

Rev D 29 Feb 2012

OriginOil[®]

End to End Algae Production Model



Highlights Of The OriginOil Study
24 February 2012

CONVERTING ALGAE TO RENEWABLE CRUDE OIL

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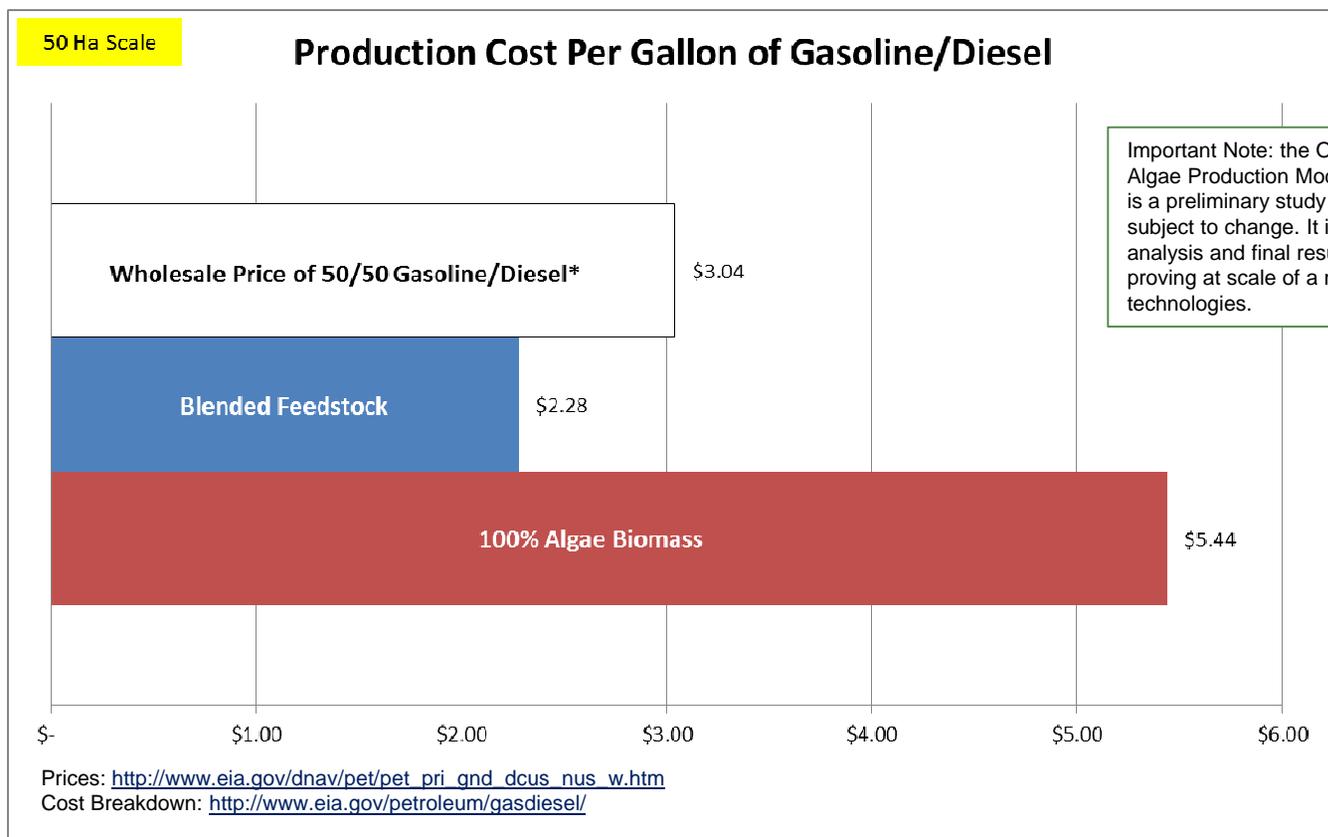
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Study: Algae-Based Fuel Now Profitable.



* Wholesale price is based on average price of gasoline and diesel (US, 2/20/2012) after cost of crude oil and refining, before marketing, distribution and taxes.

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Fuel Production Directly Onsite



- Algae producers can make renewable gasoline and diesel cost-effectively right at their site of production.
- These fuels are an ideal “insertion point” for refineries, permitting further upgrades (jet fuel etc.) by refiners.
- End to End Model indicates:
 - Potential for production costs for blends to be profitable now, without subsidy.
 - Pure algae biomass within reach of profitability.
- That’s with no subsidies or preferences, no premium for “green” fuels.

This proves a point, but many producers will choose to make biocrude, which can be converted into higher-priced renewable chemicals as well as fuel fractions.

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What's New?



- Improved production assumptions based on field experience.
- Implementation of advanced growth techniques to boost productivity.
- Improved cost numbers for harvesting stage based on experience.
- Algae may be blended with other feedstocks such as waste.
- On-site fuel conversion technology that allows algae producers to make gasoline and diesel themselves onsite*.

OriginOil plans to integrate its Algae Appliance™ harvester with downstream conversion technologies* for a single end to end harvest-to-fuel solution for algae producers.

* See Technology Note at end page.

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SOME NUMBERS

CONVERTING ALGAE TO RENEWABLE CRUDE OIL

Results – Profit and Loss



RESULTS - P&L	1 HA		50 HA	
	Value	Unit	Value	Unit
REVENUE				
<i>Ancillary Sources</i>				
Daily Revenue from Carbon Credits	40	\$	2,015	\$
Daily Revenue from Wastewater Treatment Credits	55	\$	2,753	\$
<i>Biomass Feedstock</i>				
Daily Revenue from Fuel & By-Products	9,313	\$	465,674	\$
Total Daily Revenue	9,409	\$	470,441	\$
Total Annual Revenue	3,293,088	\$	164,654,383	\$
OPERATING COSTS				
<i>Daily Cost of Blended Biomass Feedstock less Algae Biomass</i>	1,255	\$	62,757	\$
<i>Daily Capex/Opex for Conversions to Gasoline/Diesel with IH2</i>	5,380	\$	268,981	\$
Total Daily Capex/Opex for Conversion to Gasoline/Diesel	6,635	\$	331,738	\$
Total Annual Operating Costs	2,647,765	\$	130,877,442	\$
Annual Revenue	3,293,088	\$	164,654,383	\$
Annual Costs (Debt Service + Operating Costs)	2,789,150	\$	134,089,722	\$
Annual Profit/Loss	503,937	\$	30,564,661	\$

Full model available in confidence to industry partners.

Results – Resources (per Hectare)



RESULTS - Resources	1 HA		U.S. Value	U.S. Unit
	Metric Value	Metric Unit		
FACILITY				
Land Required	1.00	ha	2.47	ac
RAW MATERIAL INPUTS				
Daily Water Requirements	5,505	L	1,454	gal
Daily Carbon Dioxide Requirements	4.03	MT	4.44	US Tons
Daily Nitrogen Requirements	0.0	kg	0.0	lb
Daily Phosphorus Requirements	0.00	kg	0.00	lb
ENERGY REQUIREMENTS				
Daily Energy Requirements for Algae Growth	284	kWh		
Daily Energy Requirements for Harvesting	456	kWh		
Total Daily Energy Requirements after Free or Waste Energy	740	kWh		
Total Annual Energy Requirements	259	MWh		
PRODUCT YIELDS				
Daily Biomass Harvest	2,202	kg	4,855	lb
PRODUCTION COSTS				
Cost of Producing Dry Weight Algae Biomass	0.61	\$/kg	0.27	\$/lb
Cost of Producing Fuel (Blended Feedstock)	0.63	\$/L	2.37	\$/gal
Cost of Producing Fuel (All Algae Feedstock)	1.74	\$/L	6.59	\$/gal

CONVERTING ALGAE TO RENEWABLE CRUDE OIL

Results – Resources (50 Hectares)



	50 HA			
RESULTS - Resources	Metric Value	Metric Unit	U.S. Value	U.S. Unit
FACILITY				
Land Required	50.00	ha	123.55	ac
RAW MATERIAL INPUTS				
Daily Water Requirements	275,250	L	72,713	gal
Daily Carbon Dioxide Requirements	201.48	MT	222.10	US Tons
Daily Nitrogen Requirements	0.0	kg	0.0	lb
Daily Phosphorus Requirements	0.00	kg	0.00	lb
ENERGY REQUIREMENTS				
Daily Energy Requirements for Algae Growth	13,975	kWh		
Daily Energy Requirements for Harvesting	19,613	kWh		
Total Daily Energy Requirements after Free or Waste Energy	33,588	kWh		
Total Annual Energy Requirements	11,756	MWh		
PRODUCT YIELDS				
Daily Biomass Harvest	110,100	kg	242,729	lb
PRODUCTION COSTS				
Cost of Producing Dry Weight Algae Biomass	0.47	\$/kg	0.21	\$/lb
Cost of Producing Fuel (Blended Feedstock)	0.60	\$/L	2.28	\$/gal
Cost of Producing Fuel (All Algae Feedstock)	1.44	\$/L	5.44	\$/gal

CONVERTING ALGAE TO RENEWABLE CRUDE OIL

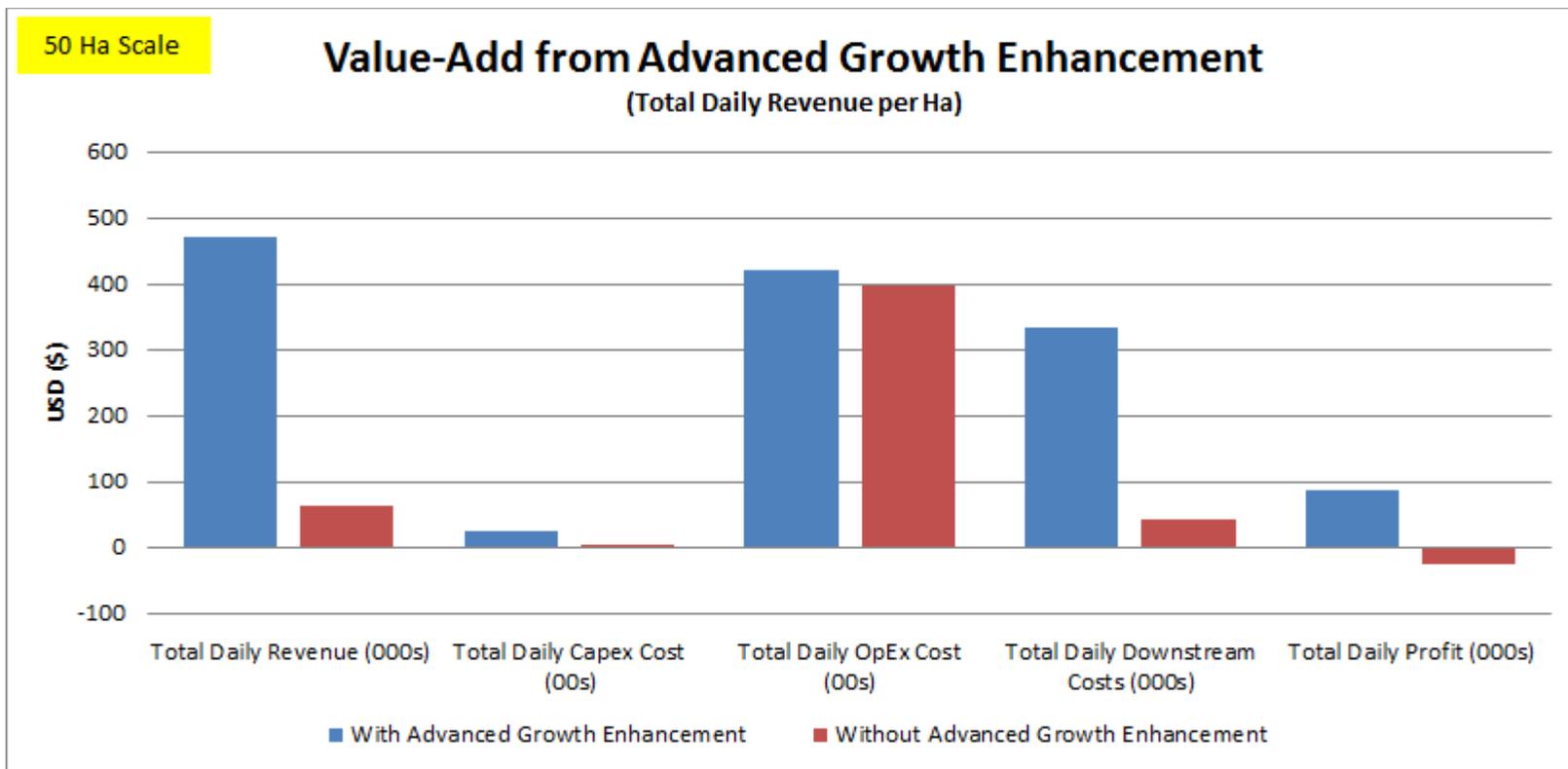


Growth, Harvesting, Conversion

MORE GRAPHS

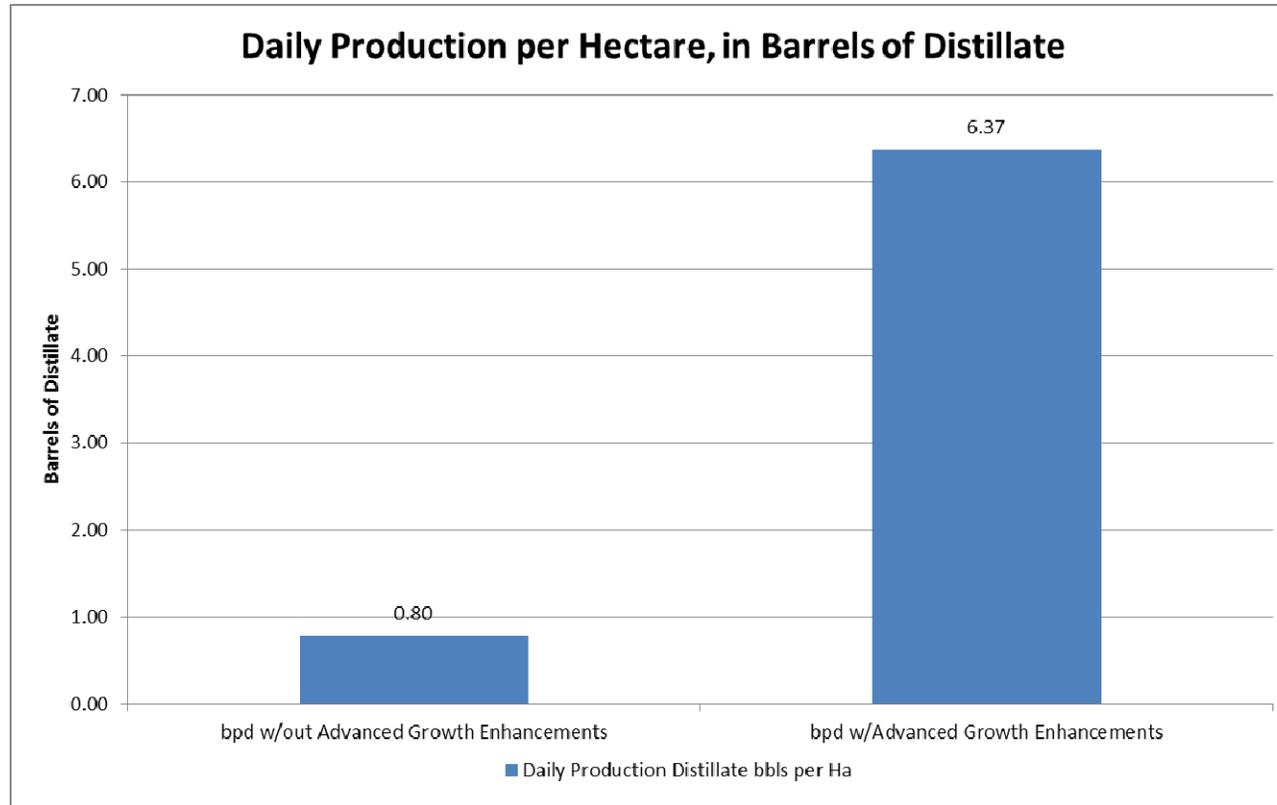
CONVERTING ALGAE TO RENEWABLE CRUDE OIL

Advanced Growth is Key to Profitability...



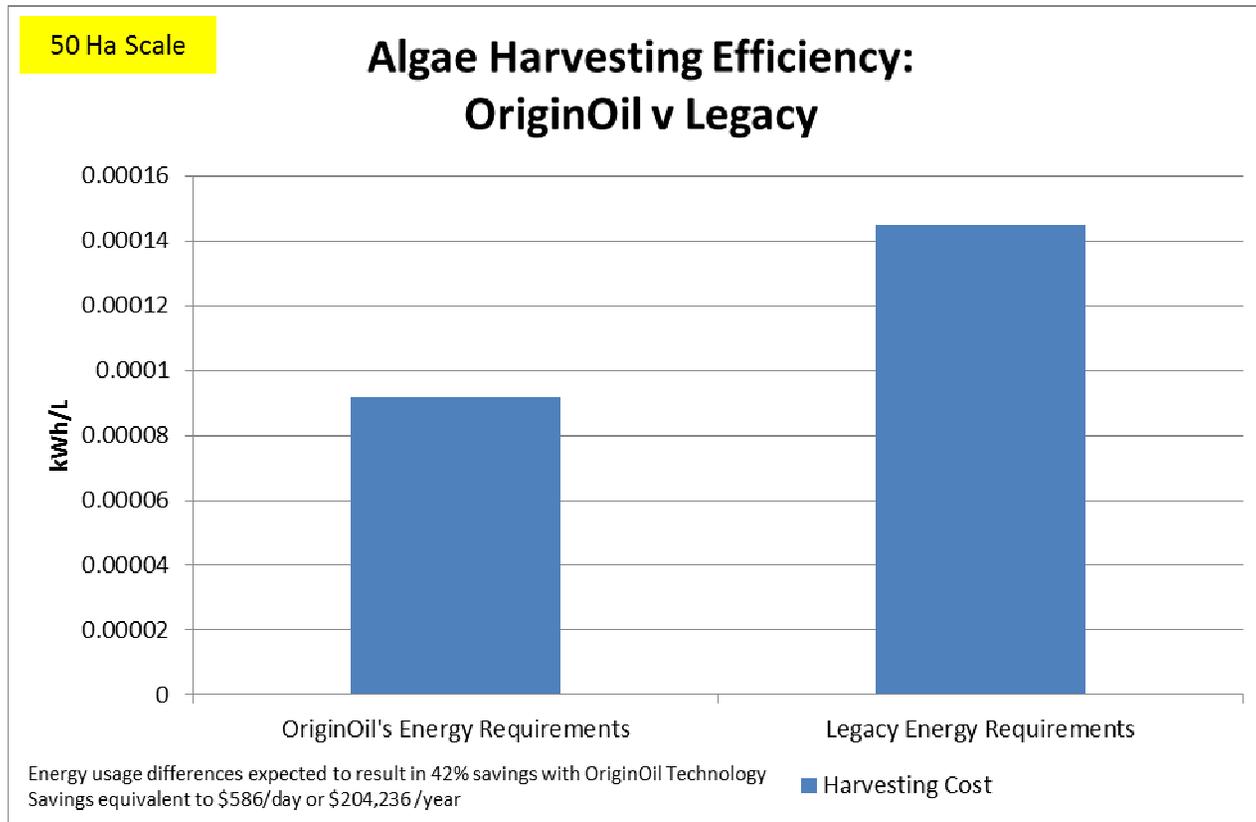
CONVERTING ALGAE TO RENEWABLE CRUDE OIL

...Making Algae Production 8x More Efficient.



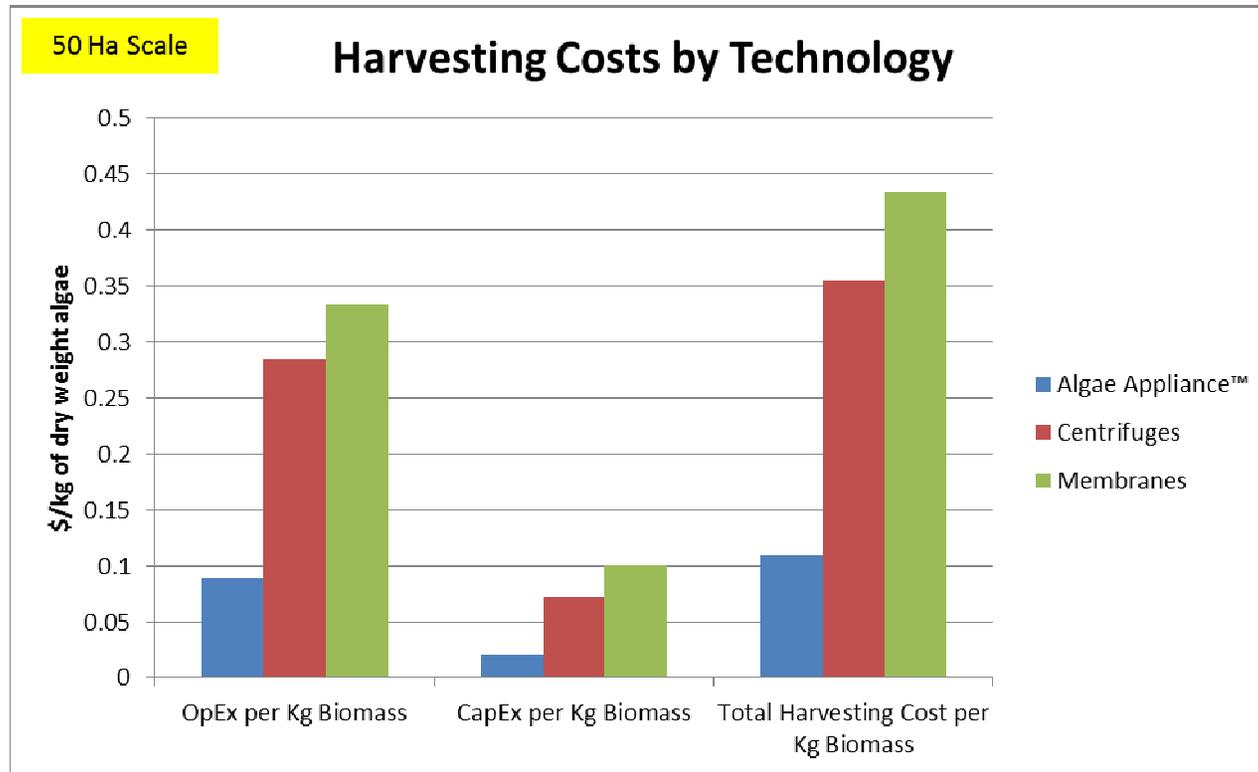
CONVERTING ALGAE TO RENEWABLE CRUDE OIL

OriginOil Harvesting is 42% More Efficient...



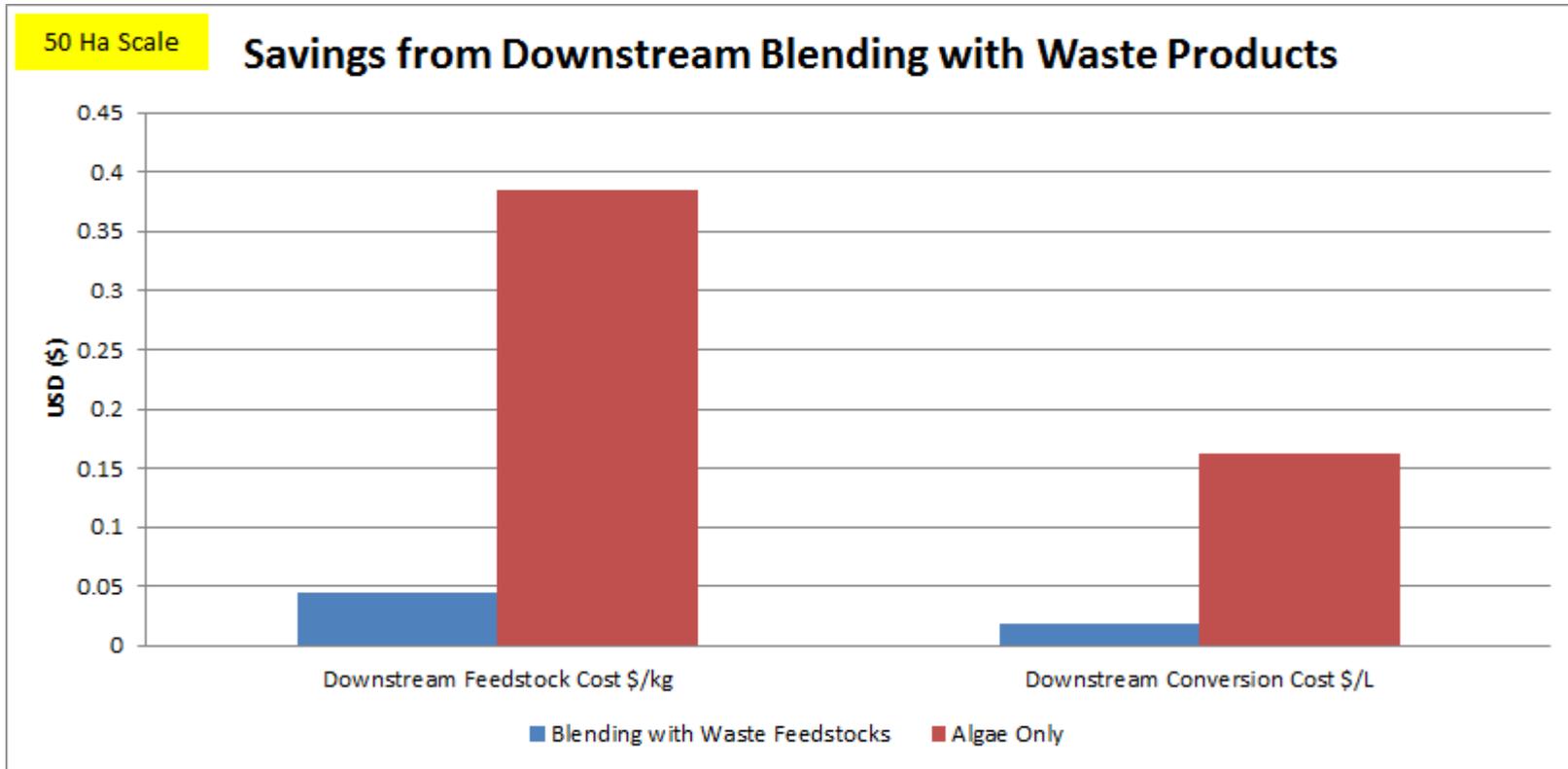
CONVERTING ALGAE TO RENEWABLE CRUDE OIL

...While Costs Are Up to ¼ of Competitors.



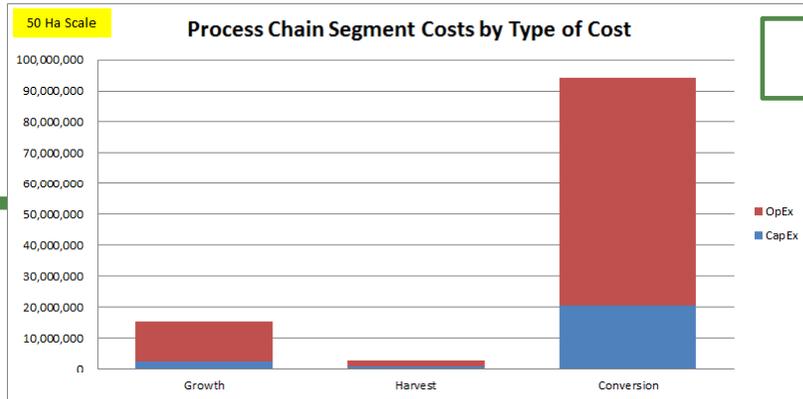
CONVERTING ALGAE TO RENEWABLE CRUDE OIL

Blending Achieves Unit Cost Reduction...



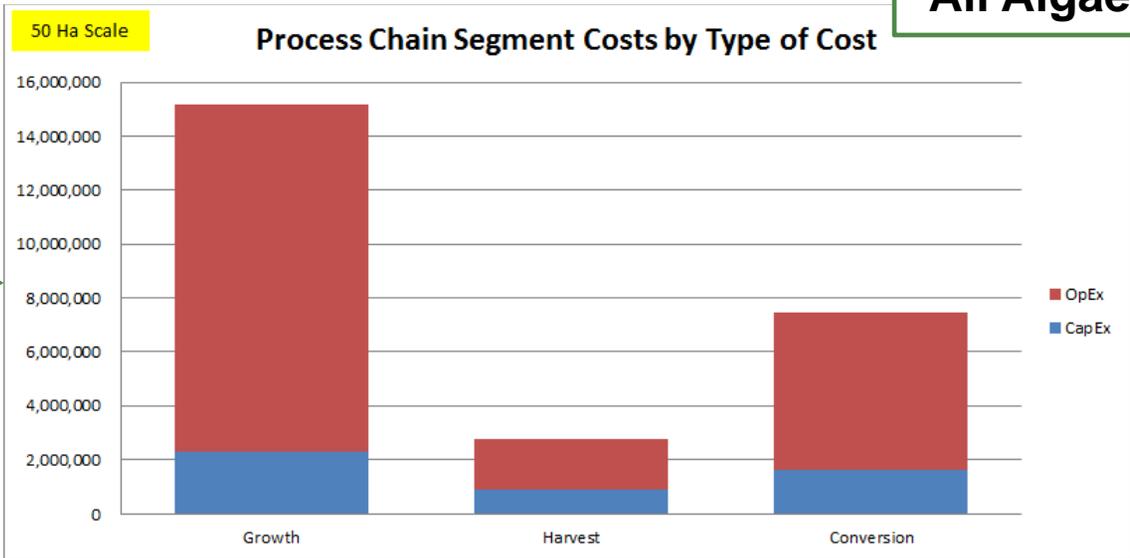
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... With Greater Conversion Cost Burdens...



Blended

Note change of scale from blended to 100% algae



All Algae

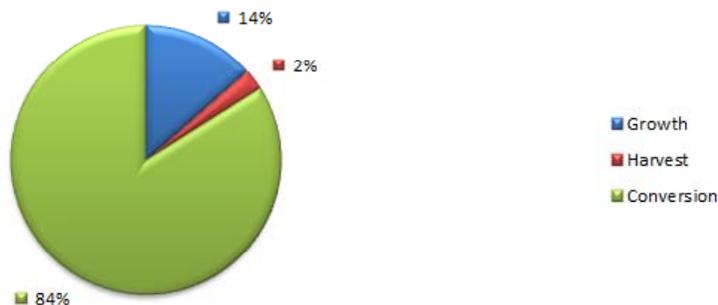
... As Algae is More Conversion Efficient.



Blended

50 Ha Scale

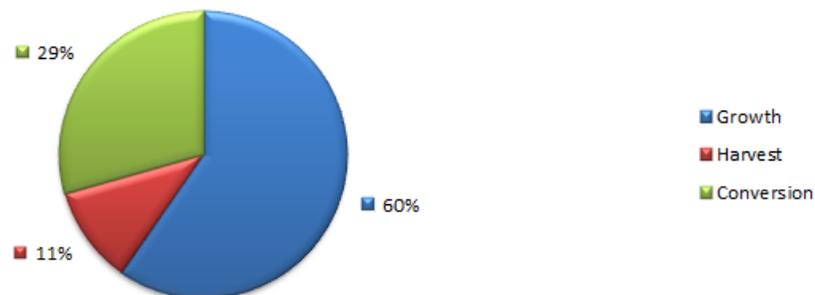
Total Cost by Process Chain Segment



All Algae

50 Ha Scale

Total Cost by Process Chain Segment



Much Greater Conversion cost ratio for Blended vs. All Algae

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Based on OriginOil's Clean Defense Summit presentation on 8 February, 2012



Defense Prioritization and the Biofuels Industry

U.S. ALGAE DEMAND TAKES OFF

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Defense Prioritization Driving U.S. Biofuels

- “The U.S. Department of Defense (DoD) is the nation's largest consumer of energy, with annual oil consumption on par with Sweden. Unlike many of Washington's civilian politicians, the DoD is going beyond lip service to actually taking substantive steps for reducing its dependence on imported petroleum.”
 - Raymond James Energy Group Company Brief on Gevo, Inc., 8 Feb 2012
- “We’re looking at second and third generation biofuels made from algae, made from things like camelina, which is an inedible part of the mustard family and the main source of this big biofuel purchase came from inedible grease that came from Tyson foods, from cooking chicken basically. So we’re – we don’t have a specific technology in mind, we just need the energy.”
 - U.S. Navy Secretary Ray Mabus, [C-Span interview of 5 Feb 2012](#)

The U.S. Military’s drive is jump-starting advanced biofuels in the US.

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Accelerating Developments



- ❑ 5 Dec 2011: DoD announces largest-ever biofuels purchase by the government, using a blend of algae and waste oil.
- ❑ US Navy on aggressive national security timetable to convert to 50% alternative fuels by 2020. 8 million barrels per year in jet and marine fuels.
- ❑ DoD, DOE and USDA invoking Defense Production Act to create demand, get biorefineries built, and set new rules.
 - ✓ All fuels must be sustainable: no impact to food supplies allowed.
 - ✓ Key role for algae: energy-rich and very similar to petroleum itself.
- ❑ Meanwhile, the aviation industry is facing tough EU carbon mandates and is supportive of biofuels initiatives. This will provide an additional demand driver that is less reliant on Congress. [Biofuels Digest, 8 Feb 2012](#)

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Excerpt

Department of Navy Biofuel Initiatives

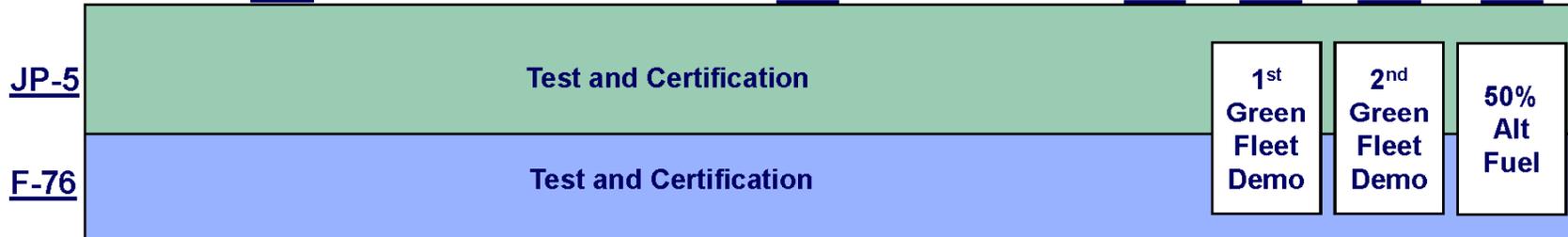
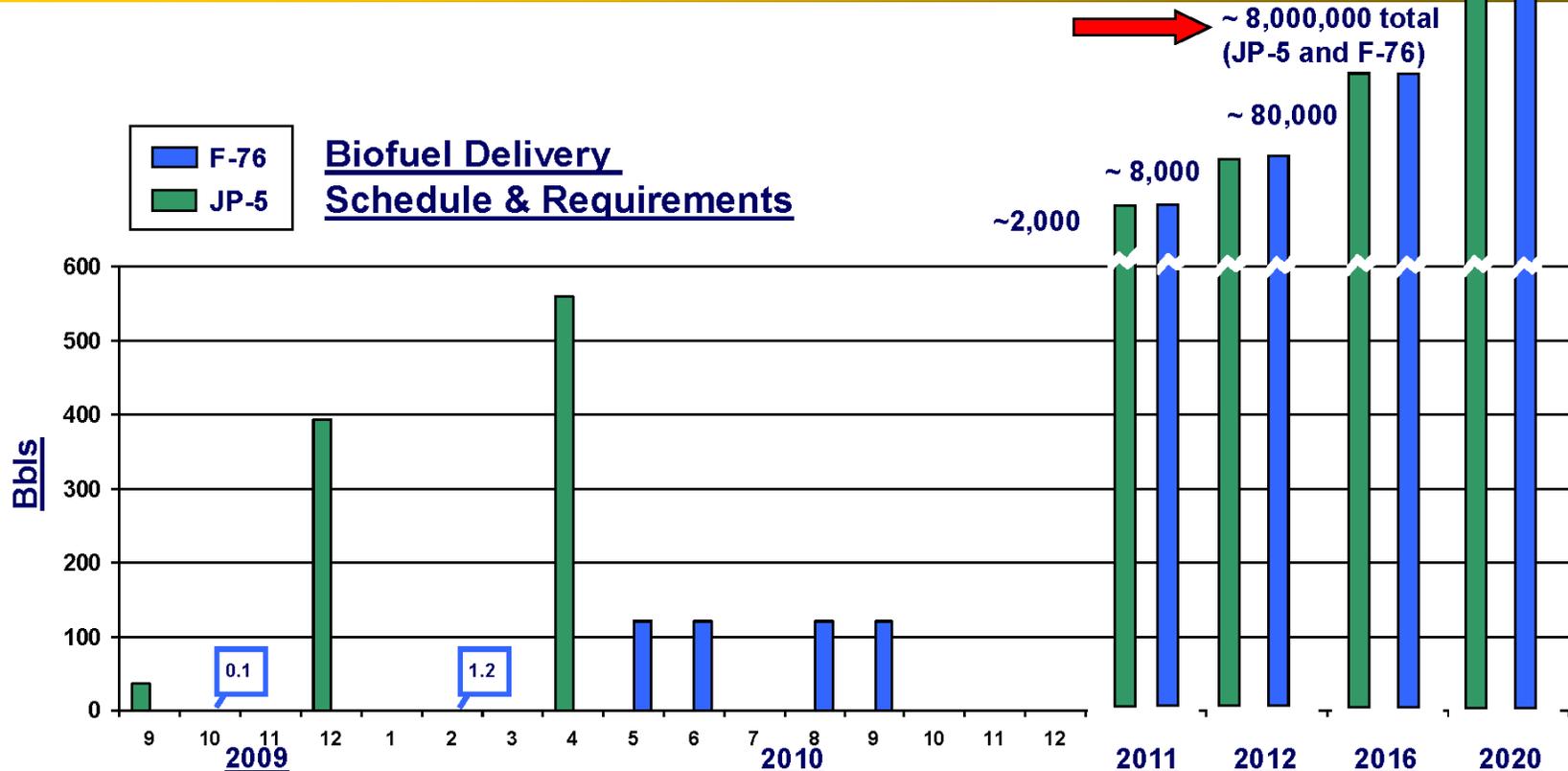
***Chris Tindal
Director for Operational Energy***

November 8th, 2011

Assistant Secretary of the Navy (Energy, Installations & Environment)



Navy Biofuel Needs





DON, DOE, & USDA Planned Effort



- **Utilizing Title III of the Defense Production Act**
 - Special provision to develop industrial base and critical technology
 - Provisions for feedstock, CAPEX/OPEX, and offtake
- **Seeking integrated biorefineries where substantially all of the business activities must take place domestically (US or Canada)**
 - Feedstock growth , processing, fuel production, blending & distribution, et alia
- **50% minimum private industry cost share**
- **We need multiple, diverse pathways and locations**
 - Oils, biochemical, thermochemical



DON, DOE, & USDA Planned Effort



- **Seeking drop-in biofuels at their maximum blend per applicable spec that function at least as well as petroleum product displaced**
 - e.g. 50:50 HRJ5:JP5 or HRD76:F76
 - Can be fuel spec in approval process, e.g. ATJ
- **EISA 526 compliant bio-derived fuels**
 - Lifecycle GHG emissions must be less than or equal to conventional fuel being replaced
- **Commercial scale – min 10 MM gal neat fuel/year**
 - **“No intermediate or long-term impact on supply of agricultural commodities involved in food production”**
 - As determined by USDA

+ Fresh Water!

How OriginOil is Helping



- ❑ 8 Dec 2011: OriginOil and DOE announce research agreement to establish industry standards for blending algae with multiple feedstocks.
- ❑ 15 Dec 2011: OriginOil in Joint Venture to develop biorefineries serving U.S. and NATO military requirements for alternative fuels.
 - ❑ The JV, Future Energy Solutions Unlimited, Inc. (FES) is funded and carrying out bankable feasibility studies supporting project development and project delivery for diversified biofuel refining centers in strategic locations around the world.
 - ❑ FES is a Service-Disabled Veteran-Owned Small Business Concern (SDVOSBC) headed by Larry Sirmans, recently CTO at Australian algae leader MBD Energy.
- ❑ 13 Jan 2012: OriginOil and DOE to co-develop an integrated system for direct conversion of raw algae into a renewable crude oil that can be used by existing petroleum refineries.

Direct conversion to fuel is now feasible at the point of algae production.

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Where We Stand

- ❑ Driven by the military, the US is moving ahead with advanced biofuels adoption, despite the lack of a carbon policy (the key driver in other countries).
- ❑ The aviation industry, driven by tough EU mandates, is an emerging player that could diversify program support.
- ❑ Algae is emerging as a key feedstock, especially when blended with waste, where it provides an energy boost and a true petrochemical profile.
- ❑ OriginOil is working with DOE on blending standards and algae-to-fuel conversion, and is helping to develop DoD integrated biorefineries in strategic locations worldwide.



The Algae Harvesting Technology Company

ORIGINOIL

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What is OriginOil?



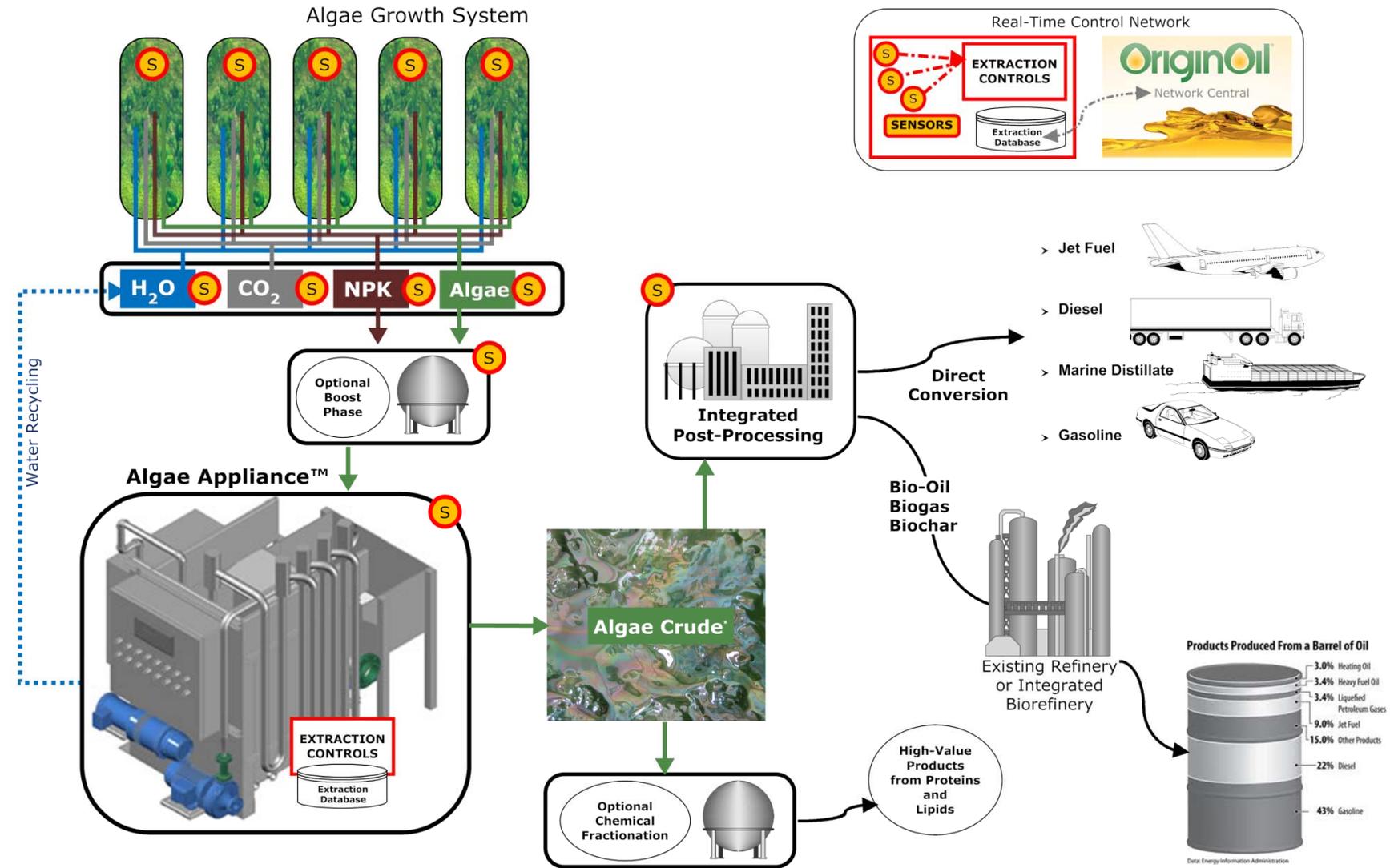
- ❑ Developed the next generation of essential technology to harvest algae for fuel, chemicals and high-value products.
- ❑ Now integrating downstream conversion to crude oil and distillates so algae companies can make fuels directly onsite.
- ❑ Field-proven with a successful pilot project at scale.
- ❑ Now in revenue with breakthrough technology: \$1m+ in booked sales in 2011.
- ❑ Building a sustainable algae industry now – by offering modular harvesting systems directly to top algae companies.
- ❑ Planning to expand through licensing and distribution deals: “Powered by OriginOil”.

OriginOil is the technology company now enabling the new algae industry.

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END-TO-END ALGAE PROCESSING



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*"Algae Crude" sample produced by Evodos™ centrifugation after Single Step Extraction™

= OriginOil Sensors

DATE 10 Feb 2012
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WHY ALGAE?

CONVERTING ALGAE TO RENEWABLE CRUDE OIL

Three Generations of Biofuels

- ❑ **First Generation** – Billions invested in corn, vegetable oils, sugar cane. Major food supply dislocations since 2008. Ethanol subsidies in deep trouble. “Rich farmers.”
- ❑ **Second Generation** – Billions more still being invested in non-food land crops such as grasses, forestry, jatropha. Food chain dislocation avoided, but major issues of land and fresh water use remain.
- ❑ **Third Generation – *Advanced Biofuels.***
 - Chemically similar to petroleum.
 - Not a food crop, needs no productive land.
 - Uses waste, brackish, or salt water.
 - Purifies water (nitrates, drugs, toxins).
 - Massive rates of CO₂ absorption.
 - Large-scale Oxygen (and Hydrogen) generation.
 - Rapid harvests, permitting industrial scale production.

Algae is the Third Generation feedstock and is expected to dominate the biofuels marketplace.

OriginOil®

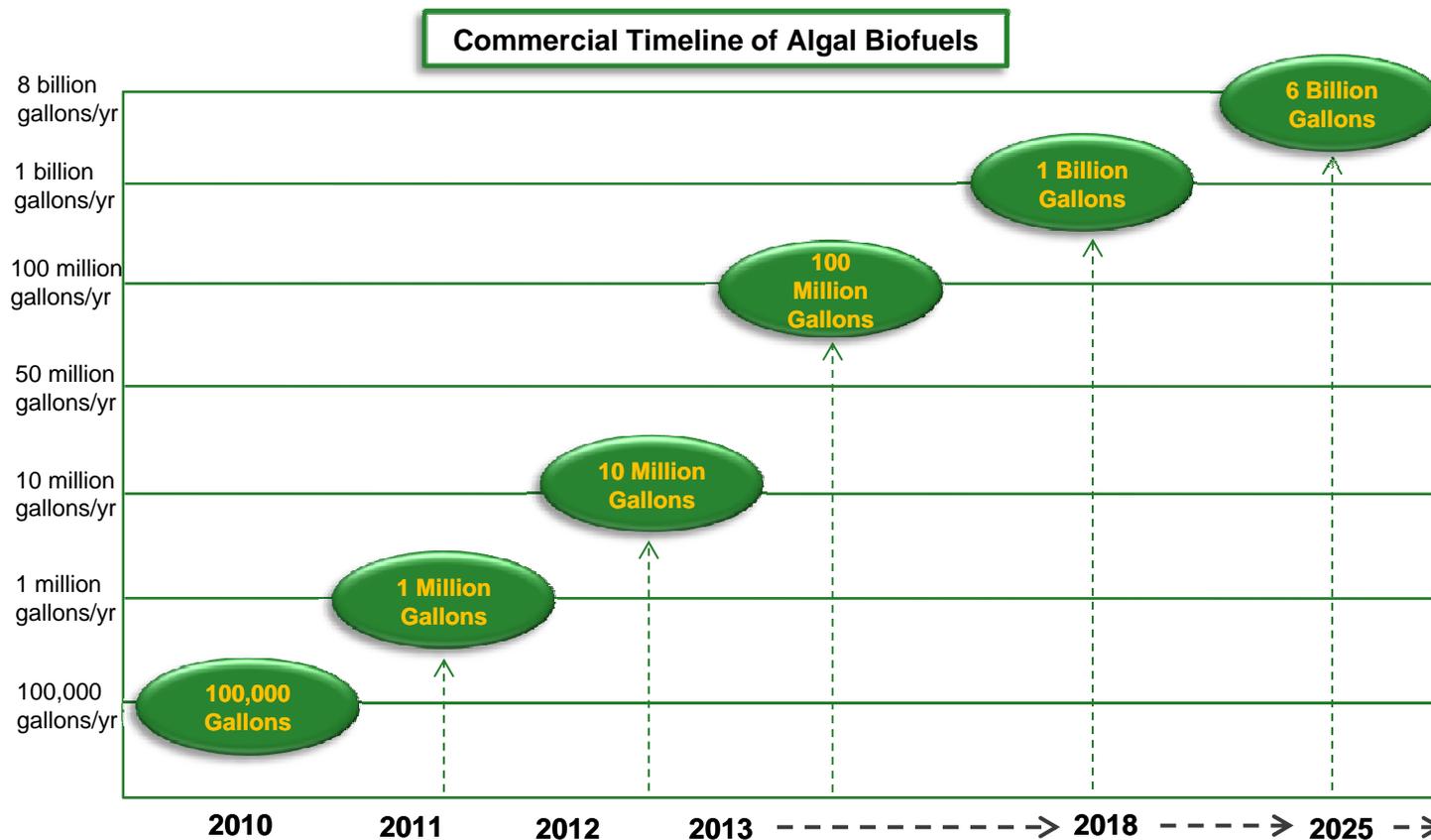


A BREAKTHROUGH TECHNOLOGY TO EXTRACT OIL FROM ALGAE

Algal Biofuels: An Engine of Growth



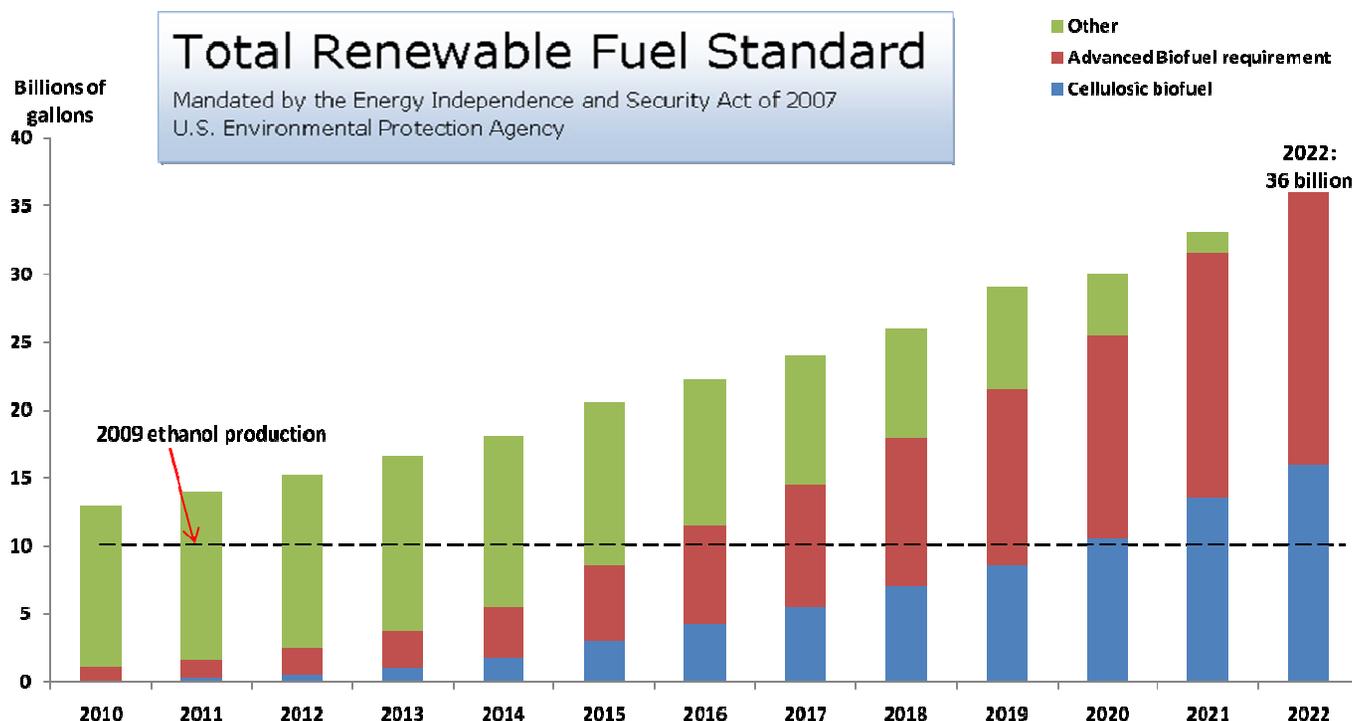
- ❑ The world biofuels market is expected to grow at a CAGR of 12%+ until 2017.
- ❑ \$105.4 billion in forecasted annual revenue by 2018.



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

A BREAKTHROUGH TECHNOLOGY TO EXTRACT OIL FROM ALGAE

The Advanced Biofuels Mandate



- Algae, the primary advanced biofuel, will benefit from U.S. mandated standards:
 - Ethanol fully replaced by 2022.
 - Fastest growth among all biofuels.

Source: <http://www.epa.gov/oms/renewablefuels/420f09023.htm>

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SCALING UP ALGAE

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Commercializing in Australia



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A BREAKTHROUGH TECHNOLOGY TO EXTRACT OIL FROM ALGAE

Aggressive Scale-Up Process



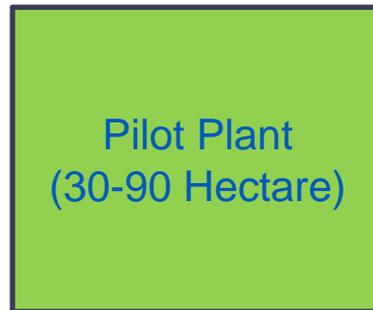
JCU Research Facility
(5,000 m²)



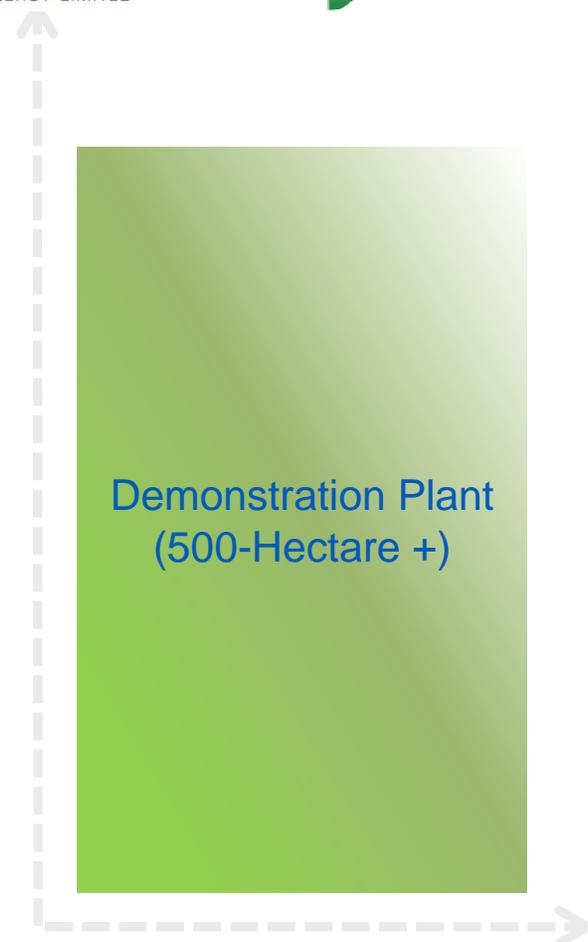
Tarong Energy
Display Plant
(1-Hectare)



Pilot Plant
(30-90 Hectare)



Demonstration Plant
(500-Hectare +)



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OriginOil Adding Reference Sites Globally



- ❑ 3 February 2012: Algae Producer Aquaviridis and OriginOil Announce Joint Commercial Agreement
 - ❑ Development of dry-land aquaculture could transform desert farm economies of the American Southwest and Mexico
 - ❑ Aquaviridis to immediately scale up to ten acres of pilot algae production by MID-2012.
 - ❑ Commercial scale production capacity is expected by the second quarter of 2013.
 - ❑ Mexicali Valley a strategic location due to favorable growing conditions, strong local and governmental support, and massive sources of carbon dioxide.
- ❑ In Europe, OriginOil's Ennesys Joint Venture targets major projects in France.

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In Conclusion...

- Algae production is being scaled up as technology barriers are overcome.
- Algae producers will soon be able to produce fuel molecules right at the point of production.
- Feedstock standards are being developed for every level of production, processing and blending for final use.
- Governmental incentives such as carbon regulations and military demand are essential to financing scaled-up projects.
- DoD-sponsored biorefineries are being developed for strategic locations worldwide that will blend algae, waste and forestry products for military consumption.
- These factors are leading to a rapid growth acceleration in the algae industry.

A Note on Fuel Conversion Technology



Technology Note

CRI's IH2 Process was adopted for this model. (IH2: Integrated Hydropyrolysis + Hydroconversion)

(The IH2 process converts virtually any type of non-food biomass feedstock—such as wood, agricultural residues, algae, and aquatic plants. High-quality hydrocarbon fuels and/or blend stocks (in the gasoline, jet and diesel range) have been produced by the IH2 technology in tests using a broad spectrum of biomass feed. IH2 products are fungible with fossil-derived fuels and are completely compatible with current infrastructure.)

Other processes being investigated for integration in collaboration with DOE's Idaho National Laboratory (INL): Licella, Honeywell, Envergent, Dynamotive, Kior, Solray, BTG, HTU Process, TCOM System... and more.

Please contact the OriginOil [Partners](#) desk to review the full model and to collaborate on downstream process evaluations.

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