# ALGENOL BIOFUELS

*Harnessing the sun to fuel the world* ®

## FESC Stakeholders Meeting
## August 20, 2014


200 dedicated people
100 scientists
9 buildings
8 years

# $250 million invested

## Headquarters and Project Development Campus


# The Four Most Important Fuels

# Algenol Flexible Production Platform

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**Algenol utilizes algae as a biocatalyst to profitably produce multiple green products**

Sunshine $CO_2$ Saltwater

Algae Platform

**Biomass**

Green Crude

Diesel
Jet Fuel
Gasoline

**Ethanol**

Fuel Bioplastic

Fresh Water

**Biochemicals**

Isopropanol
Propanol
Isoprene
1-2 Propanediol
1-3 Propanediol

**Algenol Focus Today**

**Future Opportunities**

# High Yield, Low Cost, Scalable - The Only Biofuel Under Market Price

## 4 most important fuels

OpEx ≤ **$1.30** per gallon each

**Ethanol**
**Gasoline**
**Diesel**
**Jet**

## Productivity

**Unique Platform Strain:**

**> 8,000 TGOLF** (1)

**per acre-year**

### Feedstock Conversion

1 tonne of $CO_2$ becomes 144 gallons of fuel:

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

### Comparison to Biofuels

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

### Necessary Inputs Are Abundant:

- Sunshine
- $CO_2$ from industrial sources
- Saltwater
- Spent algae becomes diesel, jet fuel, and gasoline

### Direct to Ethanol® Does Not Require:

- Farm land
- Food crops
- Fresh water
- Mandates

(1) Total Gallons of Liquid Fuel

# Disruptive Core Technology

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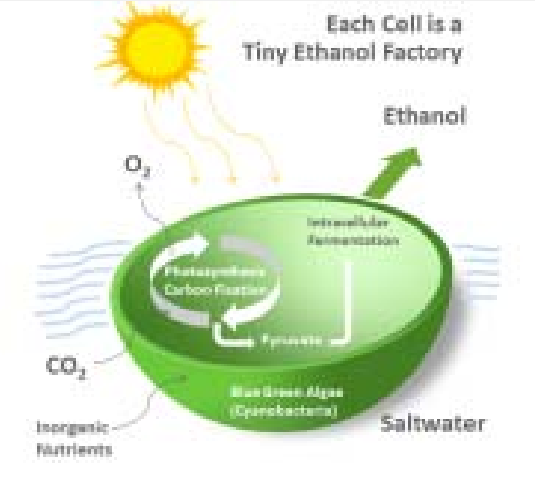
**Algenol's Direct to Ethanol® process has three main components:**

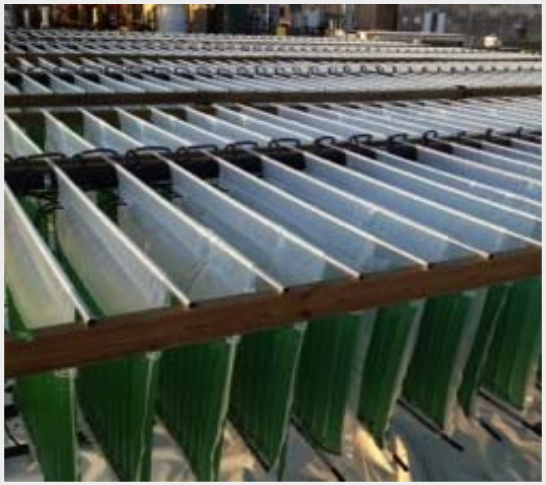
## World's Most Productive Algae Platform




Proprietary enhanced algae make ethanol and biomass **directly** from $CO_2$, water, and sunlight.

- **8,000 gallons per acre per year**
- 85% of the $CO_2$ is converted into products

## Specialized VIPER™ Photobioreactors (PBRs)



Algae are grown in saltwater contained in proprietary PBRs that are exposed to the sun and are fed $CO_2$ 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

# Energy Efficient, Downstream 2-Step Process

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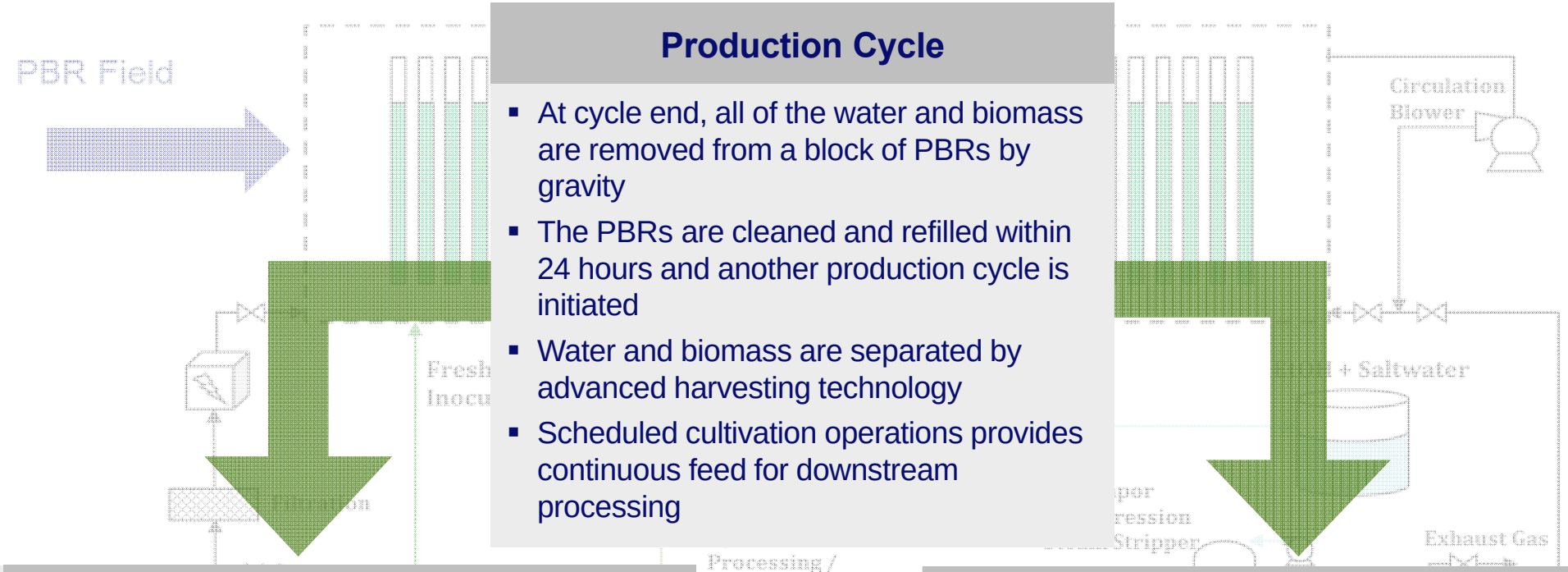



## Production Cycle

- At cycle end, all of the water and biomass are removed from a block of PBRs by gravity
- The PBRs are cleaned and refilled within 24 hours and another production cycle is initiated
- Water and biomass are separated by advanced harvesting technology
- Scheduled cultivation operations provides continuous feed for downstream processing

## Step 1 – Fuel Grade Ethanol

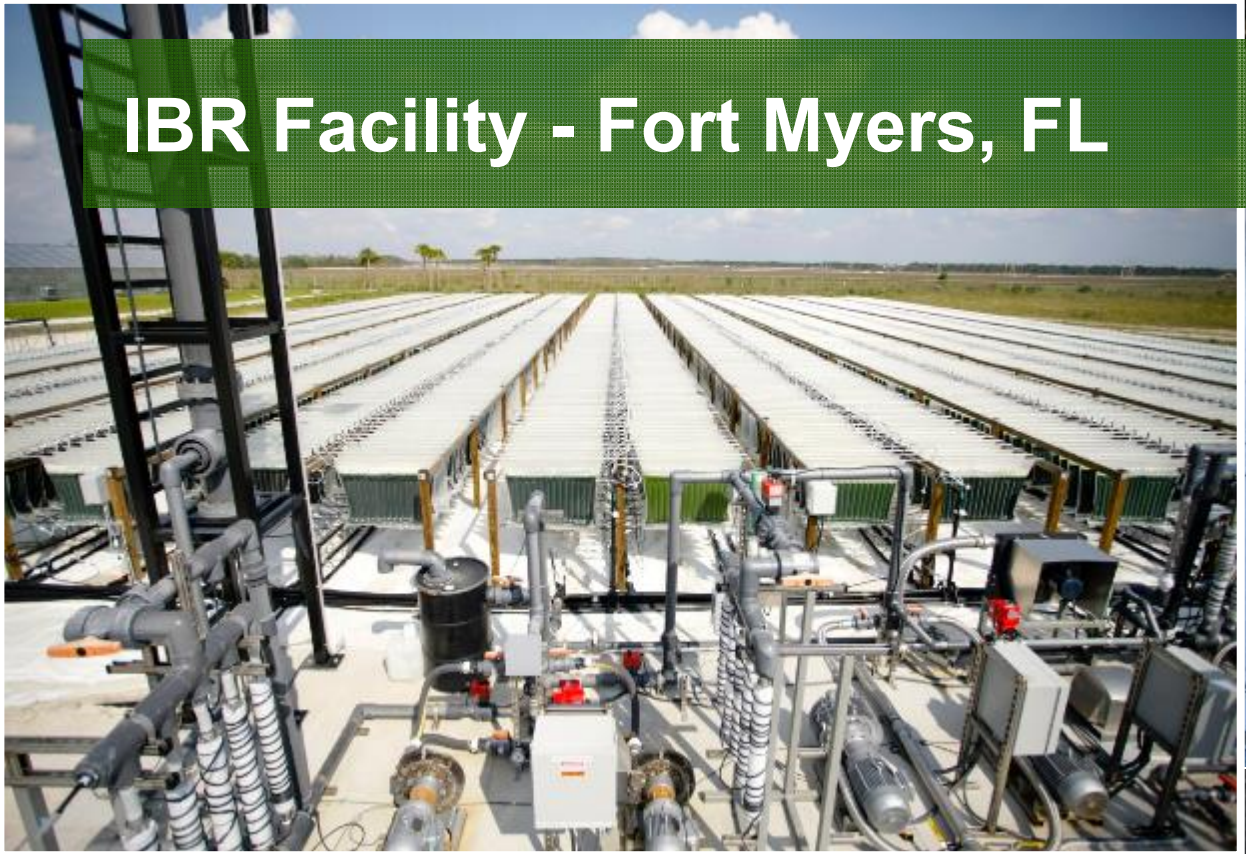
- The water obtained after separation contains .5% to 2% ethanol
- Proprietary low energy VCSS(1) concentrates ethanol 10x
- Further concentration to fuel grade ethanol by using specialized membrane separation

(1) Vapor Compression Steam Stripper

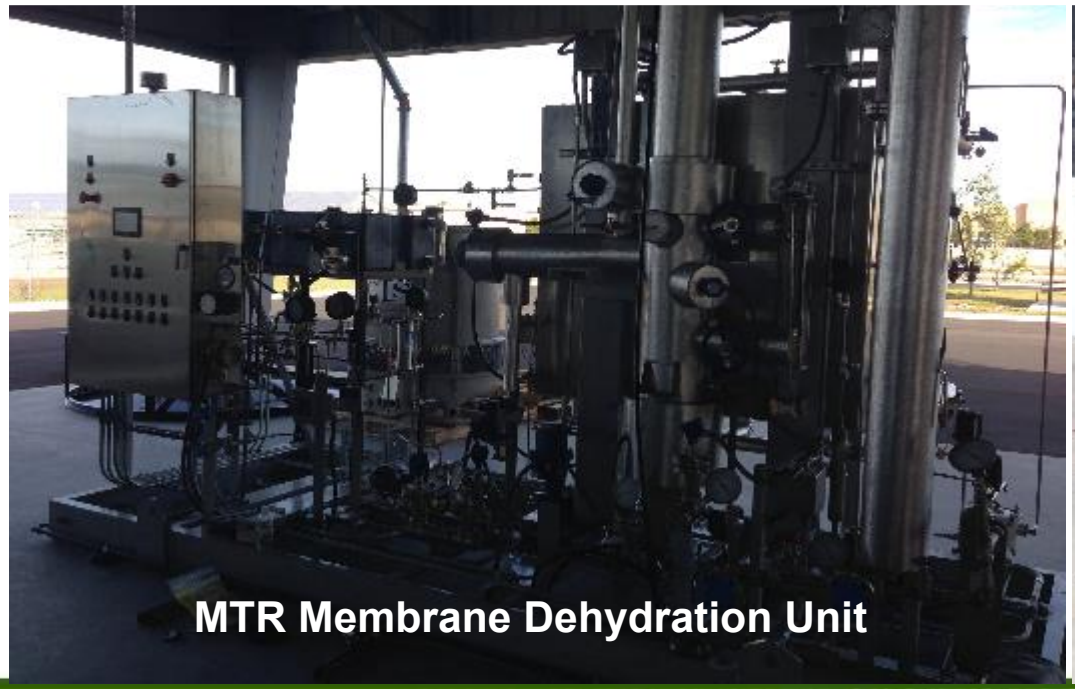
## Step 2 – Gasoline, Diesel and Jet Fuel

- Spent algae are partially de-watered and then processed by established conversion methods (hydrothermal liquefaction)
- This light green crude is ideal for a refining partner processing into drop-in fuels:
  - **Gasoline**
  - **Ultra-low sulfur diesel**
  - **Jet fuel**

# IBR Facility - Fort Myers, FL



Hydrothermal Liquefaction Unit



MTR Membrane Dehydration Unit

Vapor Compression Steam Stripper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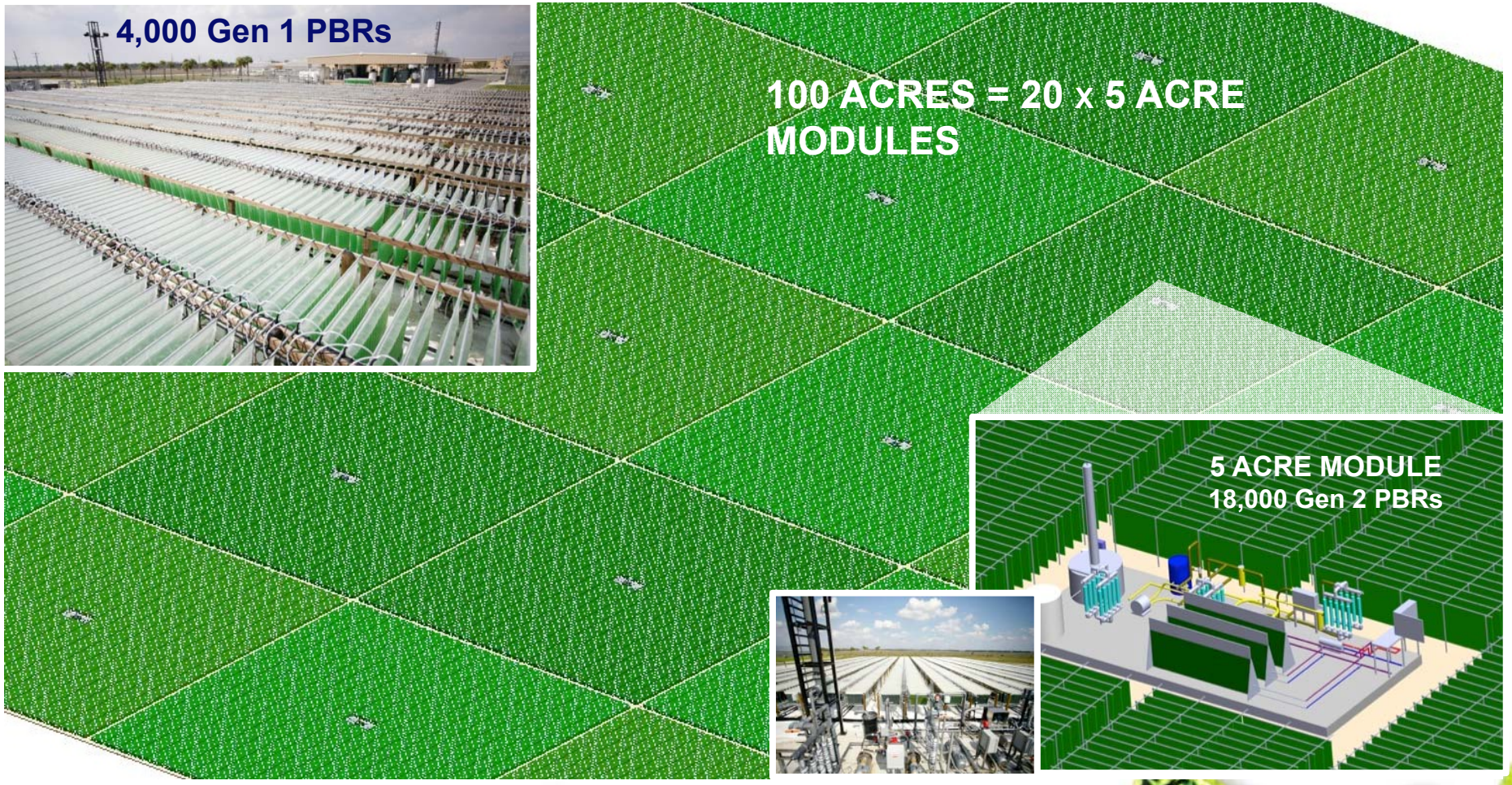
# Scalability Through Modularity

**Algenol's modular design greatly simplifies industrial deployment**

- Algenol will scale up its industrial roll-out by co-locating repetitive modules of 5 acres
- Each acre contains 3,600 Gen 2 PBRs, each 5-acre module has 18,000 Gen 2 PBRs
- The Gen 1 PBRs are 16 liters each, 4,000 are deployed at the Fort Myers IBR
- The Gen 2 PBRs are 48 liters each (full commercial scale) and deployed for over a year



# Algenol's Feedstock Advantage

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## Abundant, Stable, Low-Cost Commercial Feedstocks



- Algenol is the only demonstrated process that monetizes $CO_2$ to produce useful products
- Carbon capture and underground storage is akin to burying money, and may never be accepted practice
- Carbon converted to fuels from flue gas at a profit could become the norm for $CO_2$ emitters
- Saltwater from the ocean, bays or saltwater aquifers does not put pressure on valuable freshwater resources
- Sunshine is abundant across the temperate zones of the globe
- Algenol is not dependent on future carbon capture technology developments or carbon tax mandates

# Carbon Footprint Comparisons

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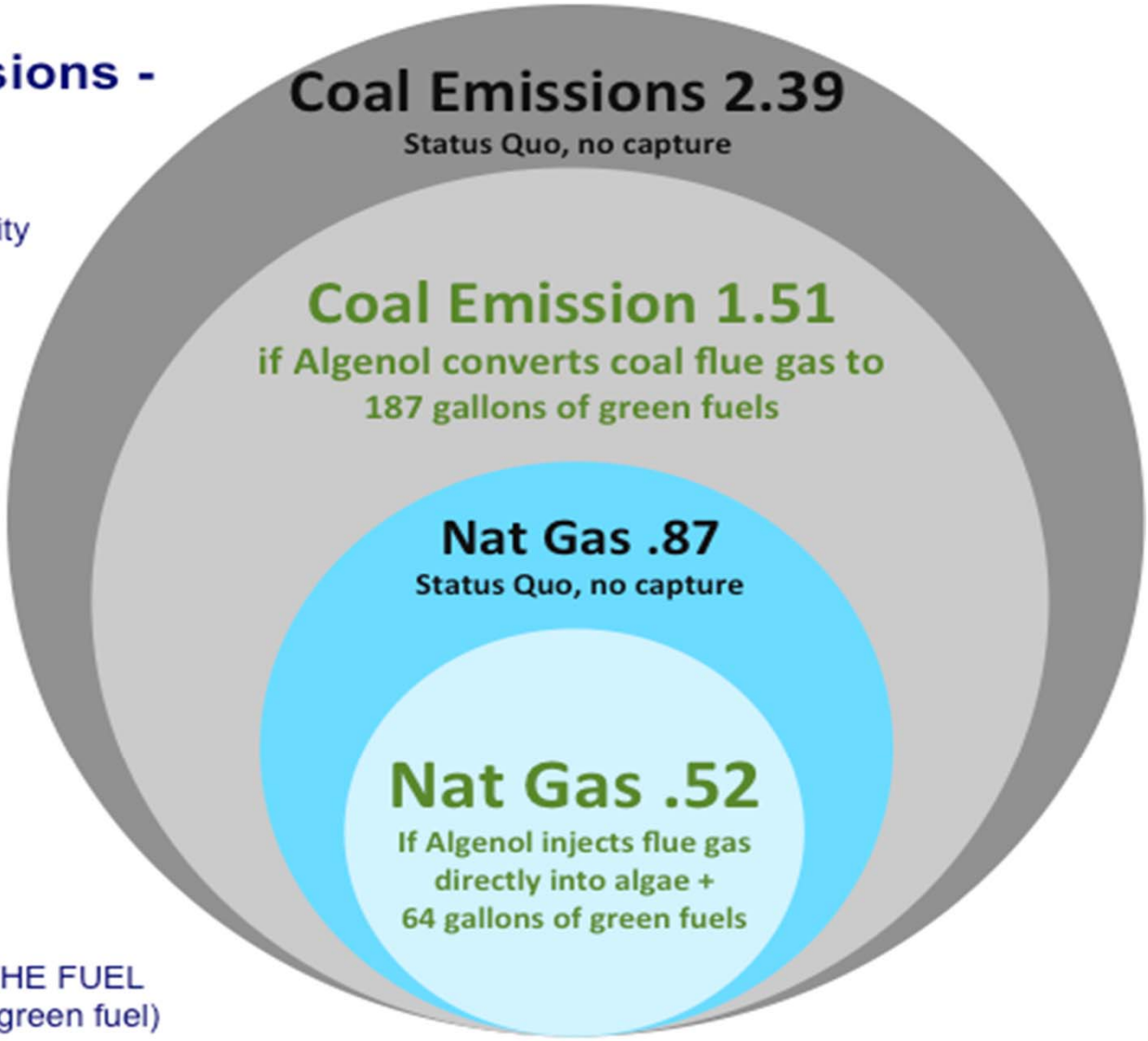
## Combined $CO_2$ Emissions - Electricity and Fuels

In tonnes of $CO_2$ per 1MWh electricity
+ gasoline or green fuel $CO_2$

**78%**

**$CO_2$ Reduction**

Coal ➔NG + Algenol




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

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# $CO_2$ MONETIZATION THROUGH UTILIZATION

**CCS (Underground Sequestration) - burying and wasting money**

- **$50 billion** a year in costs to Americans
- Huge costs to both Power Company and Electric Customers

**CCU (Utilization) means taking $CO_2$ and making money with it**

- Algenol pays Power Company and Ratepayer for the $CO_2$ from natural gas combined cycle flue gas
- Policymakers achieve climate goals
- Displaces fossil fuels, real GHG reduction
- Algenol's process turns a corporate liability into an asset
- $CO_2$ becomes a profitable commodity

# Major Commercial Projects in Evaluation and Planning

## Loan Guarantee Projects

- Planning commenced at multiple Central Florida locations and SW Arizona
- Advanced discussions with large emitters to supply flue gas $CO_2$
- Phase 1 - 100 acres (in 2015)
- Phase 2 - 2,000 acres
- Phase 3 – 10,000 acres
- Total production - 80 million gallons per year
- Total Project cost - $800 million financed through guaranteed loans

# $CO_2$ and Climate Change Mitigation Debate

## Current $CO_2$ Environment

- **$CO_2$ is currently a waste product at best, and likely to become a costly liability**
- Underground storage CCS of $CO_2$ has been mainstream approach, but not a solution
- CCS of $CO_2$ is not legally or technically possible

**$CO_2$ Cleanup Issues**

- **At best, sequestration results in buried money**
- **At worst, technology not viable, scalable, or legal**
- **Americans are rejecting $50 – $60 billion annual cost to US utility customers**
- **No one wants to pay for it…. Everyone has excuses**

# Making Money while Tackling Climate Change

## Algenol's Unique Approach

**Algenol's unique process turns $CO_2$ emissions from a liability into a revenue generating asset**

- Supreme Court ruling allows the EPA to implement a 30% cut to carbon emissions
- Algenol is the only demonstrated process that monetizes $CO_2$ to produce fuels
- Carbon Capture & Utilization (CCU) turns $CO_2$ into a repetitive reusable commodity

**$CO_2$ Utilization Benefits**

- **Algenol pays $1 a tonne for flue gas $CO_2$**
- **Rate paying customer and Utility shareholder split millions of $$$**
- **Real $CO_2$ reduction by displacing fossil fuels**
- **3.6 Billion tonne annual $CO_2$ emissions - brand new commodity market**

# Global Strategic Partnerships

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## Central Florida

Algenol is in advanced discussions with two very large $CO_2$ emitters in Florida to co-locate phases 1 thru 3 of commercial facilities in Central Florida

U.S. DEPARTMENT OF ENERGY

## 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
ENERGÍA RENOVABLE Y SUSTENTABLE

## BioFields, Mexico

Biofields owns 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)

UNI-SYSTEMS

## Brazil

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

## Ideal Growing Conditions in these parts of the world

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

M MIZRAHI DEVELOPMENTS

## Israel

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

Reliance Industries Limited

## Reliance Industries, India

Reliance is building a pilot plant duplicating the Florida IBR modules in India

## South Africa

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


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