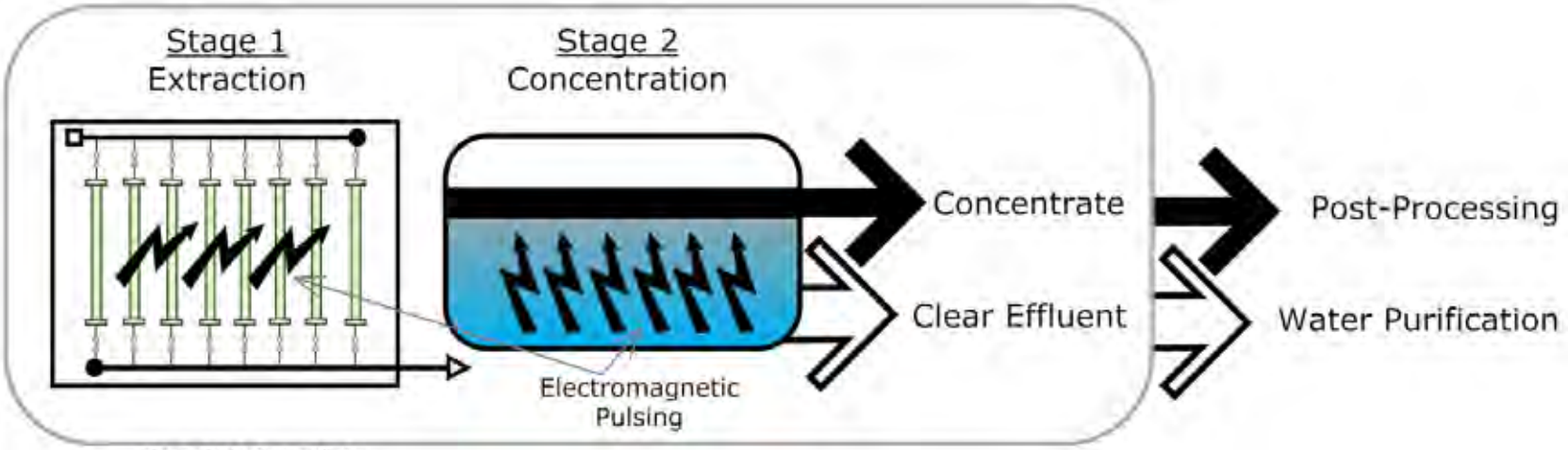
- Distillates and Gases
- Polymer Precursors
- Solvents & Adhesives
- Specialty Chemicals

* = Future Functionality S = OriginOil Sensors

DATE 8 October 2012
REVISION B - 9 October 2012

Two-Stage Harvesting System

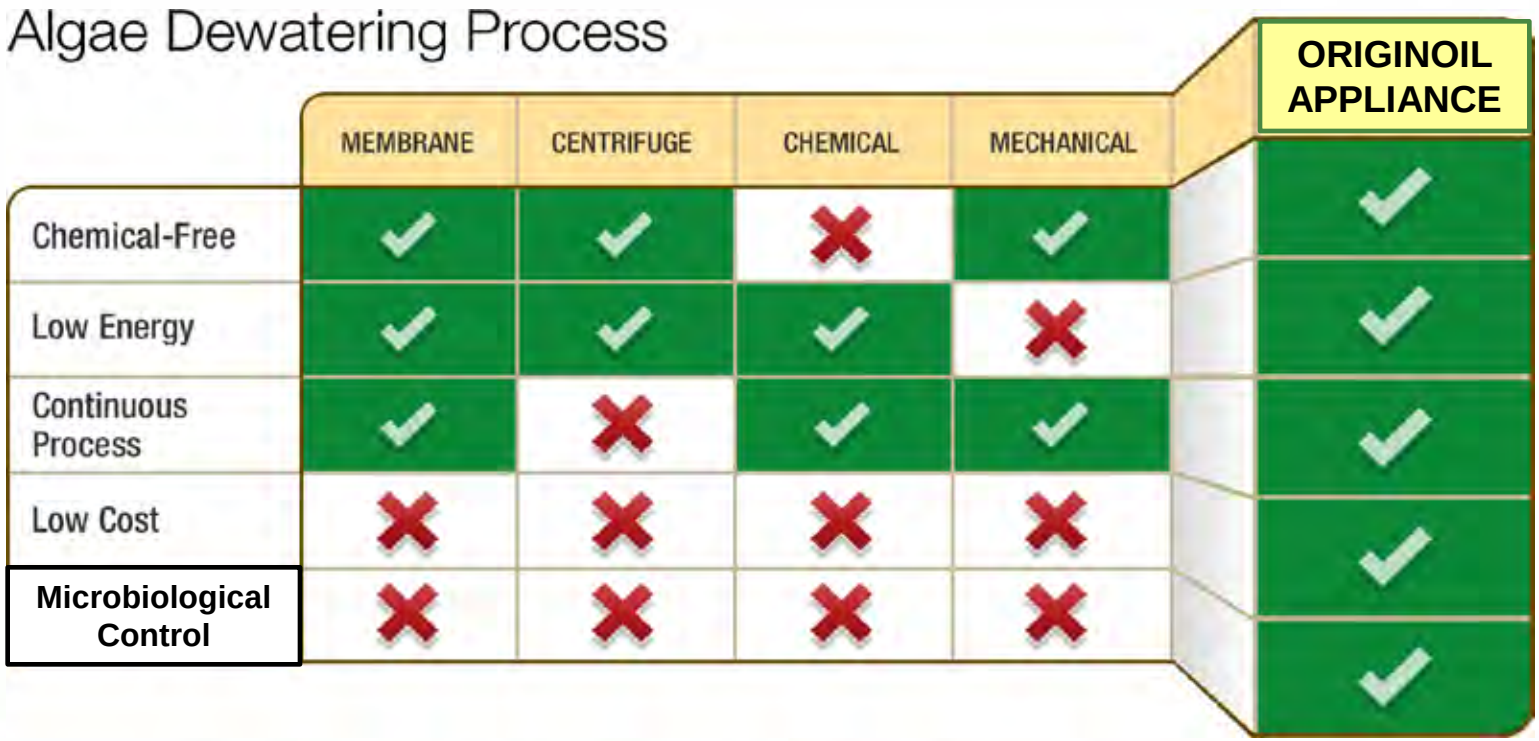
1. **Single-Step Extraction™** neutralizes algae cells' electrical charge so algae clump together (flocculate)
   - Optionally, cells can be ruptured for non-fuel uses
2. **Hydrogen Flotation™** creates a vapor cloud of micro-bubbles pushing algae solids upwards for surface collection



(Video of Appliance Model 4)

Stage One: Efficient Dewatering

- OriginOil's first stage dewaters algae more efficiently than any other solution
- Single Step Extraction eliminates fatal flaws of current dewatering methods:



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Stage Two: Integrated Concentration

- Hydrogen Flotation integrates closely with the extraction stage to *concentrate* the algae into a high-density slurry
- *No further equipment is required* to achieve 5 to 10% concentration of solids
- Surface concentrate and clear effluent are fully ready for next steps

Additional Advantages

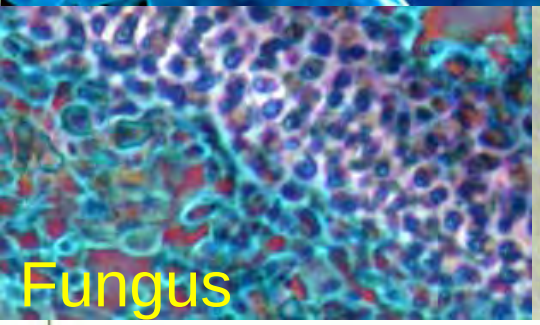
- Clean Growth:
  - OriginOil's Algae Screen™ works on living algae to eliminate most bacteria, rotifers, ciliates and adverse algae
  - Decontaminated algae grows better, demonstrating improved yield at harvest*
  - Degree of improvement exceeds 50%, with potentials exceeding 80%
- Extended Shelf Life:
  - Normally, algae begins to rot after harvesting; short shelf-life complicates yield/ROI
  - Algae Appliance decontamination delivers shelf-life up to one month**

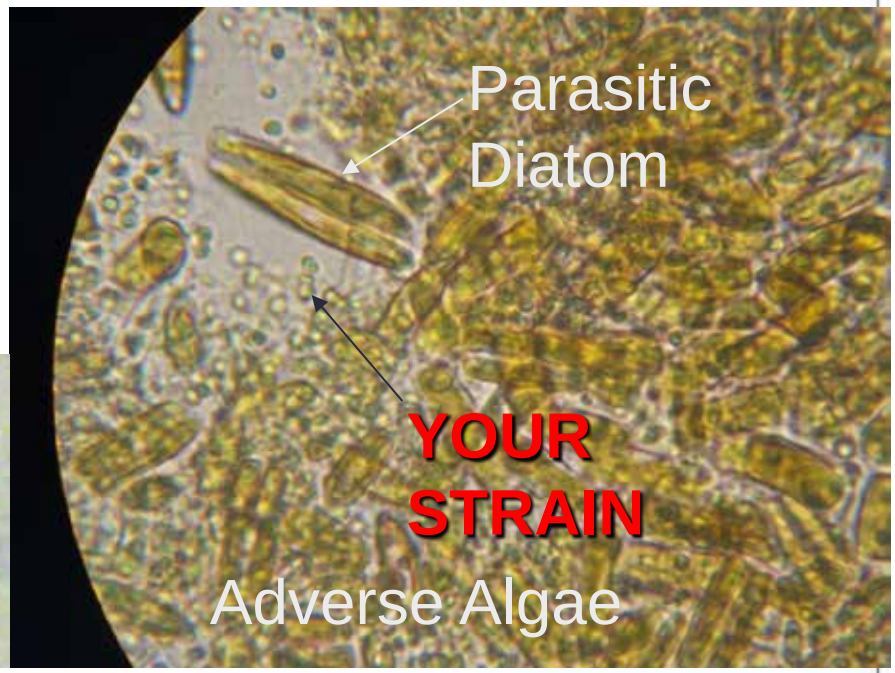
* Source: OriginOil Announces Breakthrough Innovation to Increase Algae Yield

** Source: OriginOil Internal Estimate (3rd party study in progress)

What can OriginOil do for Algaepreneurs?

The Usual Suspects that Crash Algae in Ponds and Reactors…





What can OriginOil do for Algaepreneurs?

The Drama of Contamination (Conventional Paradigms)

- "It's contaminated, it needs to be discarded"
- Use of Antibiotics
- Use of Chemicals such as Sodium Hypochlorite or Hydrogen Peroxide
- Changes in Salinity, pH or nutrients
- Several days to recover production levels due to Algae Stress/damage

What can OriginOil do for Algaepreneurs?

When Contaminated… Harvest the problems away

90 to 99% Less Bacteria

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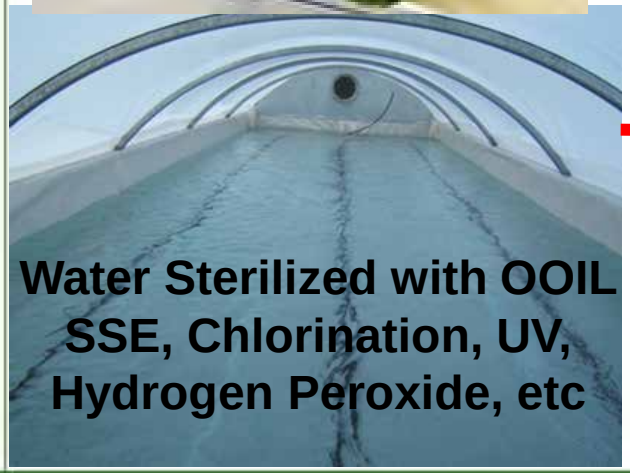
What can OriginOil do for Algaepreneurs?

When Contaminated … Harvest the problems away

Algae Paste (The cells are totally alive)



Water Sterilized with OOIL SSE, Chlorination, UV, Hydrogen Peroxide, etc

Back to Production in a few Hour$$$!!!

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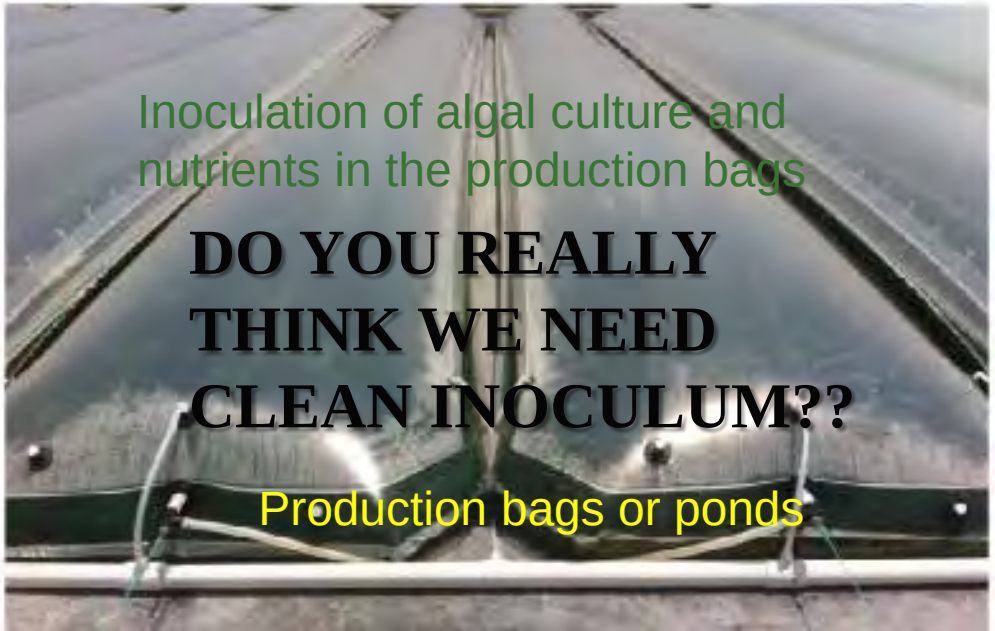
Algaepreneur Basic Need for Microbiological Control

From a few cells to Inoculation Carboys in the Culture Room

Culture intermediate scale up to 300 gallons in small photobioreactors

Culture production in large photobioreactors up to 15,000 gallon levels

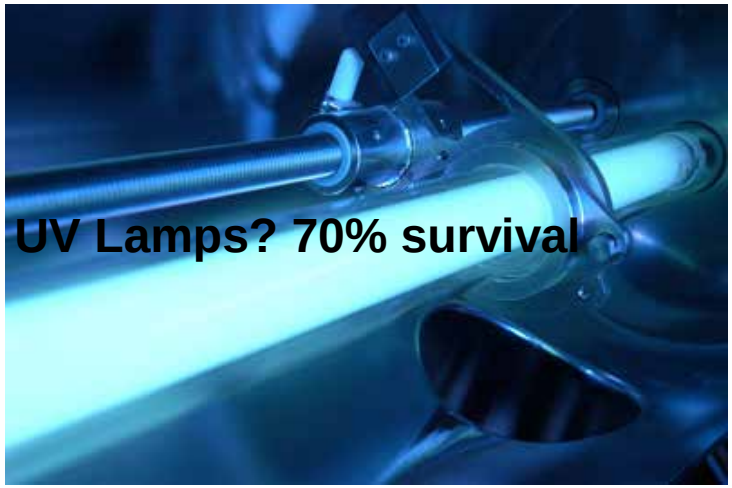


Harvest Biomass without Bacteria

Increased Shelf Life/Quality

What can OriginOil do for Algaepreneurs?

Clean Intake Water and Inoculum Supply



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What can OriginOil do for Algaepreneurs?

Increase in Production through Heterotrophic Jump

Industrial, Agricultural or Municipal Sewage

OriginOil SSE tubes sterilize and reform sewage yielding a "broth" rich in Organic Carbon and Fertilizers

"Broth"

Autotrophic Systems

Alive algae green cells (Harvested with OOIL Appliance)

Heterotrophic Systems

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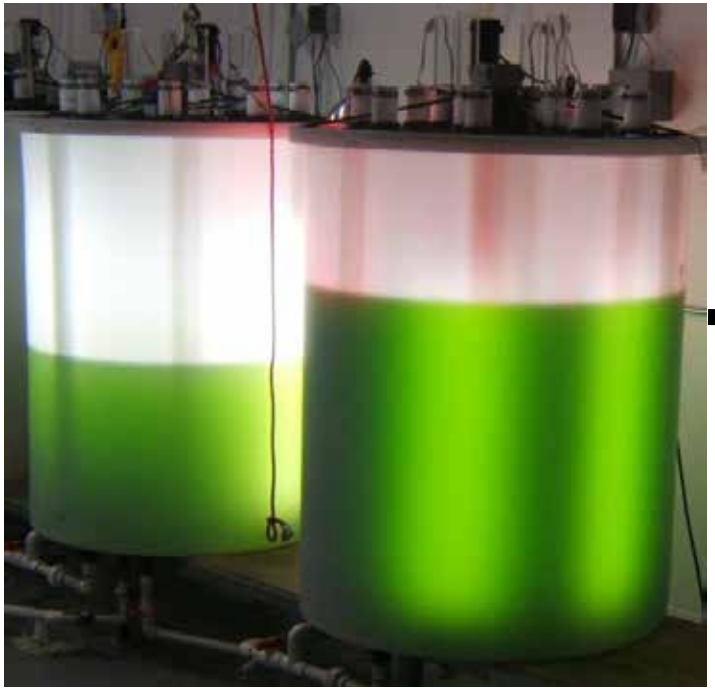
What can OriginOil do for Algaepreneurs?

Increase in Production through Heterotrophic Jump

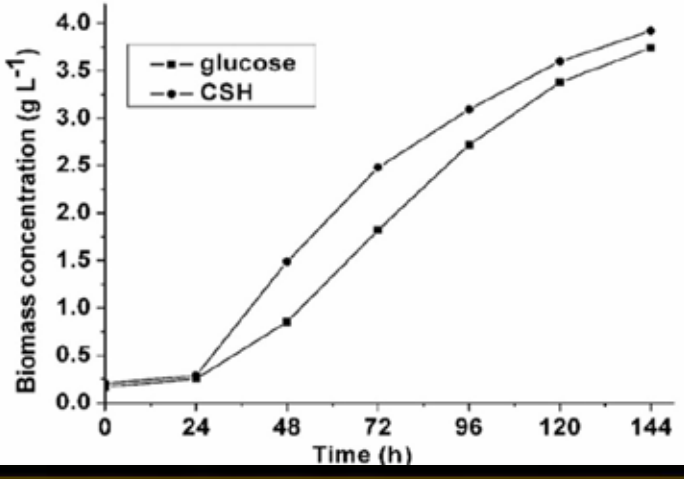
The algae cells produced in autotrophic mode are placed in fermenters that will raise the amount and fat content of algae cells several times. The trick to reduce prices is to assure heterotrophic growth while avoiding contamination without the use of costly beer-industry grade fomenters. This can be achieved by the previous treatment to neutralize micro-organisms of autotrophic algal cells and water by using OriginOil systems



Conventional Autotrophic Algae Systems

Dark (no light) Heterotrophic Algae Systems

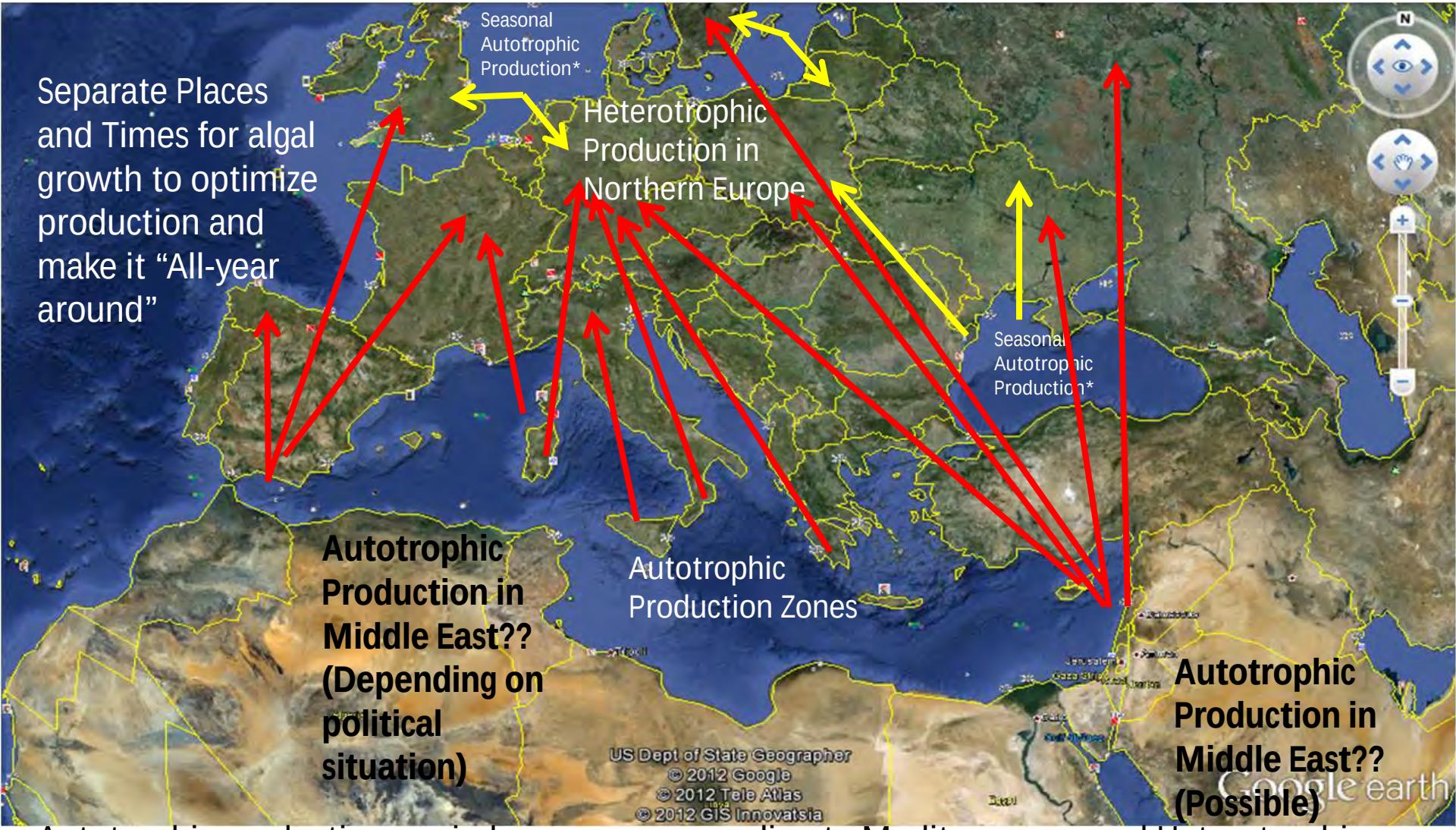
The heterotrophic systems increase the production of lipids by increasing its cell density a dozen times while increasing its fat content from 15 to 55 % by weight. The heterotrophic mode is activated when the algae culture is placed in a fermenter without light, in the presence of Oxygen and a Carbon source. **This can increase the fat content per liter up to 35 times in six days.**



Mode		Lipid (%)	Cell density	Cell growth rate
AP		10-20	< 5 g l^{-1}	< 1 g $l^{-1}d^{-1}$
HF		50-60	> 100 g l^{-1}	> 10 g $l^{-1}d^{-1}$

AP Autotrophic photosynthesis
HF Heterotrophic fermentation

A Plan Specifically Tailored for Northern Latitudes

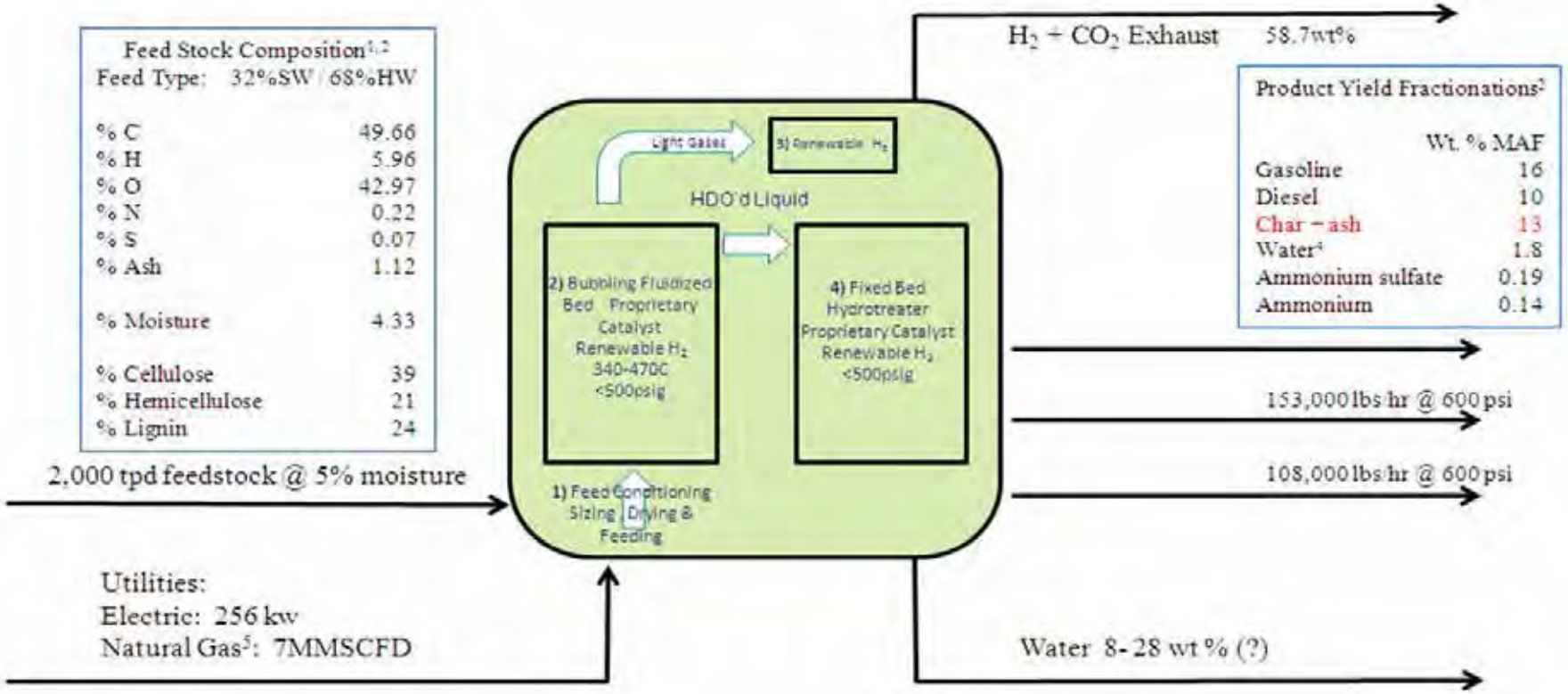


Autotrophic production carried on sunny-warm climate Mediterranean and Heterotrophic production everywhere with an organic Carbon source (sewage, dairy farms, paper mills, etc).

* Seasonal Autotrophic Production will be carried on in outdoors from April to October

The Heterotrophic biomass is harvested when it is at least 3 grams/Liter with 60% fat content. The Appliance Harvester flocculates, concentrates, lyses and hydrogenate the cells, converting them into the best feedstock for a Hydropyrolisis Refinery.

The Hydropyrolisis Refinery is a cost effective thermochemical platform to convert biomass directly into cellulosic hydrocarbons for use as fuels/blend stocks *or sources of renewable hydrocarbons for petrochemical use (IH2 model displayed here).*



1 Feedstock could be a mixture of chips (hardwood & softwood), mill sludge, bark, and or sawdust. Average moisture content of the feedstock is anticipated to be in the range of 5% - 20%, but could be higher. Lower input moisture content results in higher export steam. Particle size is expected to be 2 to 4 mm.

2 Feedstock composition influences resulting product. See IH² Product Example slide for further information.

3 It is anticipated that the char would be sent to the hog fuel boiler for combustion and production of additional export steam at traditional hog fuel boiler steam pressures.

4 Ammonia in export water is stripped in process. Stripped water is then returned to the Steam Methane Reformer for hydrogen production. Overall export water varies with moisture content of feedstock.

5 Natural gas used only at startup.

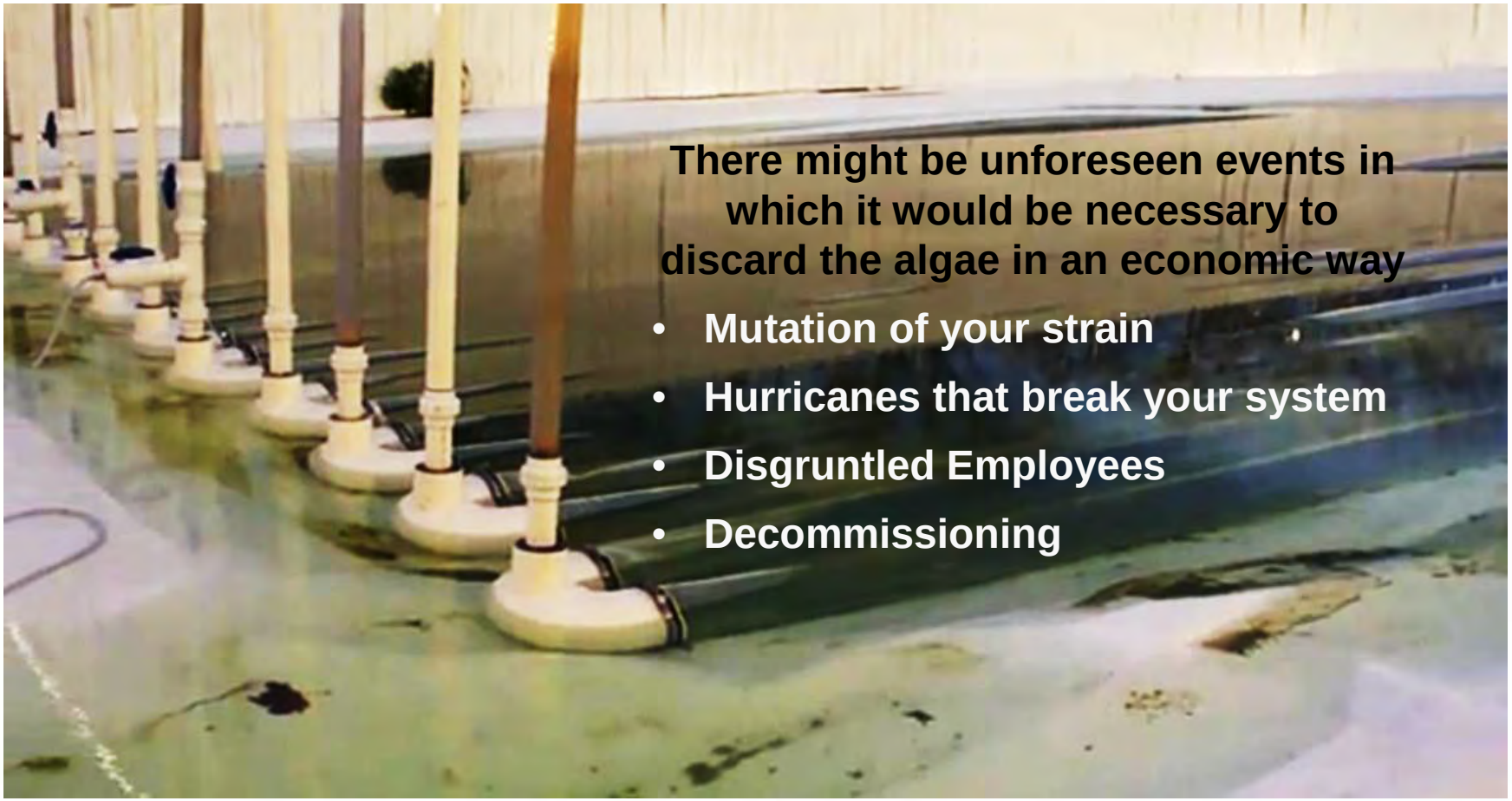
The Hydropyrolisis Refinery can use almost any kind of Carbon-based feedstock (tires, agricultural waste, sawdust, municipal waste, and algae). If the refinery uses conventional autotrophic algae, it can get yields of 23% gasoline and 22% diesel by weight from the initial feedstock. **If the refinery uses hydrogenated heterotrophic algae, these yields double**

Feedstock	Wood	Algae
C_4 + Liquid yields (MAF) wt%	28	46
Wt % Oxygen in liquid	b d l	b d l
Wt% Gasoline liquid product	18	23
Wt % Diesel liquid product	8	22
Wt % Char (MAF) wt%	13	2
Wt % CO_X (MAF) wt%	16.4	9
Wt % C_1-C_3 (MAF) wt%	13	14
Wt % Water (MAF) wt%	36	26
Wt % H_2 uptake (MAF) wt%	4.6	4.4
External H_2 required for integrated system	None	None
Ammonia wt%	0.18	2.4

The cost of production for bio-crude made with this heterotrophic-hydropyrolisis system would be around $66 dollars per barrel, produced in Germany, France, Netherlands or Sweden

What can OriginOil do for Algaepreneurs?

The need to dispose of your Strain Properly



There might be unforeseen events in which it would be necessary to discard the algae in an economic way

- **Mutation of your strain**
- **Hurricanes that break your system**
- **Disgruntled Employees**
- **Decommissioning**

What can OriginOil do for Algaepreneurs?

The need to dispose of your Strain Properly

There's going to be people that will attack GMOs in Algae regardless of how much substantial scientific evidence proves that the benefits outweigh the possible risks. An accidental spill not managed properly could kill any GMO commercial production endeavors. GMO producers must have something to kill 100% of a spill without a doubt

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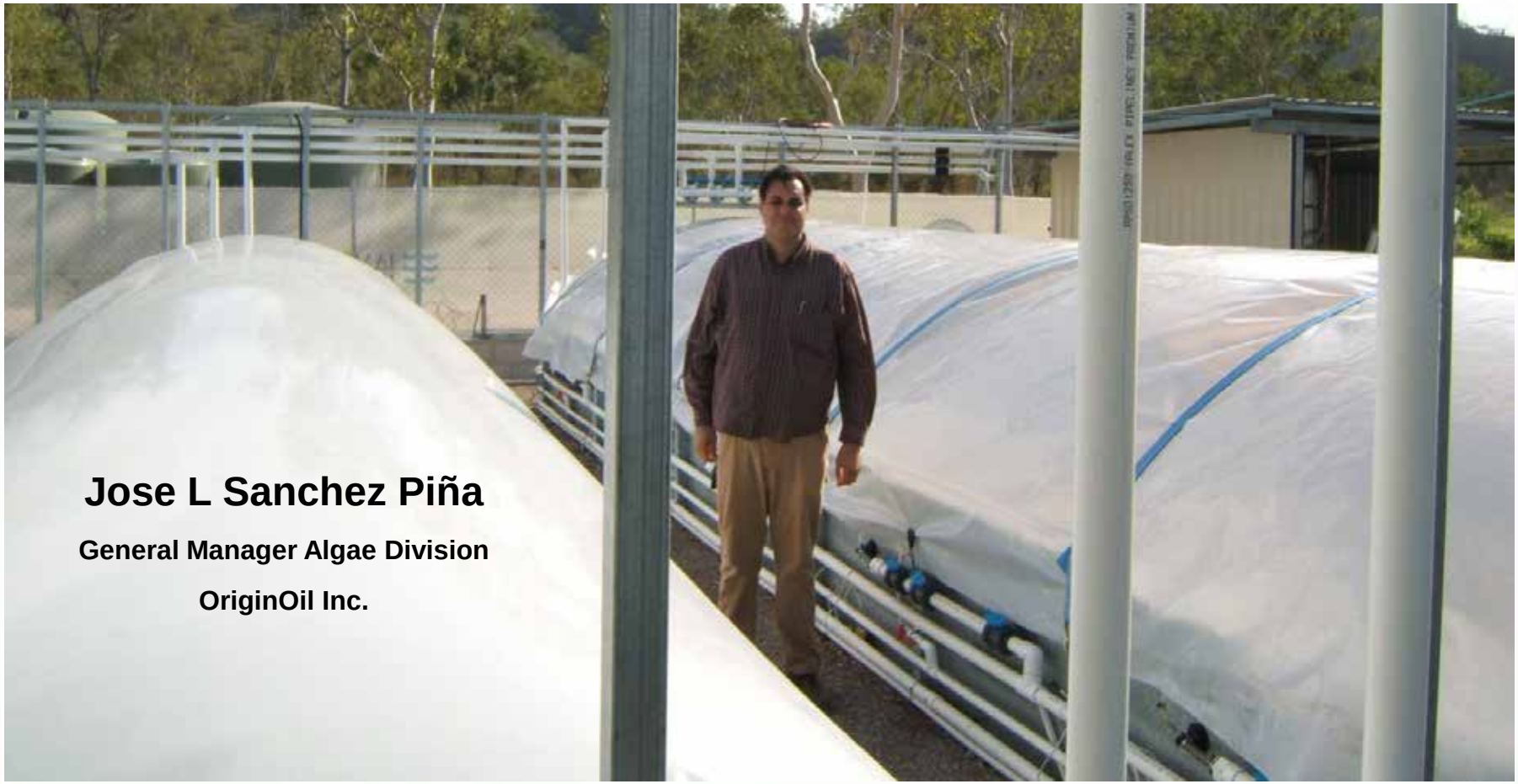
Thanks!!



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