

# ALGENOL

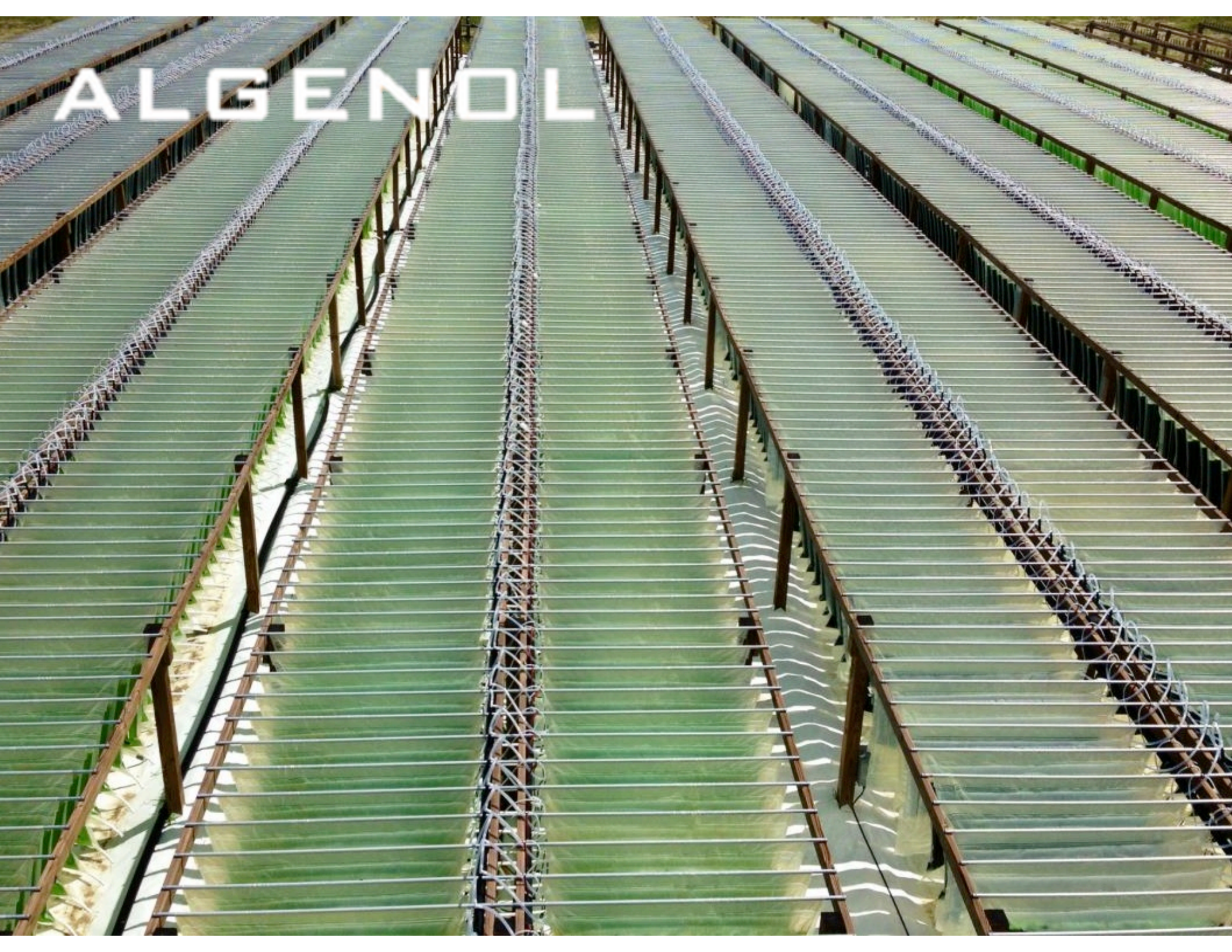
## B I O F U E L S

*Harnessing the sun to fuel the world.®*

**Presentation to ABLC**

April 22<sup>th</sup> 2014

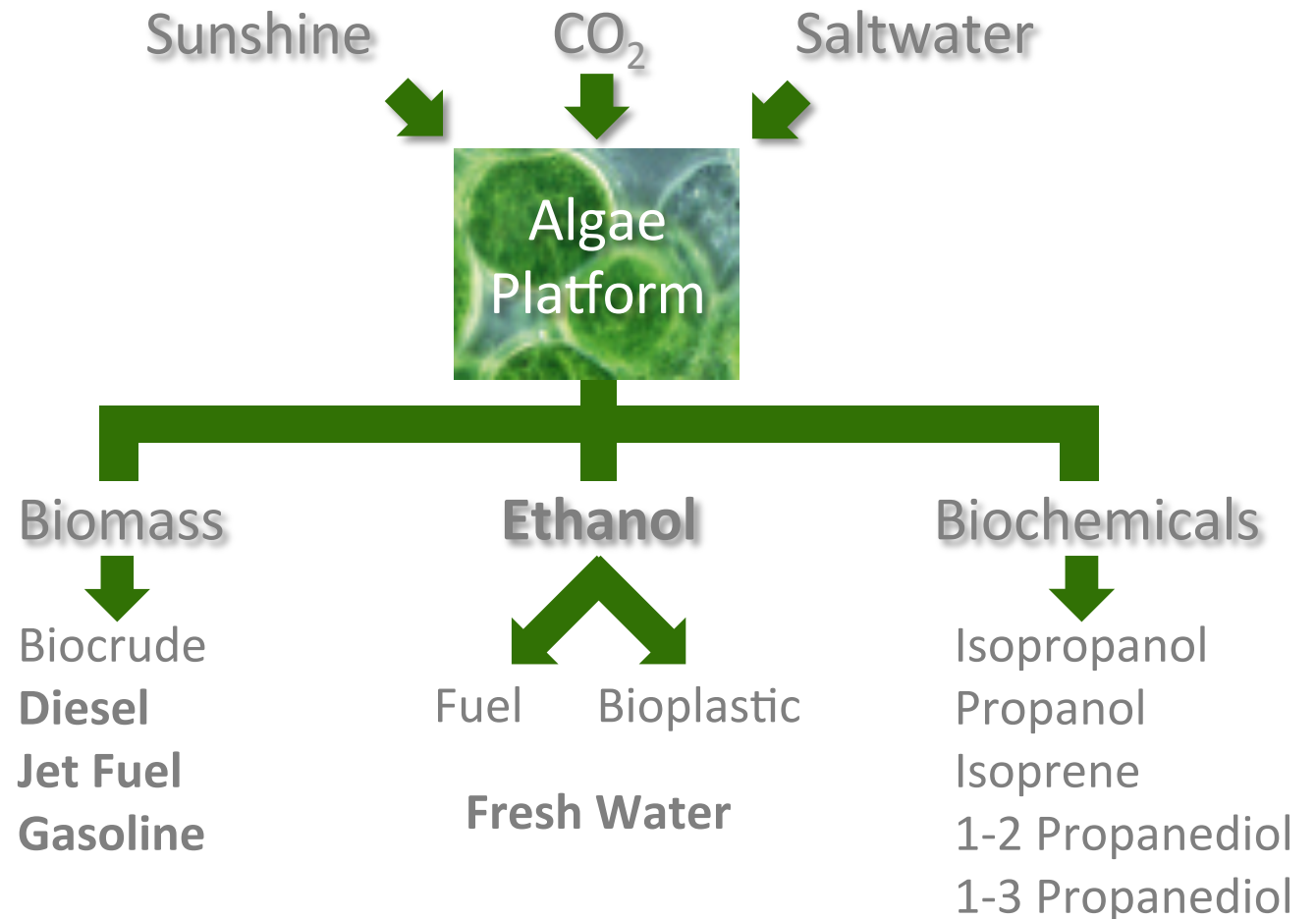
ALGENOL



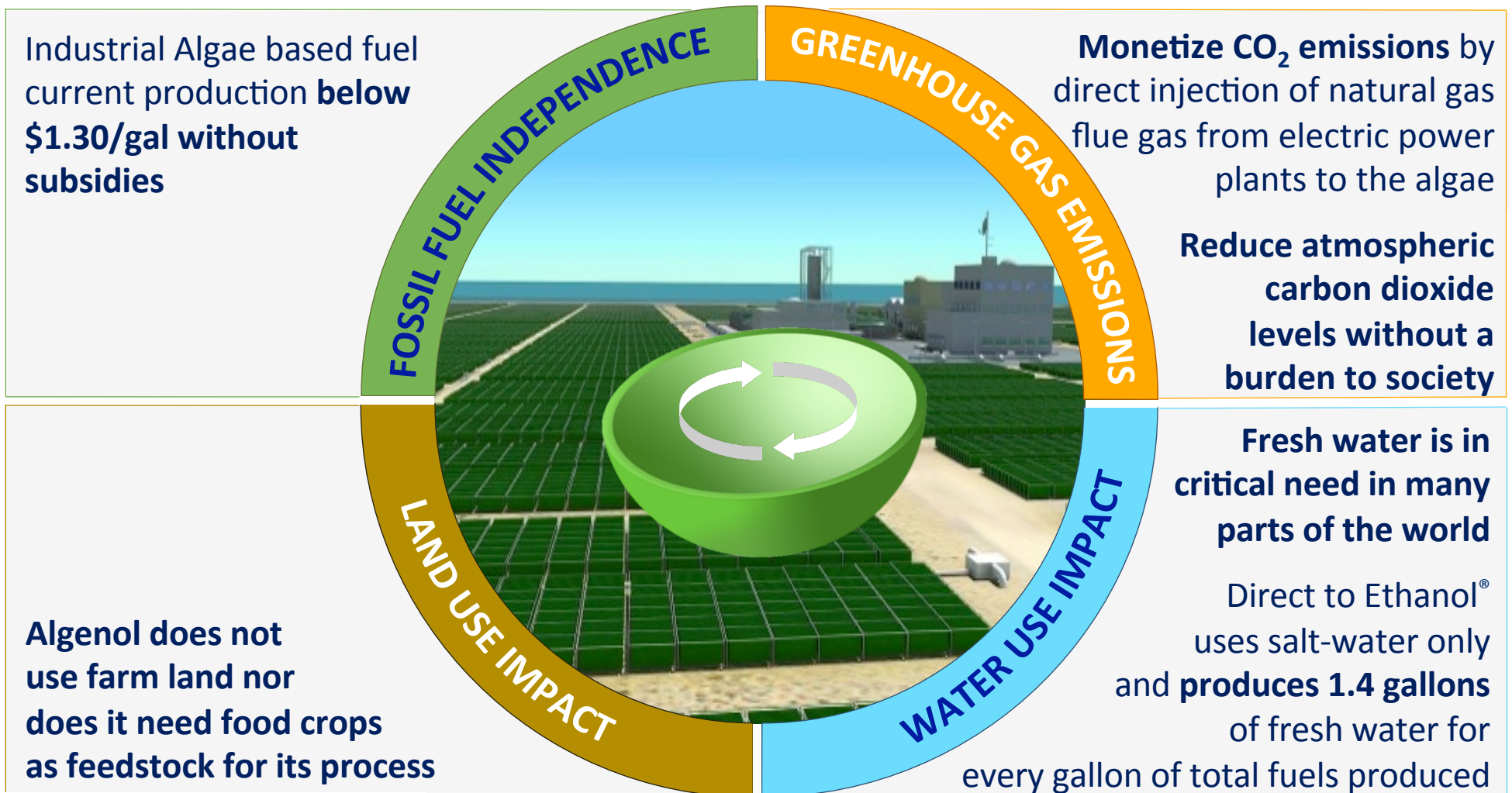


## SUSTAINABLE CARBON CAPTURE AND REUSE

Algae as a biocatalyst to profitably produce green products



# ALGENOL'S INDUSTRIAL TECHNOLOGY IS THE BEST LINK BETWEEN GREEN FUELS, FRESH WATER, AND CARBON REDUCTION



# HIGH YIELD, LOW COST – world's most scalable industrial algae platform

## Cost

OpEx ≤ **\$1.27** per gallon

**All 4 fuels**

### Feedstock Conversion

1 tonne of CO<sub>2</sub> becomes 144 gallons of fuel:

- 125 gallons of ethanol
- 19 gallons of diesel, jet fuel, and gasoline



### Necessary Inputs Are Abundant:

- Sunshine
- CO<sub>2</sub> from industrial sources
- Saltwater
- Spent algae becomes diesel, jet fuel, and gasoline

## Productivity

Unique Platform Strain:

**> 8,000 TGOLF**

<sup>(1)</sup> per acre-year

### Comparison to Biofuels

- 420 corn ethanol
- 800 Brazil sugarcane
- < 500 cellulosic



### Direct to Ethanol® Does Not Require:

- Farm land
- Food crops
- Fresh water
- Mandates

(1) Total Gallons of Liquid Fuel



Engineering

Biology

Headquarters

IBR

Process Development Unit

PBR Manufacturing

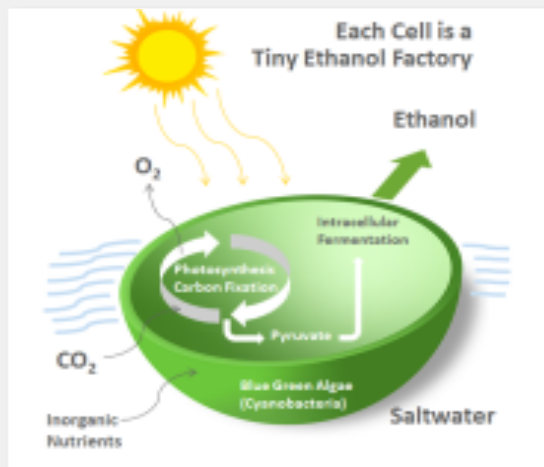
# Headquarters and Project Development Campus

Picture: October 2013

# TECHNOLOGY OVERVIEW

Algenol's Direct to Ethanol® process has three core components:

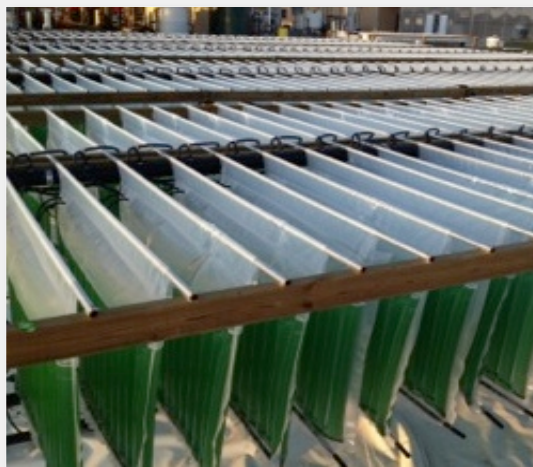
## World's Most Productive Algae Platform



Proprietary enhanced algae make ethanol and biomass directly from CO<sub>2</sub>, water, and sunlight.

- 2012 ethanol peak 9,300 gepay
- 2013 ethanol peak 10,400 gepay
- 2014 target 8,000 annualized
- 85% of the CO<sub>2</sub> is converted into products

## Specialized VIPER™ Photobioreactors



Algae are grown in saltwater contained in proprietary PBRs that are exposed to the sun and are fed CO<sub>2</sub> and nutrients.

- A production cycle runs 4 weeks
- Afterwards, the spent algae are separated from the water-ethanol mixture

## Energy Efficient Downstream Processing

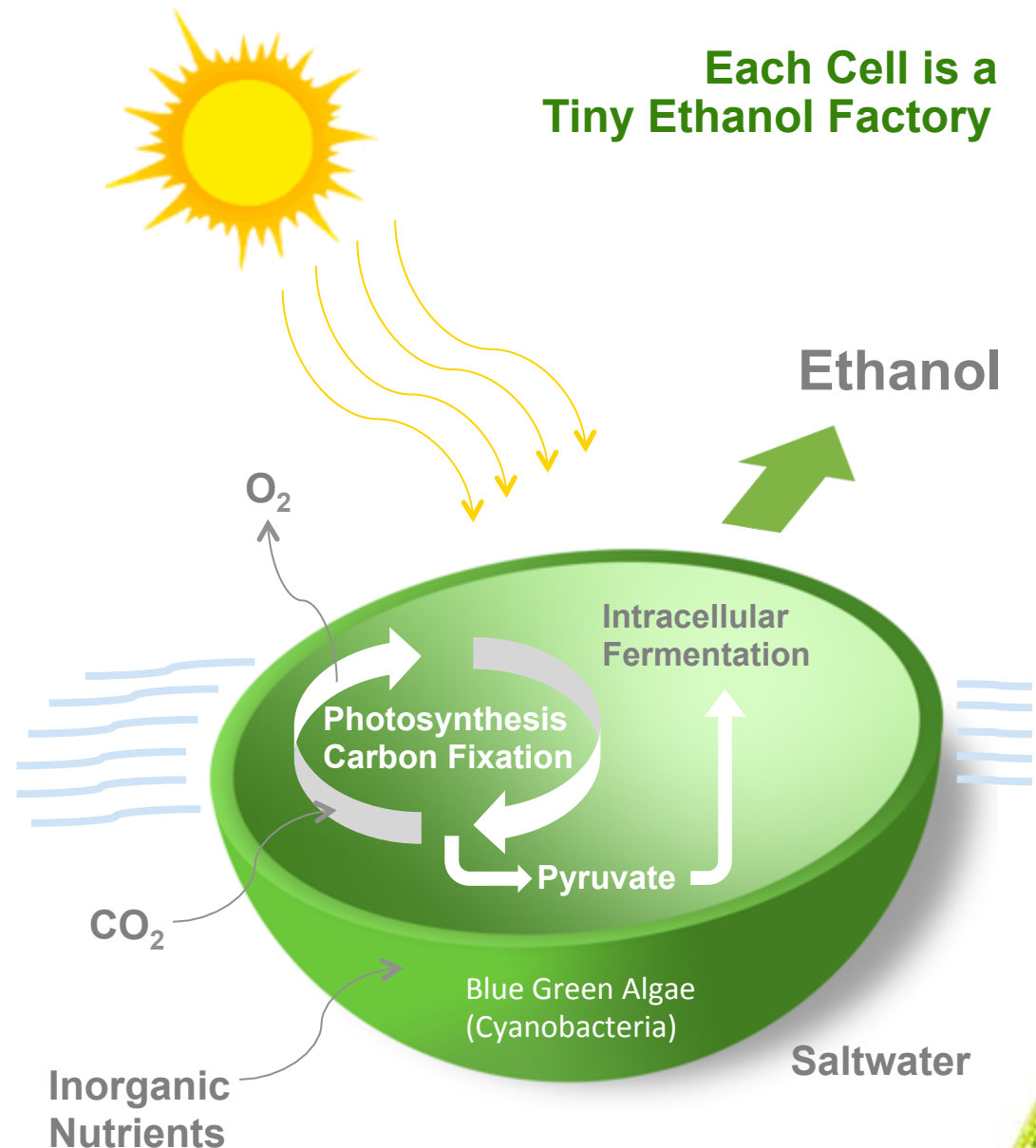


Water-ethanol mixture is sent to proprietary downstream processing equipment separates and concentrates it up to fuel grade ethanol.

- Spent algae are processed into a high grade bio-crude that can be refined into diesel, gasoline, and jet fuel

## Algenol's Direct to Ethanol® process central component is a proprietary, hybrid blue-green algae

- Algenol scientists have enhanced the algae's natural ability to produce ethanol by optimizing the key fermentation pathways
- Ethanol produced by the cell will diffuse out of the cell into the culture medium where it can be collected
- Grows very well at high temperatures and high oxygen levels
- High photosynthetic capacity
- Resists contamination
- Proprietary "molecular toolbox" for further enhancement
- Non-toxic, non-invasive, and not a plant pest



# Specialized VIPER™ Photobioreactors

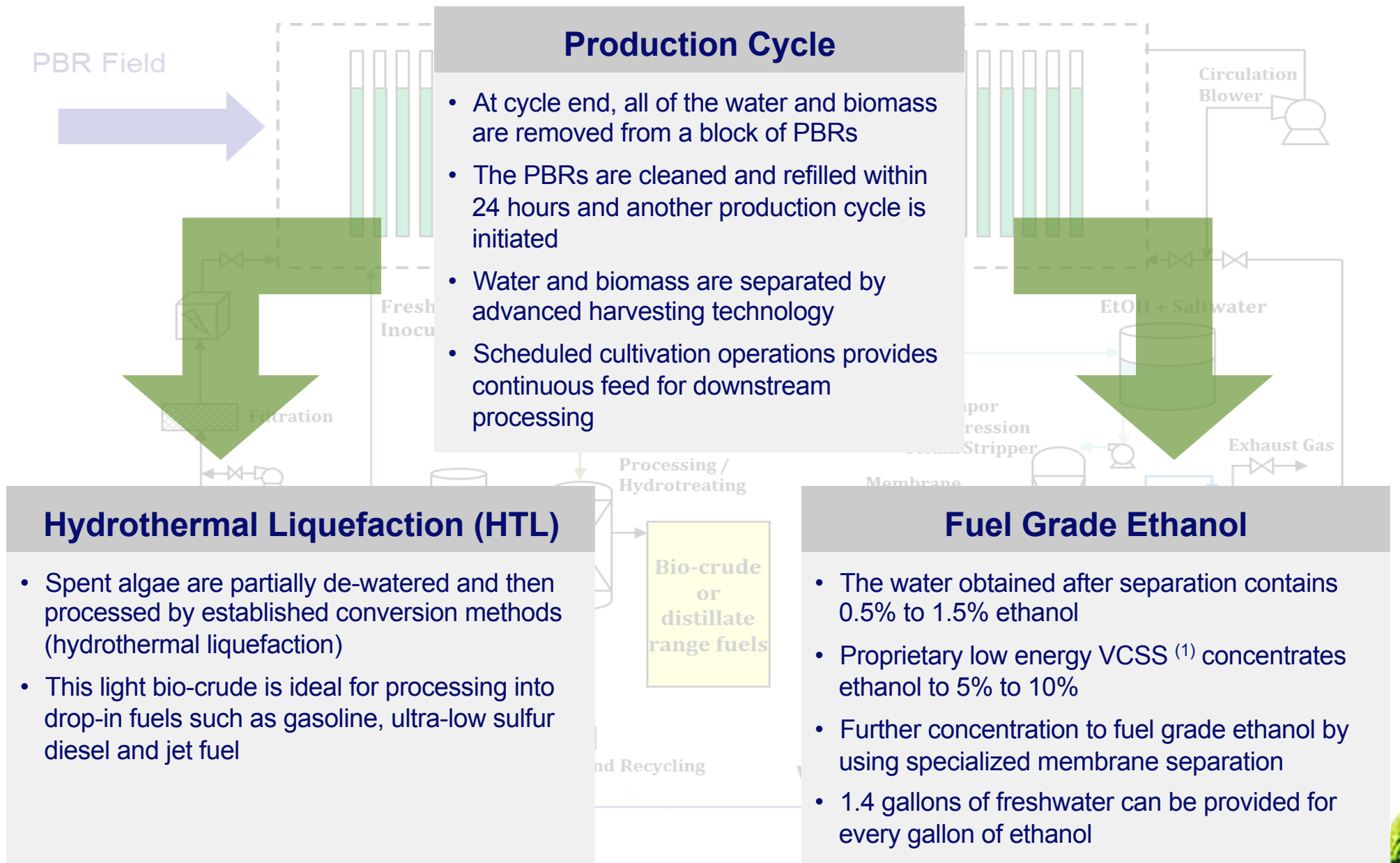
Integrated Biorefinery (IBR) (Fort Myers, Florida)

# Specialized VIPER™ Photobioreactors

ALGENOL  
BIOFUELS

Integrated Biorefinery (IBR) (Fort Myers, Florida)





(1) Vapor Compression Steam Stripper

Algae / Salt Water Separation Unit



Vapor Compression Steam Stripping Unit



Membrane Dehydration Skid



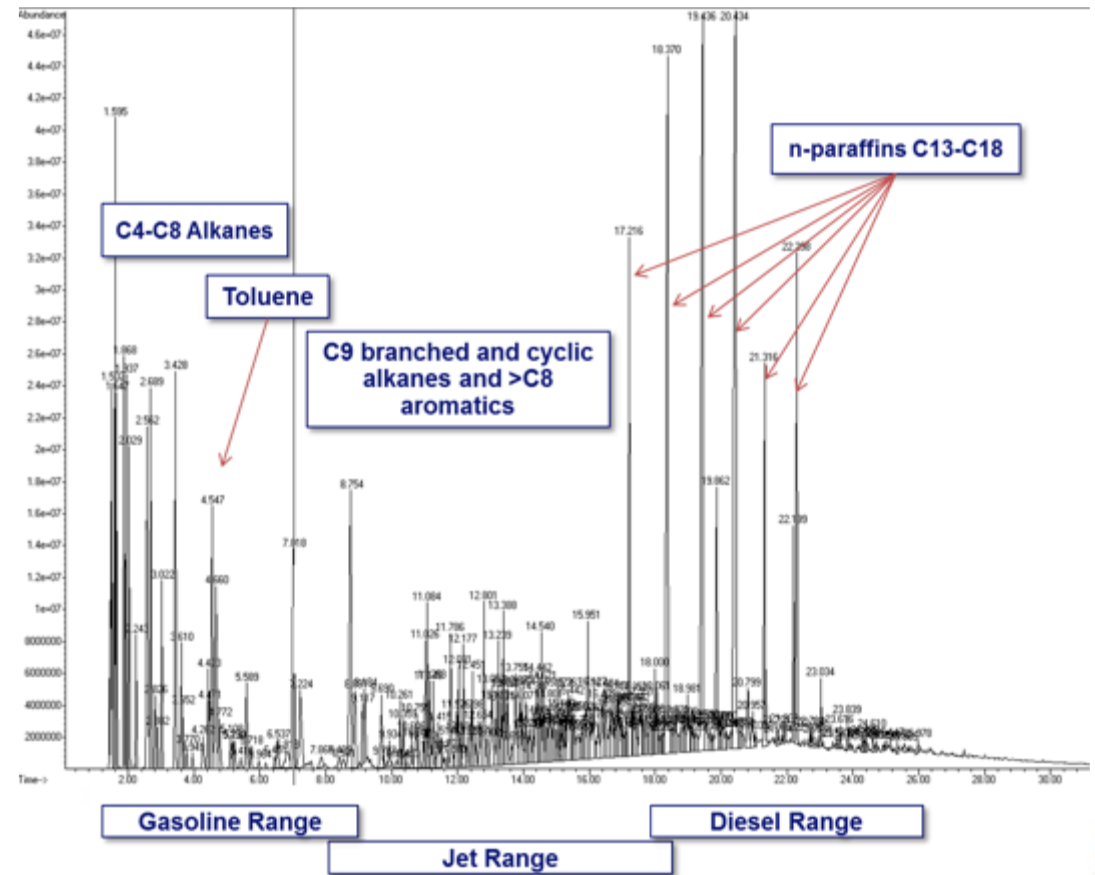
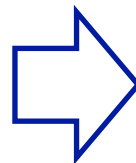
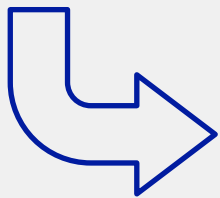
Hydrothermal Liquefaction Unit



- Hydrothermal liquefaction (HTL) converts algal biomass to hydrocarbon oils in the gasoline, jet and diesel range
- Conversion of spent algae to a second renewable fuel stream allows for efficient use of our primary feedstock – CO<sub>2</sub>

## Efficient Conversion

Up to 70% of carbon in biomass can be converted into fuels in the diesel, jet, and gasoline range.

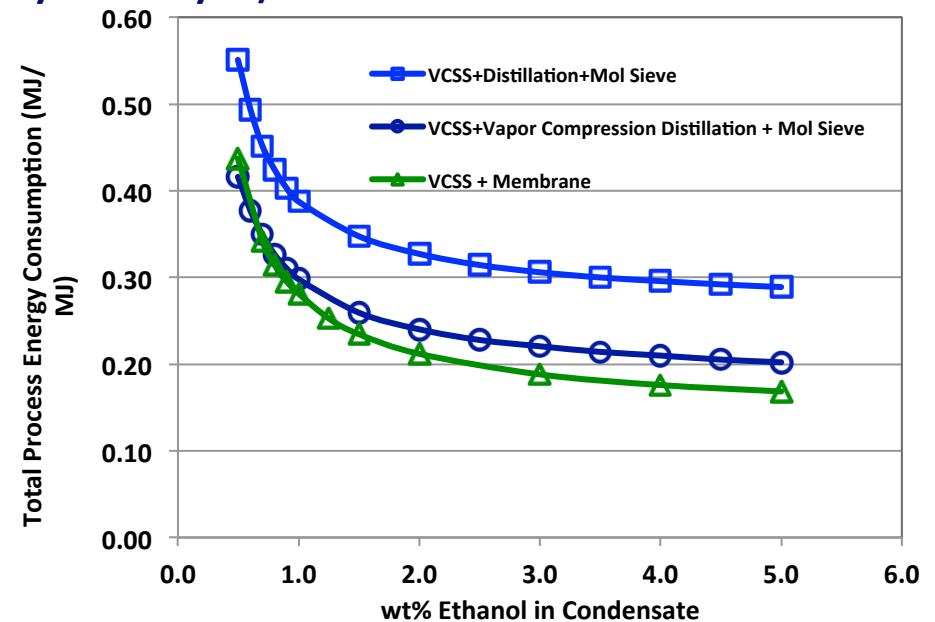
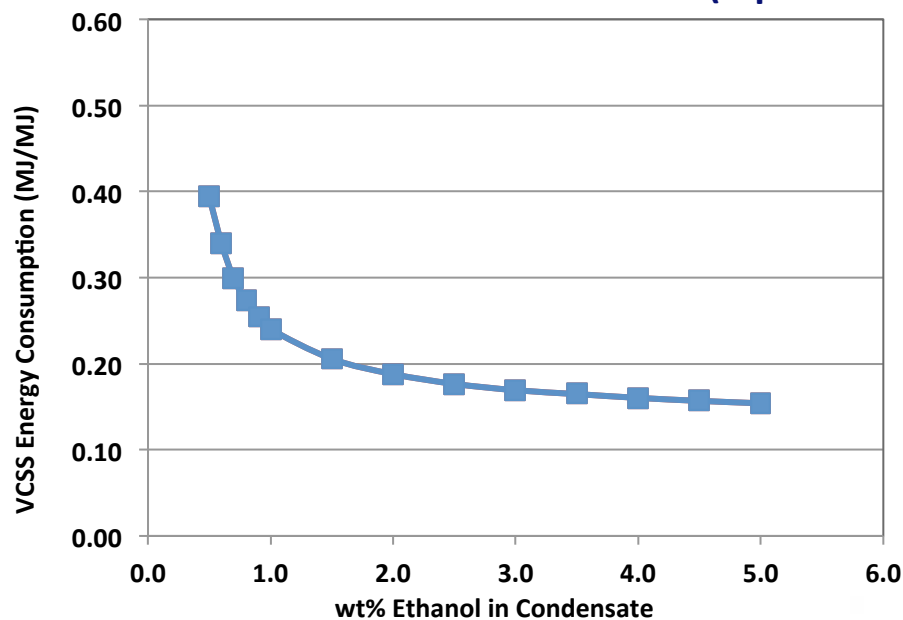


# ENERGY DEMAND AND CARBON FOOTPRINT

- Energy demand for mixing, gas delivery, pumping, etc. added in\*
- Total system energy demand plotted vs. condensate concentration for different dehydration options\*\*

- VCSS is a largest energy consumer
- Energy demand depends strongly on ethanol concentration in condensate\*
- At 1% condensate, VCSS represents about 20% parasitic load

Energy Consumption Determined by Process Simulations (\*, \*\*) (Input to Life Cycle Analysis)



\*D. Luo, Z. Hu, D. Choi, V. Thomas, M. Realff, and R. Chance, *Env. Sci. & Tech.*, 2010, **44** pp 8670–8677

\*\*D. Luo, Z. Hu, D. Choi, V. Thomas, M. Realff, B. McCool and R. Chance, unpublished results

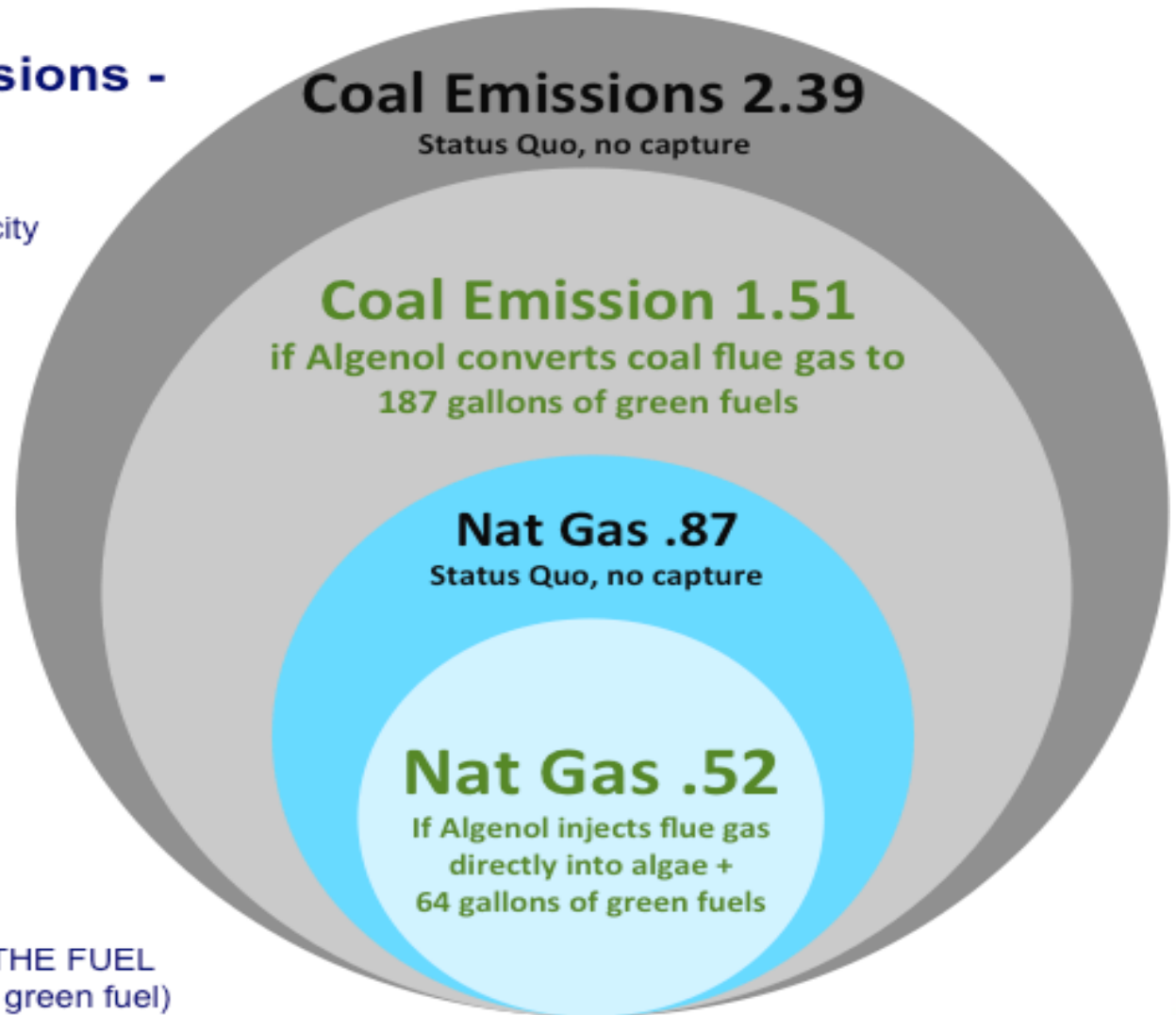
## Combined CO<sub>2</sub> Emissions - Electricity and Fuels

In tonnes of CO<sub>2</sub> per 1MWh electricity + gasoline or green fuel CO<sub>2</sub>

**78%**  
CO<sub>2</sub> Reduction

Coal → NG + Algenol

THIS DOES INCLUDE BURNING THE FUEL IN YOUR CAR (regular gasoline or green fuel)



# CO<sub>2</sub> MONETIZATION THROUGH UTILIZATION

## ALGENOL'S PARADIGM SHIFT

- **CCS means burying and wasting money**
  - Huge costs to both Power Company and Customer
- **CCU means taking CO<sub>2</sub> and making money with it**
  - NO cost to Power Company nor Customer

### Flue gas from NG plant

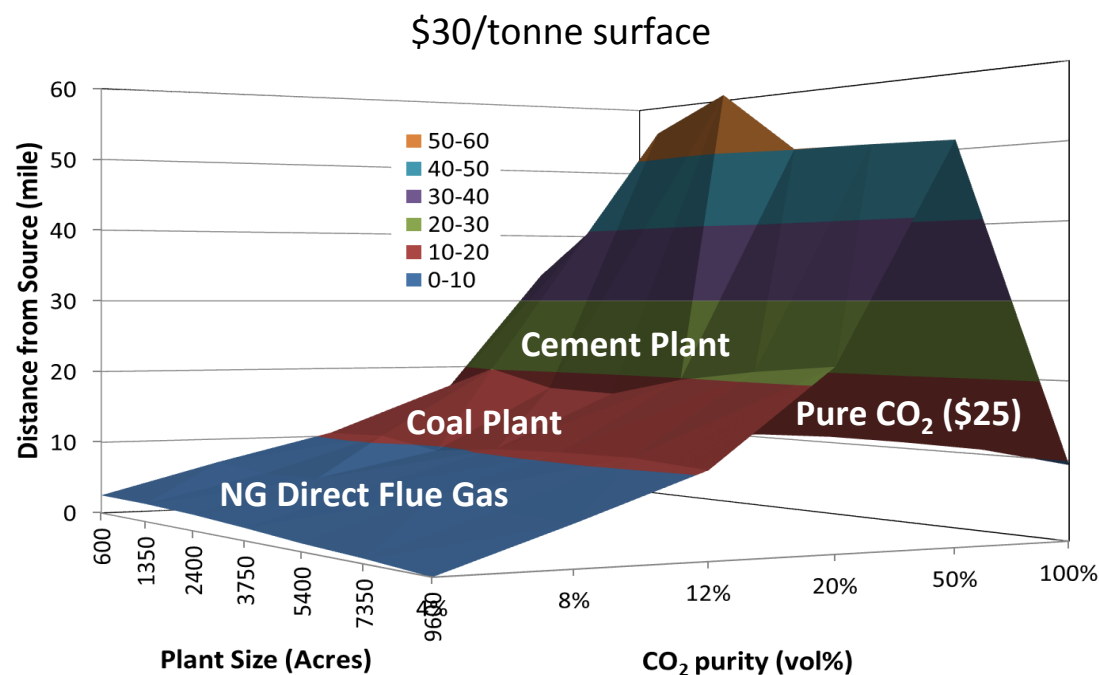
- 4 vol% CO<sub>2</sub>, price paid at source:\$0
- **Must co-locate**
- Cheapest Option
- Does NOT require expensive capture

### Pure CO<sub>2</sub>

- Can transport great distance

### Flue gas from Coal / Cement

- 12-20 vol% CO<sub>2</sub>, price paid at source:\$15-40
- Will require cleanup



# SCALABILITY THROUGH MODULARITY

ALGENOL

- Algenol's modular design greatly simplifies industrial deployment.
- Algenol currently operates an array of 4,000 photobioreactors.
- **REPETITIVE MODULES OF 5 ACRES.**
- The algae container at full scale are only 48L PBRs.
- Each acre contains 3,600 PBRs, Each 5 acre module is 18,000 PBRs. All industrial roll-outs are done in repetitive 5 acre modules.
- **Phase 1** – 100 acres (20 x 5 acre modules) **Phase 2** – 1,200 acre industrial (240 x 5 acre modules) **Phase 3** – expansion to 11,000 acres + 100 million gallons of fuel.

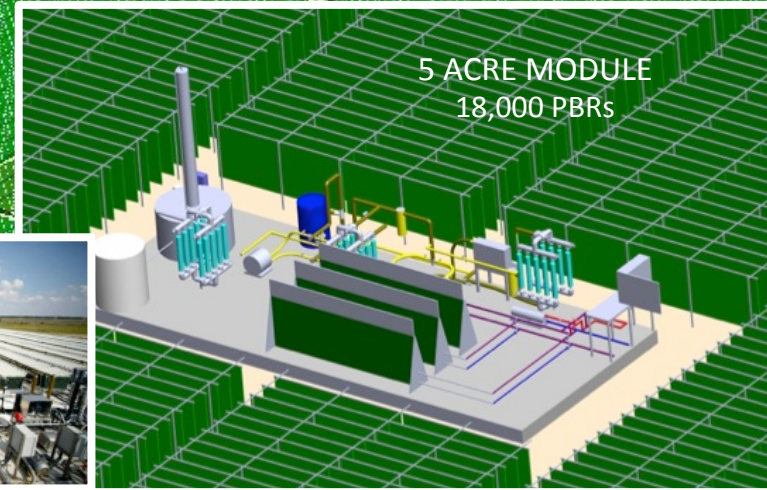
4,000 PBRs MODULE



100 ACRES = 20 x 5 ACRE MODULES



5 ACRE MODULE  
18,000 PBRs



# IBR SCALE-UP IN THE FUTURE

1.8 acres

100 acres

1,300 acres

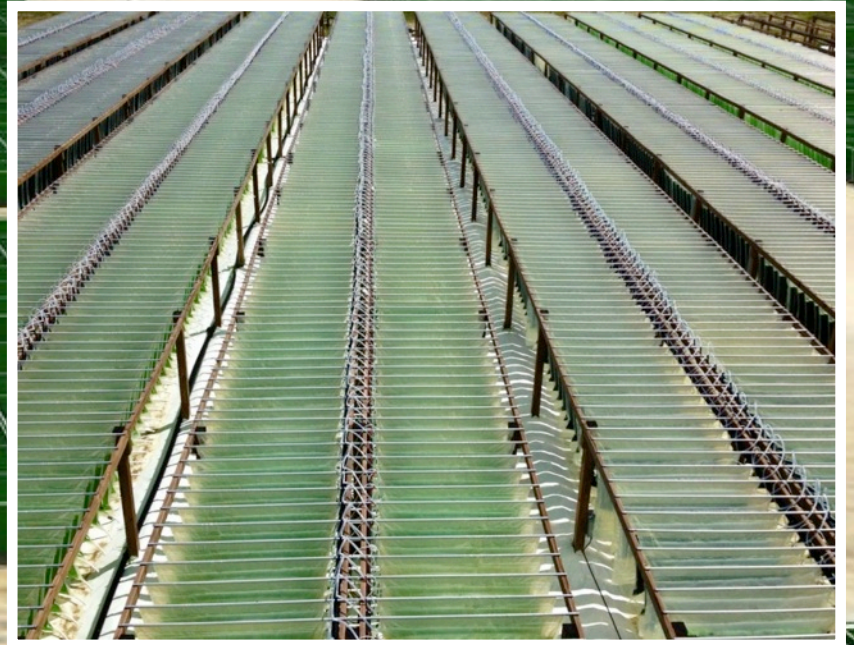
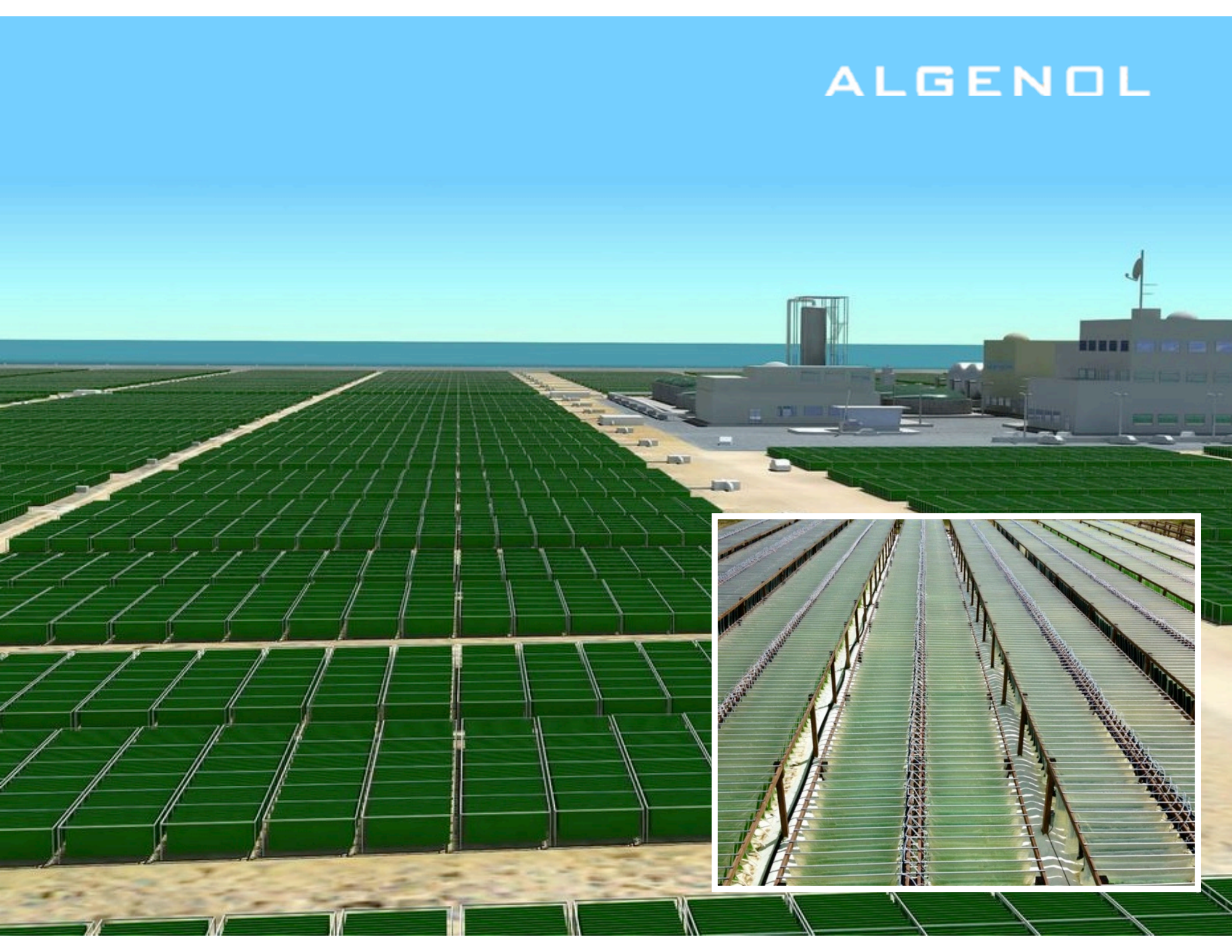
Future Scale Up

2014

2015

2016

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## XX Project 1 in Florida

- Phase 1 - 100 acres
- Phase 2 - 2000 acres
- Phase 3 - 4000 acres
- Phase 4 - 8000 acres      70/15 million gallons

## XX Project 2 in Florida

- Phase 1 - 100 acres
- Phase 2 - 1200 acres
- Phase 3 - 4000 acres      35/7.5 million gallons

# GLOBAL REACH – technology modularity enables rollout in multiple geographies

## Central Florida

Algenol is in advanced discussions with two very large CO2 emitters in Florida to co-locate phase 1 thru 3 commercial facilities in Central Florida.

**Phase 1 thru 3 totals 11,000 acres**  
**Phase 1 - 2015, Phase 2 – 2016, Phase 3 - 2017**  
**100 MILLION GALLONS OF 4 FUELS**

## Lee County, Florida

**Algenol shareholders have invested over \$250 million.**

Plus \$10 million from Lee County, and \$25 million from US Department of Energy to build the IBR.



## BioFields, Mexico

Biofields has obtained rights to approximately 42,000 acres of land adjacent to an electric power plant on the Pacific coast of Mexico (with regulatory clearance and environmental permits to build a biorefinery).

## Brazil

Uni-Systems is developing co-location strategies with existing sugar cane ethanol facilities.

**UNI-SYSTEMS**

## Ideal Growing Conditions

- Grows very well at high temperatures and intense sunlight.
- High salinity tolerance.
- 3–50°C temperature range.
- Marginal lands ideal.
- Vertical VIPER™ PBRs allow deployment on uneven terrain with minimal land movement cost.

## Israel

Our partner is evaluating a site in Israel next to a large power plant.



## Reliance Industries, India

Reliance is building a pilot plant duplicating the Florida IBR modules in India (startup July 2014).

## South Africa

Evaluation of a site in South Africa next to a carbon emitter.

# MASSIVE BUREAUCRACY AT EVERY LEVEL OF GOVERNMENT

Agency	Governing Law	Permit or reg.	Status	Timeline
	National environmental Policy Act (NEPA)	Environmental Assessment (EA) or Environmental Impact Statement (EIS)	Pending Final Loan Guarantee approval	6 months – EA Up to 2 years - EIS
	Farm Bill, Epact 2005	Covenants and set asides for DOE, USDA loan guarantee funds	Pending condition selection for loan negotiations	3 to 6 months negotiations, but may jeopardize Algenol's acceptance of funds
		Alcohol Producer Fuel Permit	Permit in place	< 2 months
	Clean Air Act	Part 79 Fuel registration	Pending application for ethanol	< 3 months, after chemical analysis of final fuel available
		Part 80 RIN generation (RFS)	Determination with EPA on best filing approach	Up to 4 years
		New Source review (NSR) – Air Construction Permits	Pending final construction plans	Months
		NSR Performance standards	Pending final construction plans	Months
		Air operating permits	Can only be filed once construction is completed	Months
	Toxic Substance Control Act (TSCA)	Microbial commercial activity notice (MCAN)	Application filed 3 months ago	Months/uncertain

# MASSIVE BUREAUCRACY AT EVERY LEVEL OF GOVERNMENT

Agency	Governing Law	Permit or reg.	Status	Timeline
EPA 	Clean Water Act	Wastewater discharge permits	Pending final construction plans	Months
		Industrial storm water permits	Pending final construction plans	Months
		Spill prevention. Control and countermeasure	Pending final construction plans	Months
	Safe Drinking Water Act	Water use permit (through state)	Ongoing discussions with Florida DEP	< 3 months, after chemical analysis of final fuel provided
		Water construction permit (through state)	Ongoing discussions with Florida DEP	Months
		Underground injection control (UIC) program (EPA or state)	Ongoing discussions with Florida DEP	Months
US Army Corp. of engineers (Primarily for site construction)	Clean Water Act	Dredge and Fill	Need determination of requirement	Months
		Storm Water construction permits	Pending final construction plans	Months
<b>US Army Corps of Engineers®</b>		Permit for construction of wastewater facility	Pending final design and construction plans	Months/uncertain

HOW DOES ANYONE EXPECT US TO NAVIGATE THIS ????

# MASSIVE BUREAUCRACY AT EVERY LEVEL OF GOVERNMENT

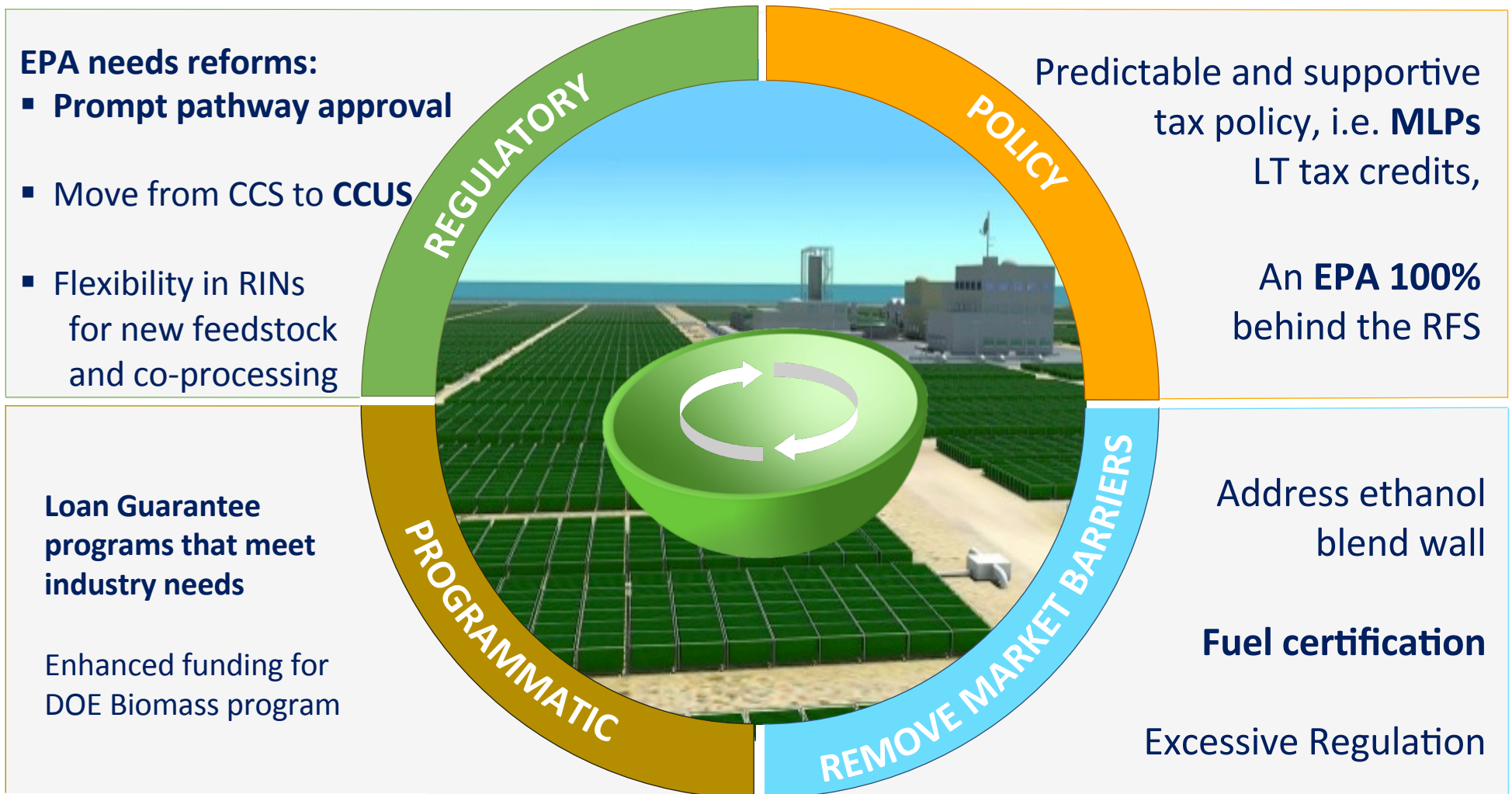


**The EPA is the #1 business risk**

**The EPA is the #1 threat to Algenol**

- fuel pathway certification is not approved for the greenest fuel
  - E85 test procedures fail the test within 30 seconds
- GHG rule excluding CO2 CCU (utilization / beneficial reuse is presently excluded)

# ALGENOL POLICY SUPPORT REQUIREMENTS



The US government can do far more to bring the benefits of our technology to market