Is 2013 the Year of the Algae?

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

Before we answer that question… Lets take an historical perspective of the Petroleum Industry… 1860's when Kerosene substituted Whale oil

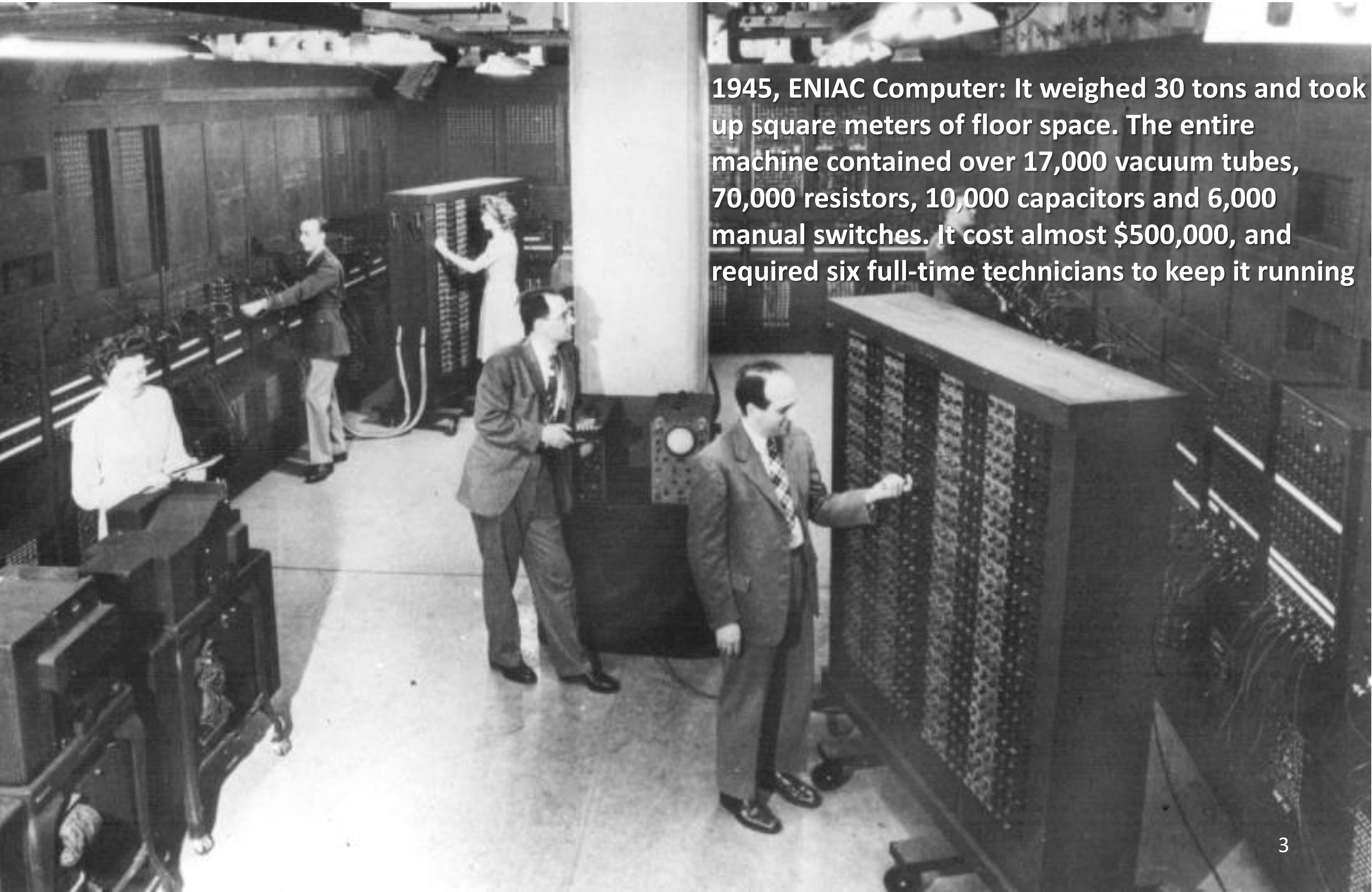
First part of XIX Century: Whaling to obtain oil

Oil well : Titusville Pennsylvania 1859

The successful substitution of whale oil for Petroleum was due to the fact that Petroleum was easier to get, less risky, in more quantities but overall **cheaper** than whale oil.

Kerosene was the most widely used petroleum based product until the late XIX Century. **By the early XX Century automobiles were developed, and liquid fuels increased petroleum demand**, then plastics and petrochemicals came over maturing and consolidating the industry.

Before we answer that question… Lets take an historical perspective of the Computer Industry… 1945: First ENIAC Computer

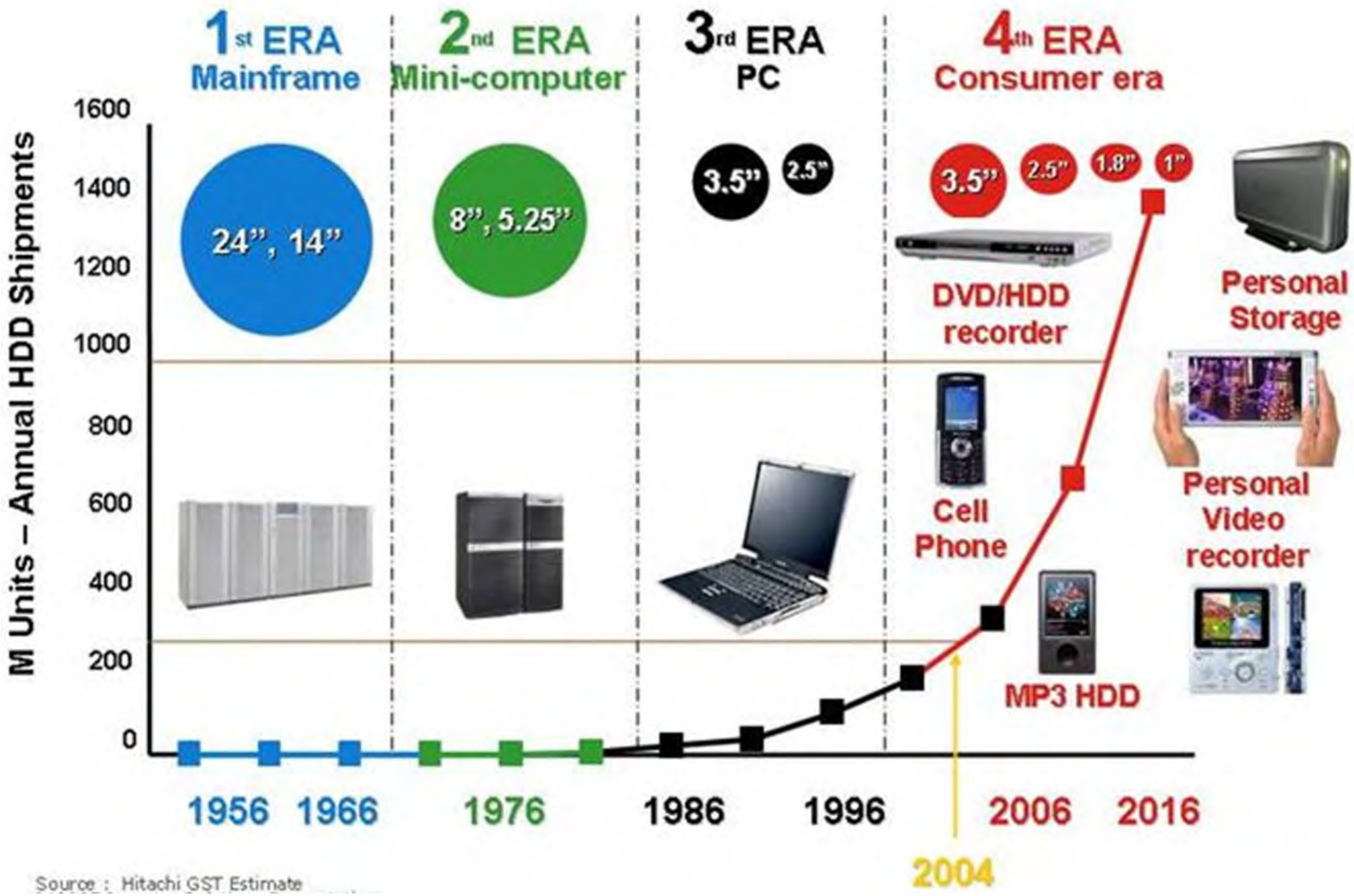


1945, ENIAC Computer: It weighed 30 tons and took up square meters of floor space. The entire machine contained over 17,000 vacuum tubes, 70,000 resistors, 10,000 capacitors and 6,000 manual switches. It cost almost $500,000, and required six full-time technicians to keep it running

Sounds Familiar? (USA)

With a demand of 6.79 billion barrels of liquid fuels per year . If we use open ponds and algae with 30% fat content to produce this oil, even with production rates of 35 grs/m2-day, 24.8 million hectares would be required, which is equivalent to the surface area of the State of Michigan, costing 2.49 Trillion dollars in initial capital investment…

In 1980, the computer market bloomed, going from PCs to Laptops. Around 1993, Internet reached the masses, after that the consumer electronics, cars and telephones required processing power, later new devices such as I-pods, Personal Videos and intelligent phones matured the use of computers…



Is 2013 for the Algae Industry the same as 1905 was for Petroleum Industry or 1980 was for the Computer Industry?

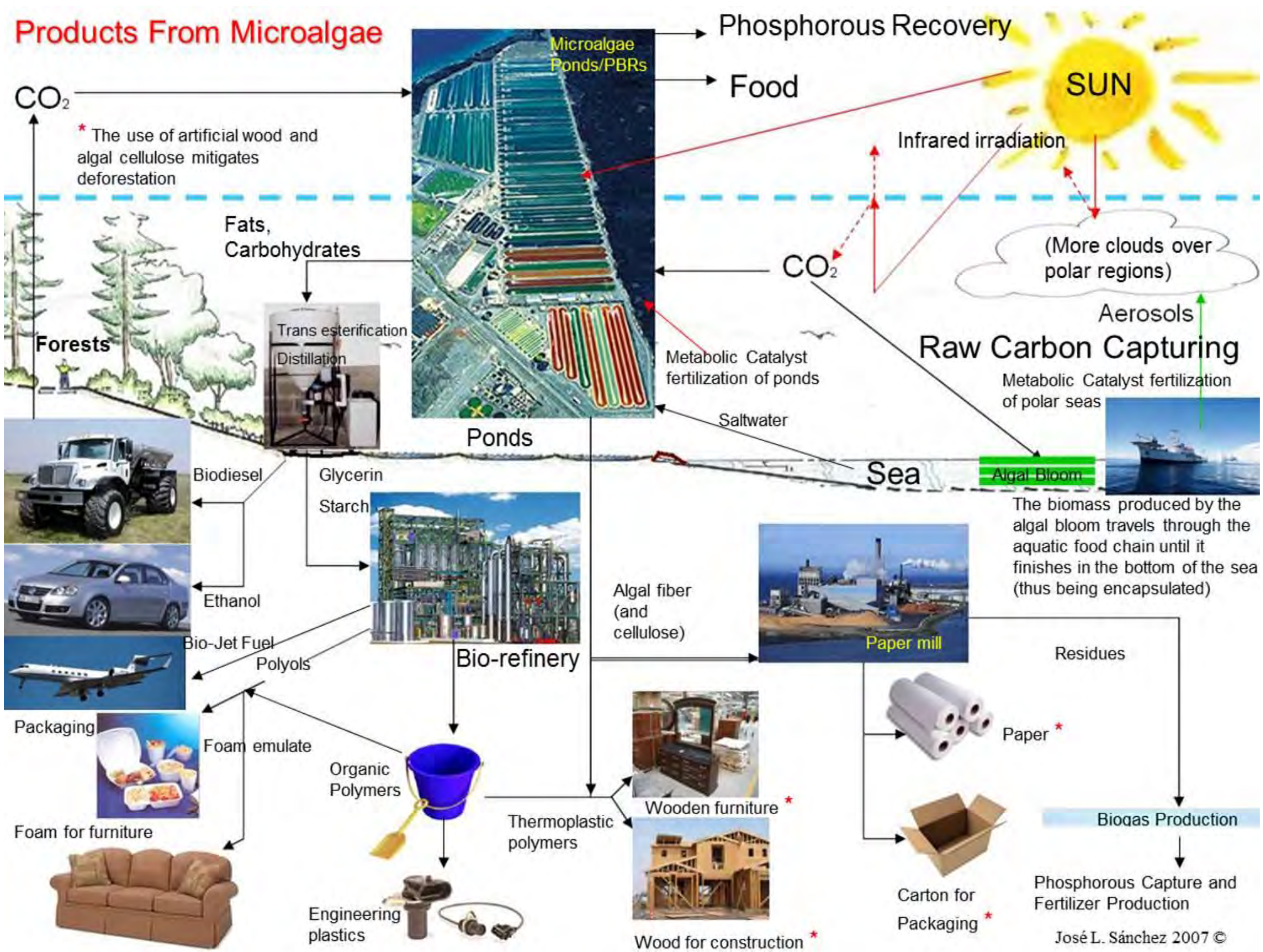
This would depend on the decisions that Algae Growers would make now that would allow them to be successful before the investors get fed up and stop the financing… (Which regretfully is happening right now)

That means that they need to choose the right products, the right technologies and the right processes in order to reduce costs and obtain profitability.

I have the following recommendations for algae producers to make "The Year of the Algae" to come soon:

1. Choose the right product that will make you be profitable

If producing biofuels, avoid biodiesel and ethanol for automobiles (1 Euro per liter) and go for Bio-Jet fuel that has higher market prices (about 10 Euros per liter) with similar production costs



2. If your product is fuels, carry out in a three stage project

Recommended 3 stages of development

	First Stage (2012-2013)	Second Stage (2013-2015)	Third Stage (2015 and up)
Products	Spirulina Protein Omega 3	Phycocyanin Phycoerytrin Asthaxantin	Bio-jetfuel JP5 Biodiesel BioGasoline
Partners	Algasol OriginOil	Algasol OriginOil BioMolecular Nutraceutics Fuji Algae	Algasol OriginOil IH2 Shell, Exxon, BP Rolls Royce or GE
Markets/Customers	GNC Aquaculture Farms Nutraceutics	L'Oreal Farmacias Similares (Mex) Century Pharma (India) European Pharmaceuticals	US NAVY, Siemens Luftansa German Auto Co's
Initial Investment	4 Million Dlls	25 Million Dlls	350-500 Million Dlls
Anual Sales	5 Million Dlls	100 Million Dlls	280-400 Million Dlls

2. If your product is fuels, carry out in a three stage project

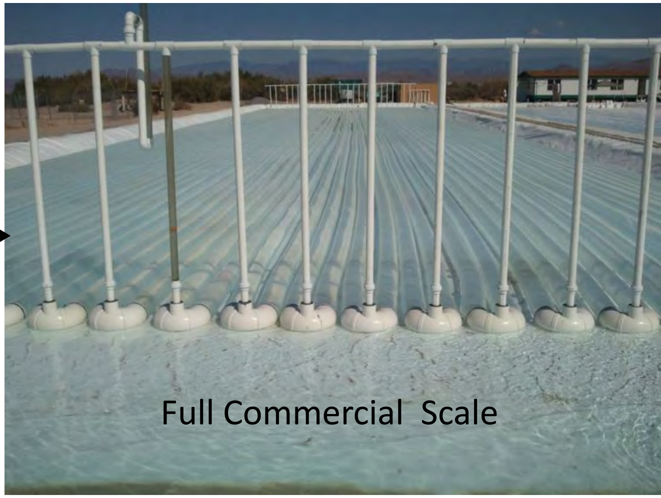
The rationale behind this Three Stage plan is to assure that you will have income as soon as possible and sustain your operations (R&D, Product Development and Market Placing), long enough to acquire the infrastructure, personnel and know-how to be ready for the biofuels business (and be credible enough before investors to get the proper financing for it).

Table Size
1-4M Capital

Lab Scale

Small Commercial Scale

1-2 Hectare
10-25M Capital



500 Hectares
+100M Capital

3. Choose the right algae production technology for your product

Don’t be dogmatic. Open ponds seem to be cheaper than other production methods, but they cannot reach large production densities. The final cost of a kilogram of algae is not very sensitive to the initial cost of the algae production system. It is more sensitive to fertilizer, CO_2 and labor costs which decrease as the algae production density increases.

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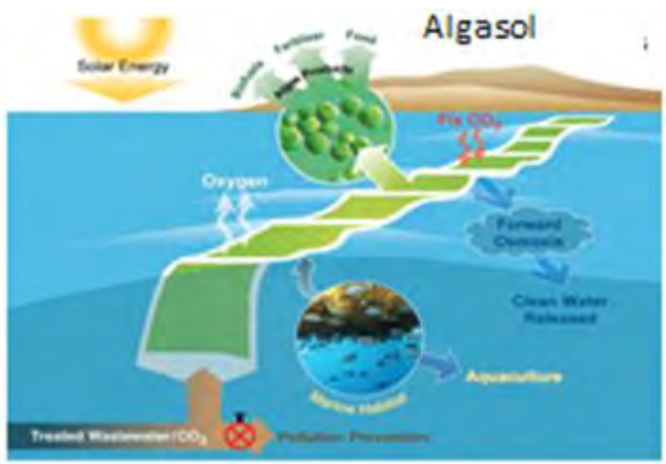
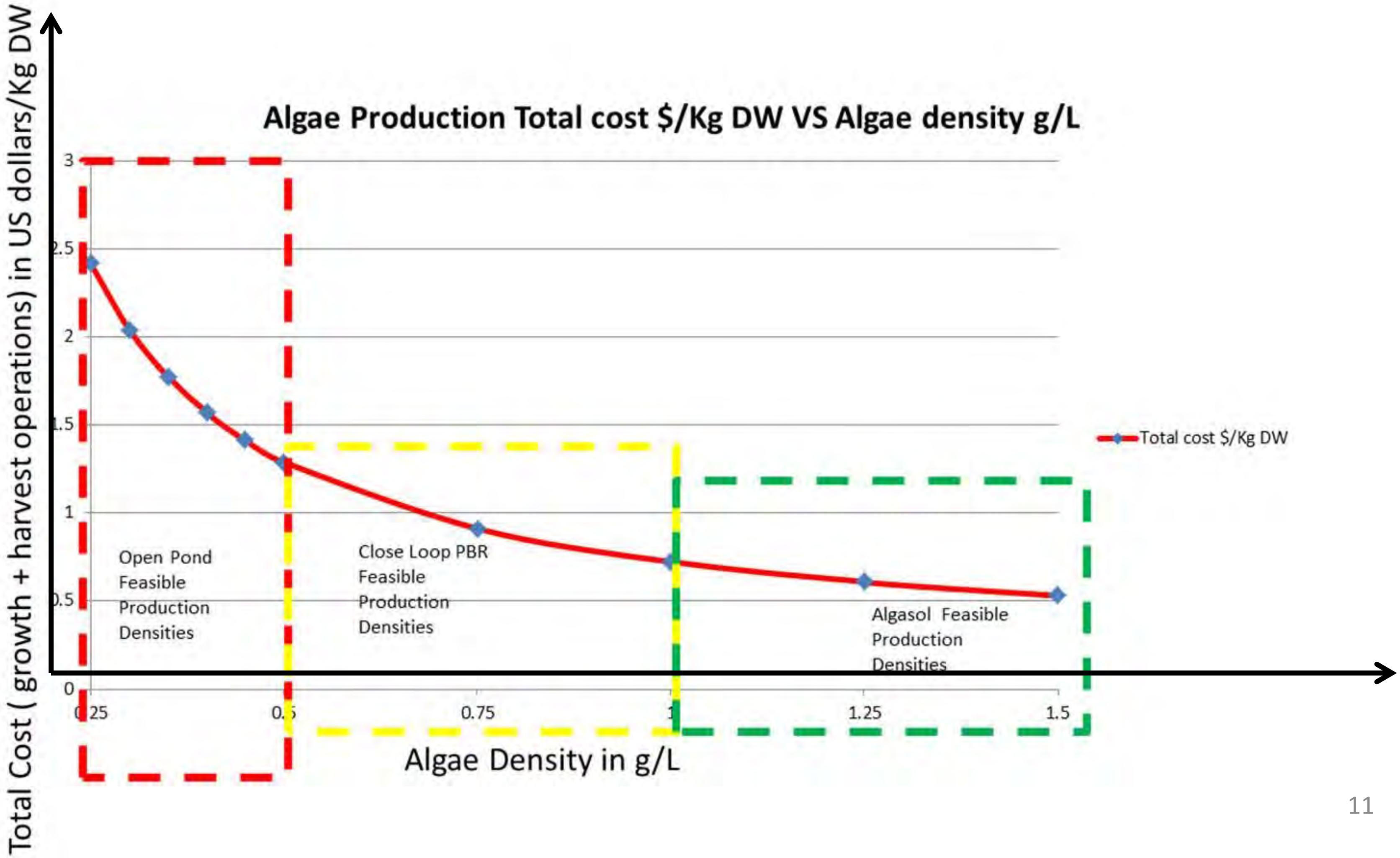


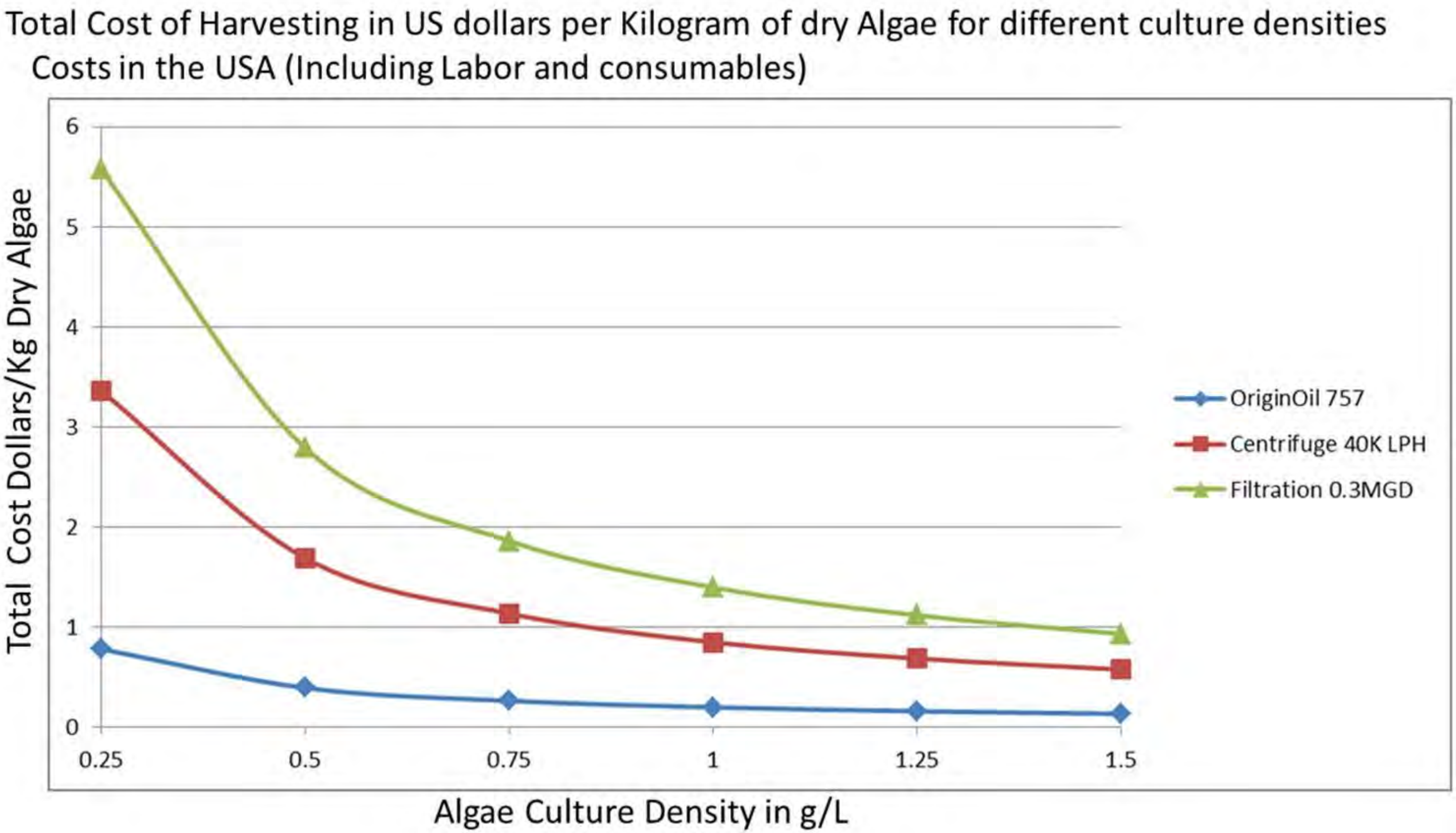
VS

3. Choose the right algae production technology for your product

Given that initial capital costs do not really affect the cost per kilogram of algae and the operational costs affect more the costs, **the production cost VS algae production density curve is usually more or less the same for all production methods, so the larger the algae production density, the least the cost per kilogram.**



4. Choose the right process for your product: example Harvesting System



The OriginOil Appliance 757 would not only harvest algae into 5 to 10% solids paste, it also reduces bacteria in the algae paste and water, which induces increased shelf life and allow swift de-contamination of production cultures without chemicals.

4. Choose the right process for your product: example Heterotrophic Jump for fuel production in Europe

Industrial, Agricultural or Municipal Sewage

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

“Broth”

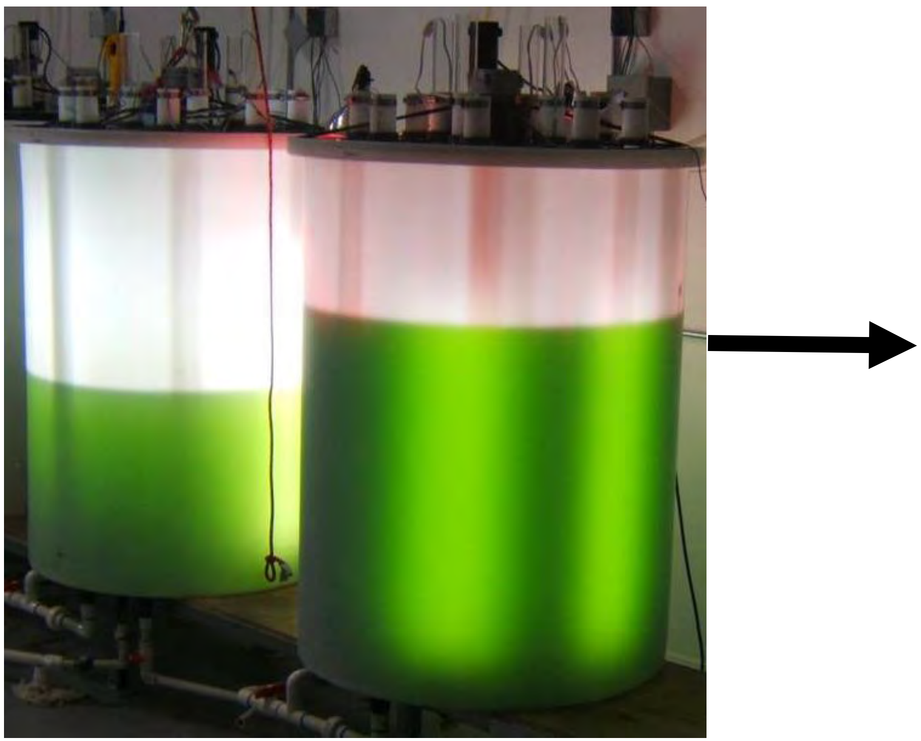
Autotrophic Systems

Alive algae green cells (Harvested with OOIL Appliance)

Heterotrophic Systems

3. Choose the right process for your product: example Heterotrophic Jump for fuel production in Europe

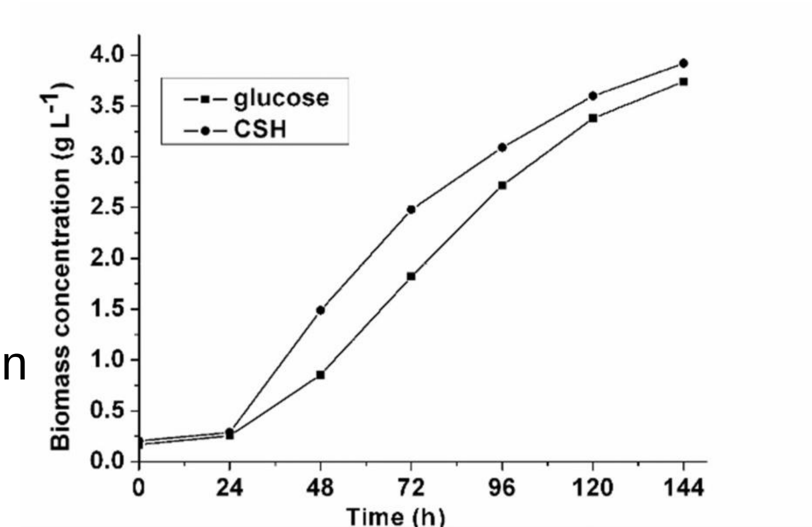
The algae cells produced in autotrophic mode are placed in fermenters that will raise the amount and fat content of algae cells several times. The trick to reduce prices is to assure heterotrophic growth while avoiding contamination without the use of costly beer-industry grade fomenters. This can be 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

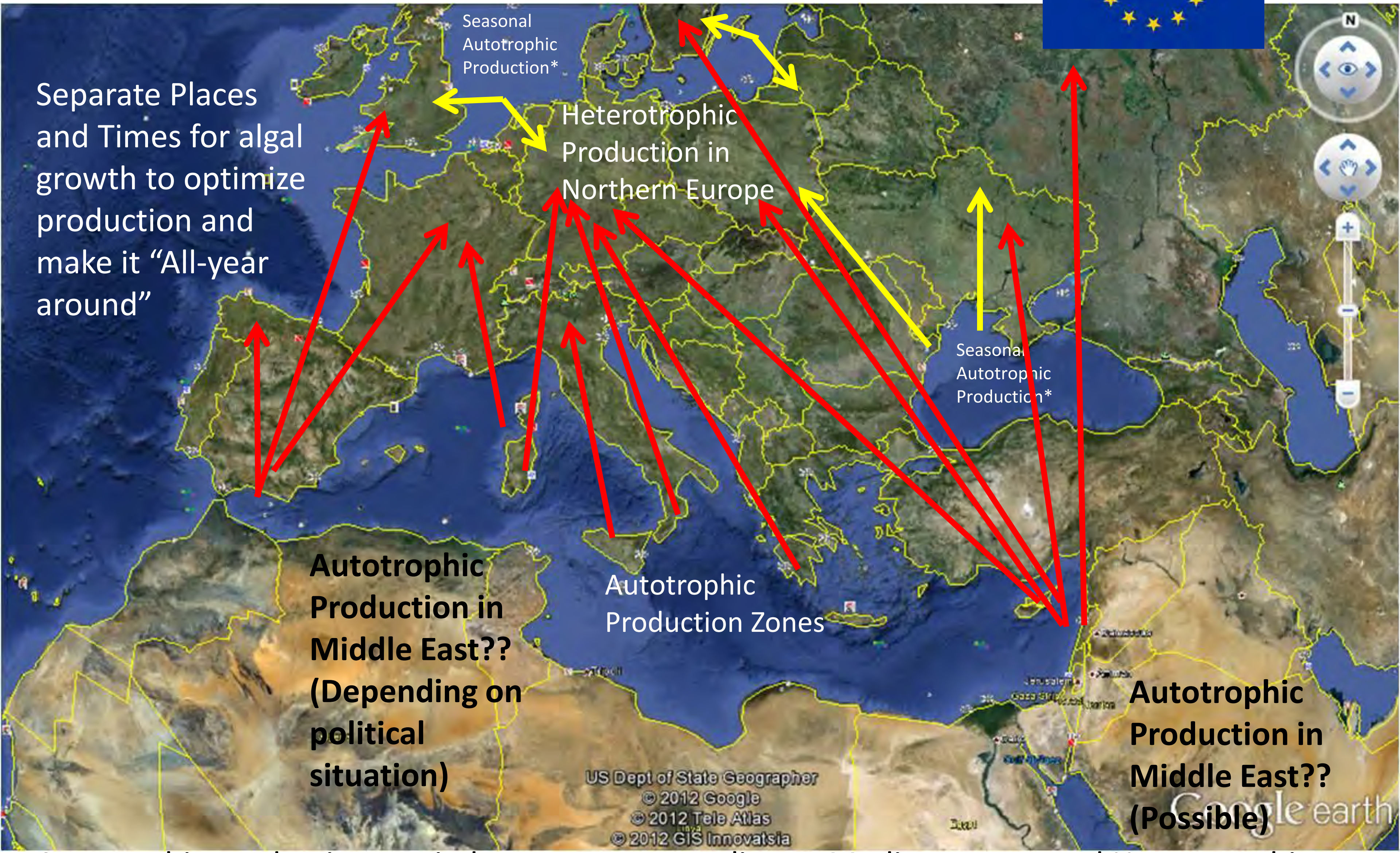
The heterotrophic systems increase the production of lipids by increasing its cell density a dozen times while increasing its fat content from 15 to 55 % by weight. The heterotrophic mode is activated when the algae culture is placed in a fermenter without light, in the presence of Oxygen and a Carbon 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 Europe

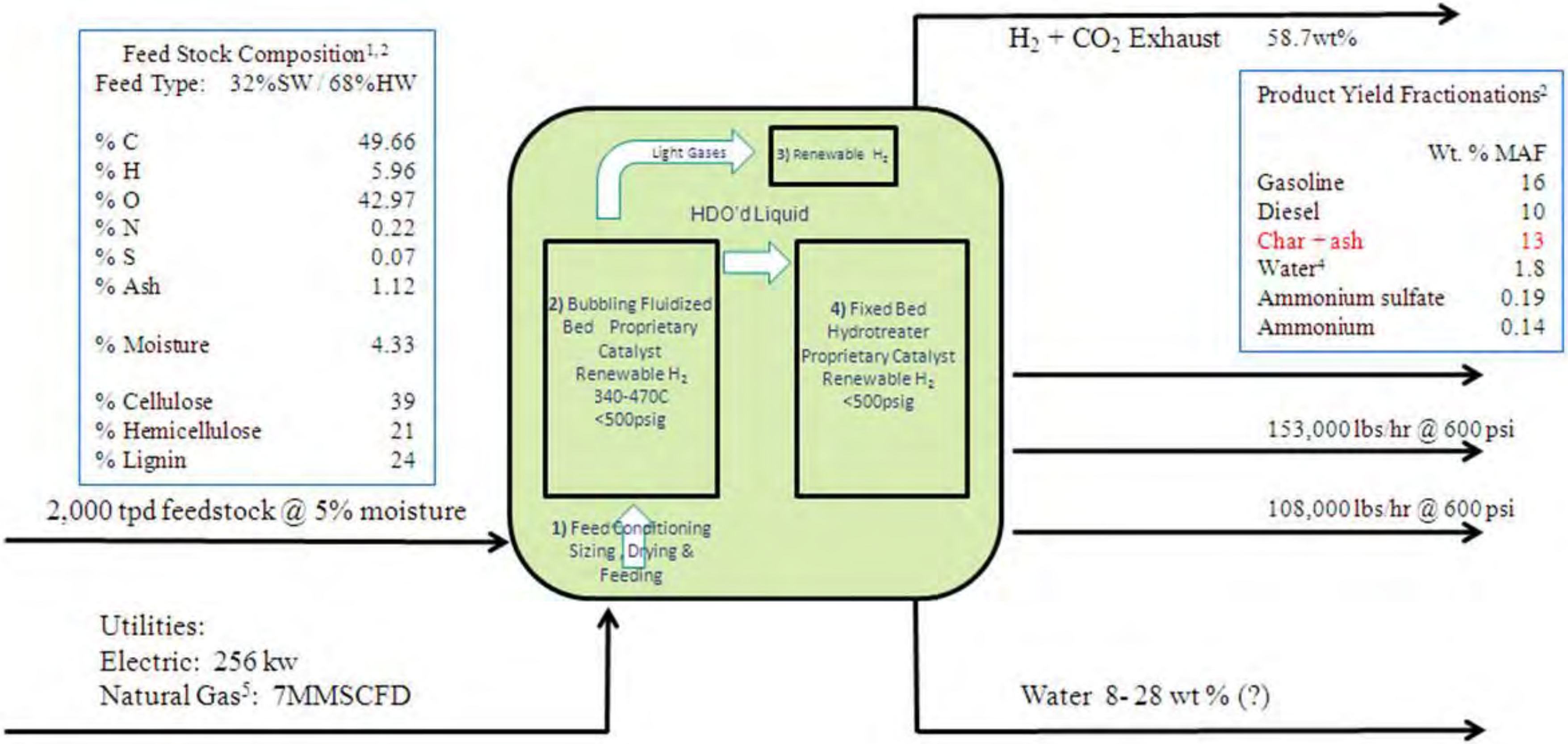


Autotrophic production carried on sunny-warm climate Mediterranean and Heterotrophic production everywhere with an organic Carbon source (sewage, dairy farms, paper mills, etc).

* 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*



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

5. Crunch the numbers for your cost structure in different scenarios and use them to do your business and financial plans

Annual Costs of Open Pond Micro-algae farm operation in Mexico

Capital Costs

Item	Initial Capital Costs (in Millions of 2010 USD)	Note	Additional information	Cost/Ha
Amine Plant	70.4	Amine plant can scrub 1.6 Million tons of CO_2/year from a thermoelectric power plant, considering that 500 Kg of CO_2 are required/Hectare.day, this facility serves 8750 Ha of Micro-algae ponds	Infrastructure to be financed with a loan from the World Bank with an interest rate of 3.71 %/year and a grace period of 12 years. Annual capital costs are estimated by multyplying 0.1047 times the initial capital costs	$842
CO_2 Dehydration and Compression	35.2	Serves 8750 Ha of Micro-algae ponds		$421
Pond Construction	474	Considering a construction cost of $54,171 USD/Hectare		$5,672
CO_2 Distribution Systems	24	Approximately 39 km of CO_2 pipeline main and its smaller distribution laterals for 8750 Ha		$287
Algae Harvesting Equipment	218.75	Harvesting and treatment equipment for water cleaning and replenishing after harvesting		$2,618
Transportation equipment and post-processing facilities	54.5	One transportation truck per every 5 hectares and one medium post-processing facility shared by 100 hectares		$652
Bio-refinery	55.77	Bio-refinery capable of processing 800,000 Tons of micro-algae bio-mass per year		$667
		Annual Capital Costs per hectare		**$11,159**

Operational Costs

Raw Material/Hectare	Material Used/processed in Kg/Ha.year	Cost of Raw material in $/kg	Annual Cost of Raw material $/Hectare.year	
Urea	25550	$0.47	$11,881	
Phosforic acid and phosphates	5100	$0.55	$2,805	
		Annual costs for raw materials		**$14,686**

5. Crunch the numbers for your cost structure in different scenarios and use them to do your business and financial plans

Labor and operational costs	Notes	Cost/unit	Annual labor and operational costs/ Hectare.year
Cost of direct labor	1 full time workers per hectare of micro-algae pond, one technician for every 5 hectares	$6400 USD/year for an unskilled worker, $11,600 USD/year for a technician	$8,720
Electricity	Each hectare requires approximately 19500 Kwh/year	$0.17 USD/Kwh (Mexican Rate)	$3,315
Administrative costs	Each hectare requires 10 % of the time of an administrative worker, 5 % of a mid-manager personnel and 1 % of a top manager	$24,000 USD/year for an administrative worker, $38,400/year for mid-management personnel and $72,000/year for top management personnel	$5,040
Maintenance	Each hectare requires 10 % of the time of a very skilled technical labor	$24,000 USD/year for a very skilled technician	$2,400
Production Supplies	Yearly production supplies costs are roughly above 2.5 % of initial investment/Ha	Initial investment cost is $106,000 USD/Hectare (includes CO2 procuring and Algae Processing)	$2,709
Harvesting supplies	Yearly harvesting supplies costs are roughly above 3 % of initial investment/Ha	Initial investment cost is $106,000 USD/Hectare (includes CO2 procuring and Algae Processing)	$3,250
Research and development costs	A research laboratory is staffed by 2 very skilled technical workers and a highly educated scientist This laboratory serves 100 hectares of micro-algae	$24,000 USD/year for a very skilled technician and $72,000 USD/year for a top scientist	$1,200

Annual Labor and operational costs — **$26,634** per Ha-year

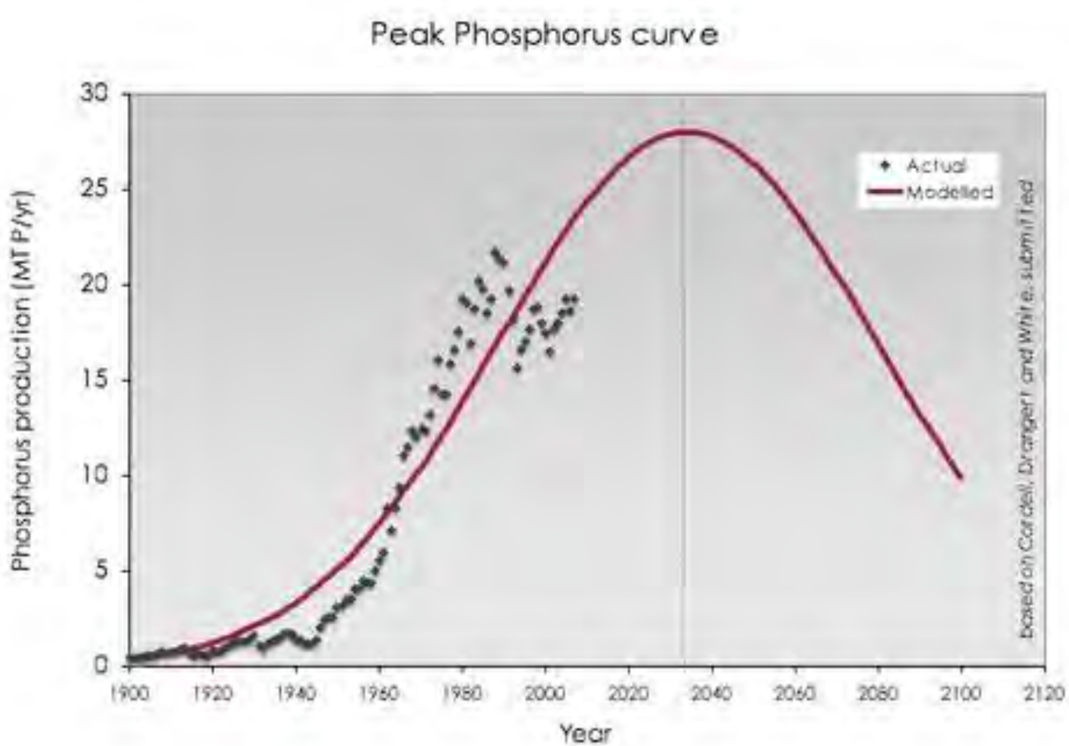
Total Annual Costs per hectare — **$52,479** per Ha-year (total)

		Break-even price per liter of algae oil	With 15 % profit
Expected production @ 15 g/m2.day	19720 Liters of oil/year	$2.66	$3.06
Expected production @ 20 g/m2.day	26280 Liters of oil/year	$2.00	$2.30
Expected production @ 25 g/m2.day	32866 Liters of oil/year	$1.60	$1.84
Expected production @ 30 g/m2.day	39440 Liters of oil/year	$1.33	$1.53

Algae Oil Production Cost Scenarios for a 8750 Ha Open Pond farm in Mexico

The Year of the Algae will come when one producer succeeds in obtaining algae based products at the same or more competitive prices than conventional agriculture or petroleum.

This will occur today, or in the next 5 years. Even if that's not the case, the year of the algae will need to come before 2025, given that we would require algae systems to retrieve Phosphorous from sewages**. The Phosphorous reserves will peak in 2035, after that, we either have a way of getting P for fertilizers or face famine. This is the "internet" for algae systems, given that algae is one of the few forms we know to retrieve P from the oceans or sewages.**



Source: Professor Stuart White, Director, Institute for Sustainable Futures, University of Technology, Sydney

Thanks!!

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