

The Future of Transportation Fuels and Improved Ecological Plans Lies in Advanced Biofuels



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About Advanced Biofuels USA

- 501(c)3 nonprofit organization.
- Mission statement:
to promote public understanding, acceptance,
and use of advanced biofuels



Why this practicum site?

- Personal interest
- Future alternative
- Very interesting field to look at



The reasons the world needs Advanced Biofuels

- Energy Security
- Military Strategic Flexibility
- Climate Change Mitigation
- Rural Economic Development



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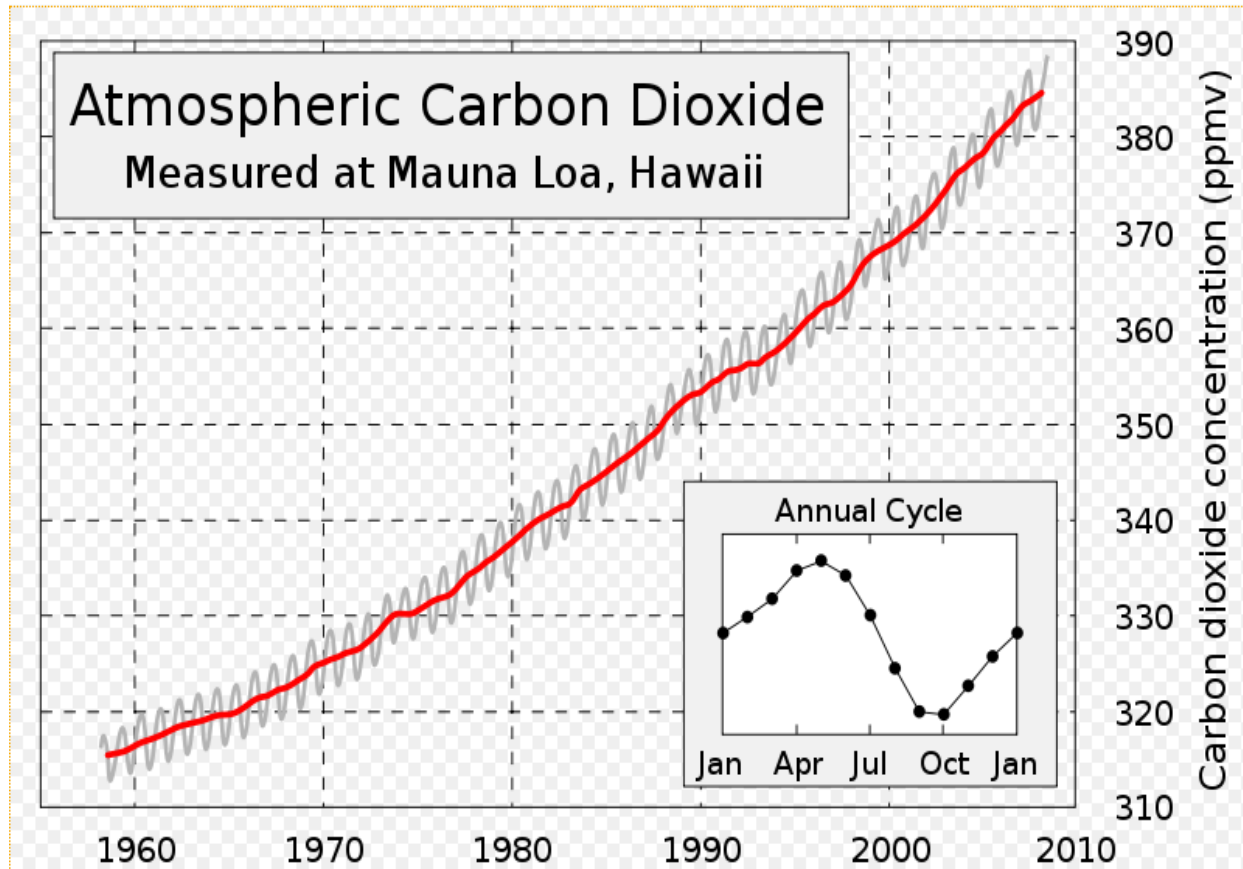
<http://ecology.com/ecology-today/wp-content/uploads/2008/12/biofuels-dtu-danish-center-for-b.jpg>

Terminology

- Advanced Biofuels are high-energy liquid transportation fuels derived from: low nutrient input/high per acre yield crops; agricultural or forestry waste; or other sustainable biomass feedstock.¹
- Sustainability
- Renewable

¹ Ivancic, M. Joanne. Advanced Biofuels USA. Truly Sustainable and Renewable Future. <http://advancedbiofuelsusa.info> (accessed on April 23, 2010).

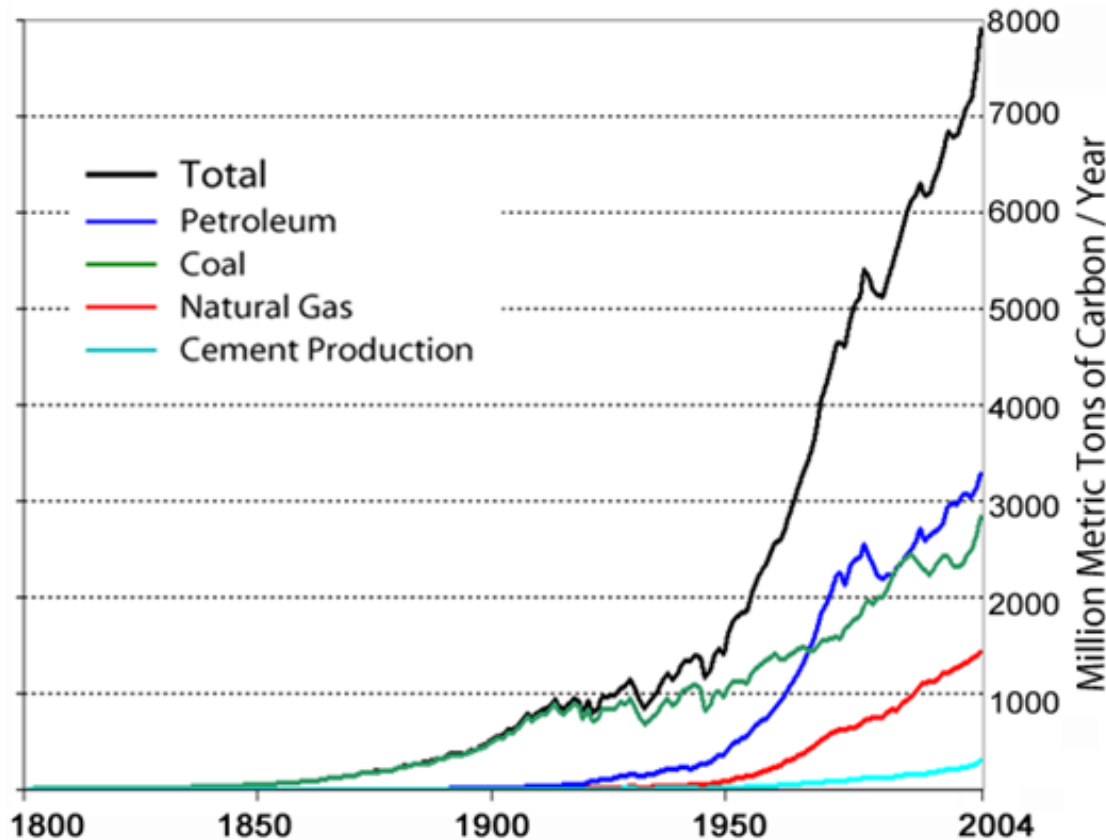
Carbon dioxide concentration measured at Mauna Loa, Hawaii



Al Gore "An Inconvenient Truth"

This figure was created by Robert A. Rohde from published data and is incorporated into the Global Warming Art project.
<http://en.wikipedia.org> (accessed on April 24, 2010).

Global Fossil Carbon Emissions



$> 3 \cdot 10^{12} \text{ kg} \approx 6.6 \cdot 10^{12} \text{ lbs.}$

United States Department of Energy. A Compendium of Data on Global Change. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, Tenn., U.S.A.

Resources of advanced biofuels

- Advanced biofuels can be produced from non-food, non-feed, sustainably grown feedstock and agricultural wastes.
- perennial grasses (switchgrass, miscanthus), jatorpha, camelina, and poplar
- agricultural or food processing waste
- “forest waste”
- new technologies are looking into municipal solid waste



Classification

- First generation biofuels

Advanced Biofuels

- Second generation biofuels
- Third generation biofuels
- Fourth generation biofuels

Goals

The Energy Independence and Security Act of 2007

- Produce 36 billion gallons of renewable fuels by 2022
- 21 billion gallons from advanced biofuels (more than 58%)
- 16 billion gallons from advanced cellulosic biofuel
- 11.1 billion gallons was already produced

The Energy Independence and Security act of 2007. The Effect of Private Wire Laws on Development of Combined Heat and Power Facilities. <http://www.oe.energy.gov> (accessed on April 20, 2010).

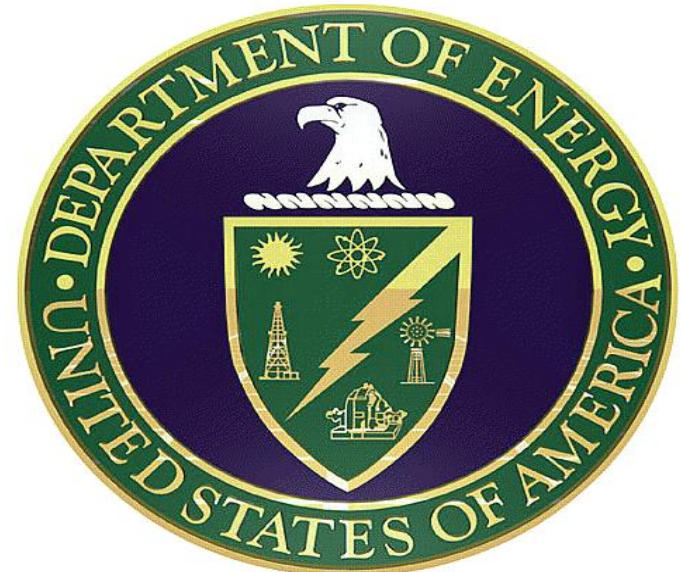
United States Department of Energy. *Office of Science*. Production of Biofuels from Biomass. <http://www.science.energy.gov> (accessed on April 19, 2010).

United States Department of Energy. Obama Announces Steps to Boost Biofuels, Clean Coal, 3 February 2010. <http://www.energy.gov> (accessed on April 19, 2010).



Who is investing

- The U.S. Department of Energy (DOE)
 - \$1 billion for research and development project that will enhance the nation energy supply through increased energy efficiency and clean energy sources
 - \$114 million to build small-scale biorefinery projects in Colorado, Missouri, Oregon, and Wisconsin



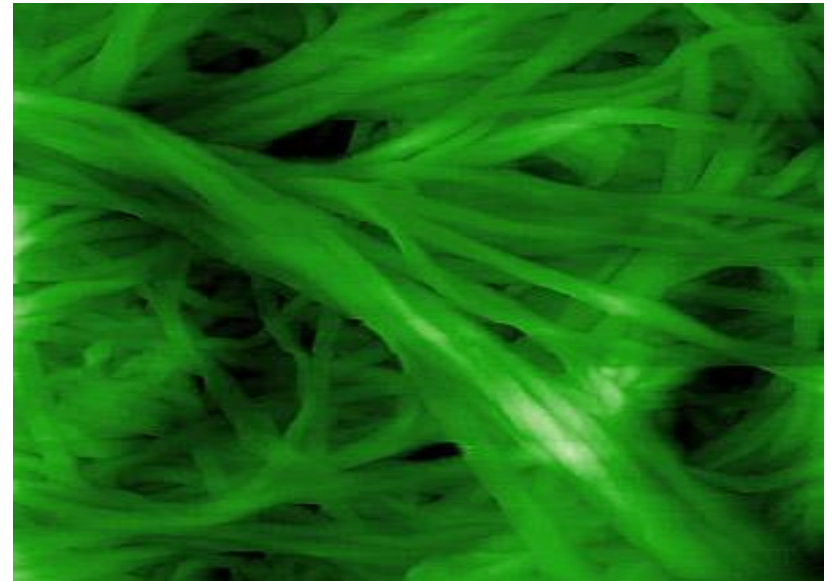
Available technologies

- Fermentation
- Acid hydrolysis
- Enzymatic hydrolysis
- Gasification
- Thermochemical reactions
- Catalysis
- Algae processes



Ethanol From Cellulosic material

- Ethanol derived from cellulose
- Ethanol derived from hemicellulose



Ethanol derived from cellulose



Ethanol derived from hemicellulose

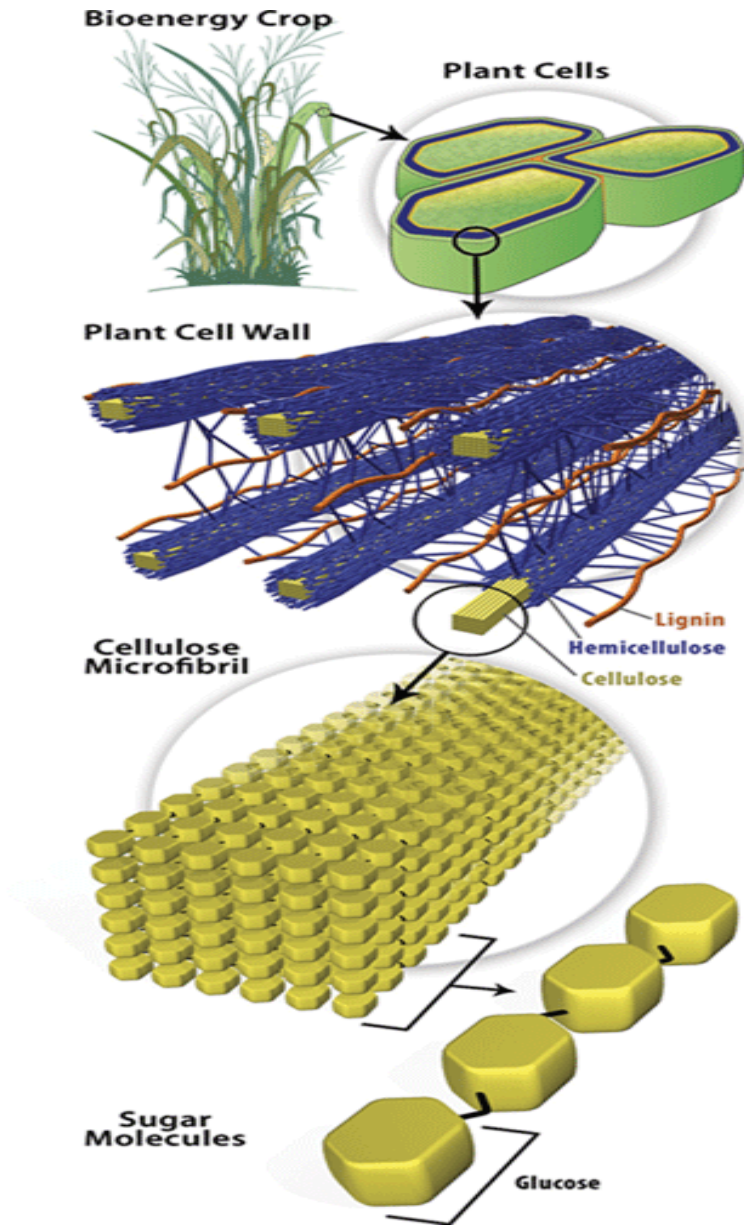
- random, amorphous structure with not so great strength as cellulose
- more accessible to degradative enzymes
- five carbon sugars

Ethanol derived from cellulosic material

Technologies

- acid hydrolysis
- enzymatic hydrolysis
- thermochemical processes

Hidden Treasure in Bioenergy Crops



Advantages of Cellulosic Resources for Ethanol Production

- Abundance and widespread volume (forests hold about 80% of the world's surface biomass)
- Affordable
- Inexpensive feedstock

Disadvantages of Cellulosic Resources

- Pretreatment step: the hemicelluloses break down into five carbon sugars
- Time consuming process
- mix of 5 and 6-carbon sugars formed during the hemicelluloses hydrolysis
- difficulty in “unwrapping” and solubilizing the cellulose and hemicelluloses
- ethanol mixes with water, it might freeze in existing pipeline systems.

Alternative to Ethanol might be Butanol

- Energy density increased, higher energy content
- Less corrosive
- More hydrophobic

Alternative to Ethanol might be Butanol

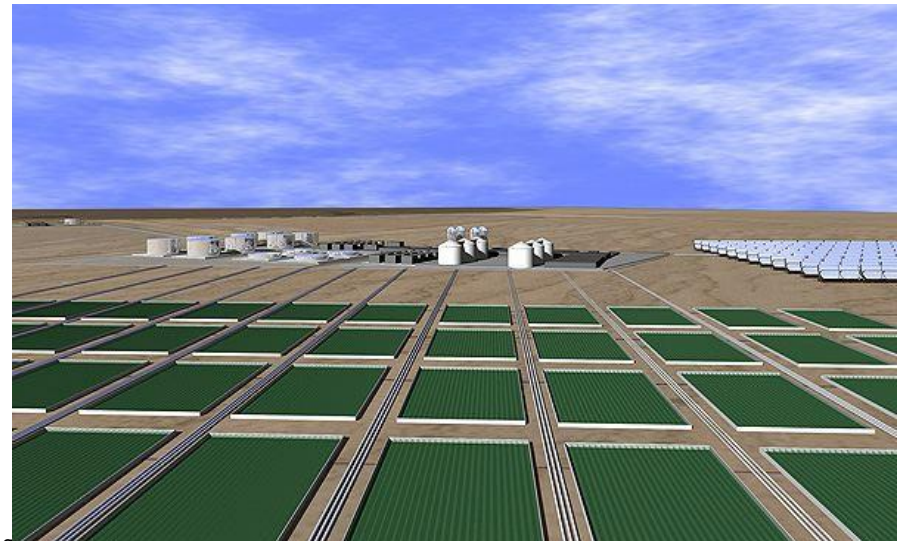
- 90 to 95% of the energy density of gasoline
- Can be used in gasoline engines
- Can be pipelined in existing systems today

Companies that are interested

- British Petroleum and Dupont
- Chevron with Georgia Tech and Weyerhaeuser
-looking into biobutanol from forestry products as feedstock
- Honda and Research Institute of Innovative Technology (RITE)
-butanol using bacteria

Advanced Biofuels from Algae

- High yields of oil
- Don't require arable lands and potable water
- Experimental production has been done in the laboratories



<http://www.matternetwork.com/images/Matter/algae4.jpg>

http://images.businessweek.com/ss/09/04/0416_biofuel/image/017_algenol.jpg

Methods of oil extraction

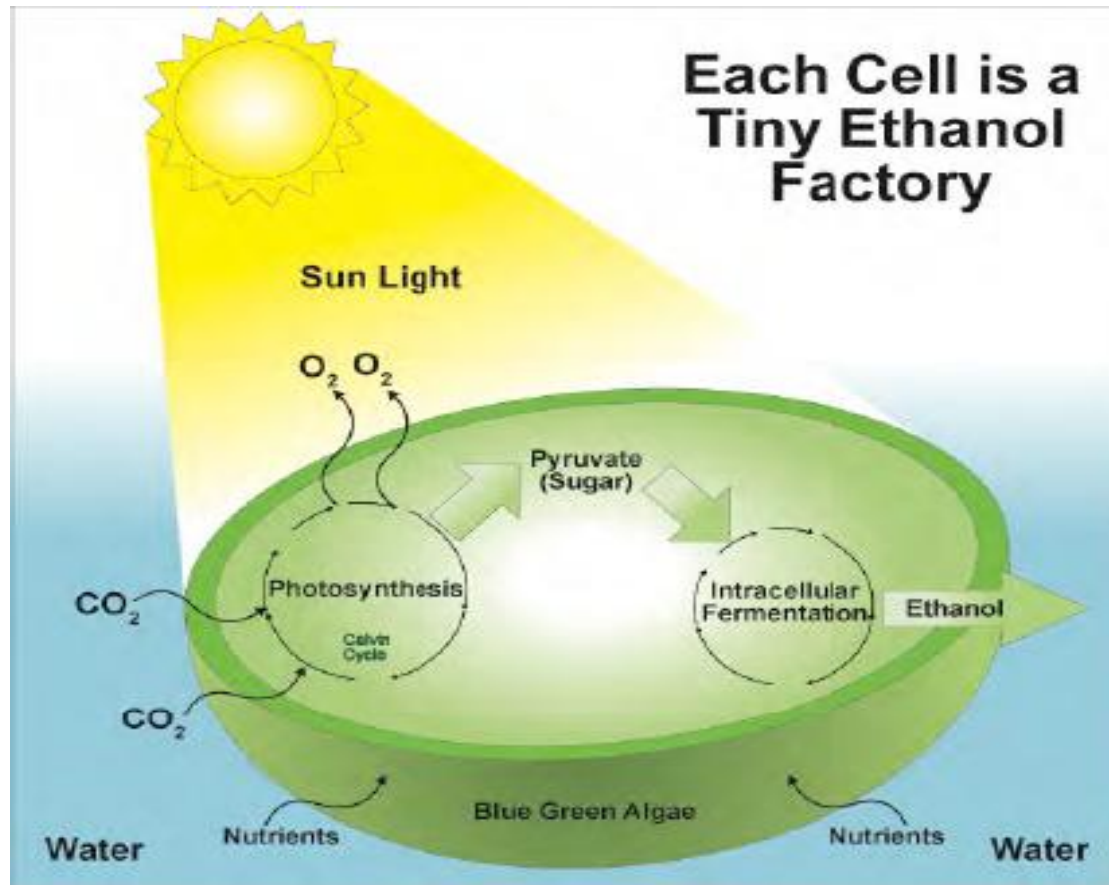
- Expeller/press
- Hexane solvent
- Supercritical fluid extraction
- Drying
- Electro-shock principles

Electro-shock principles

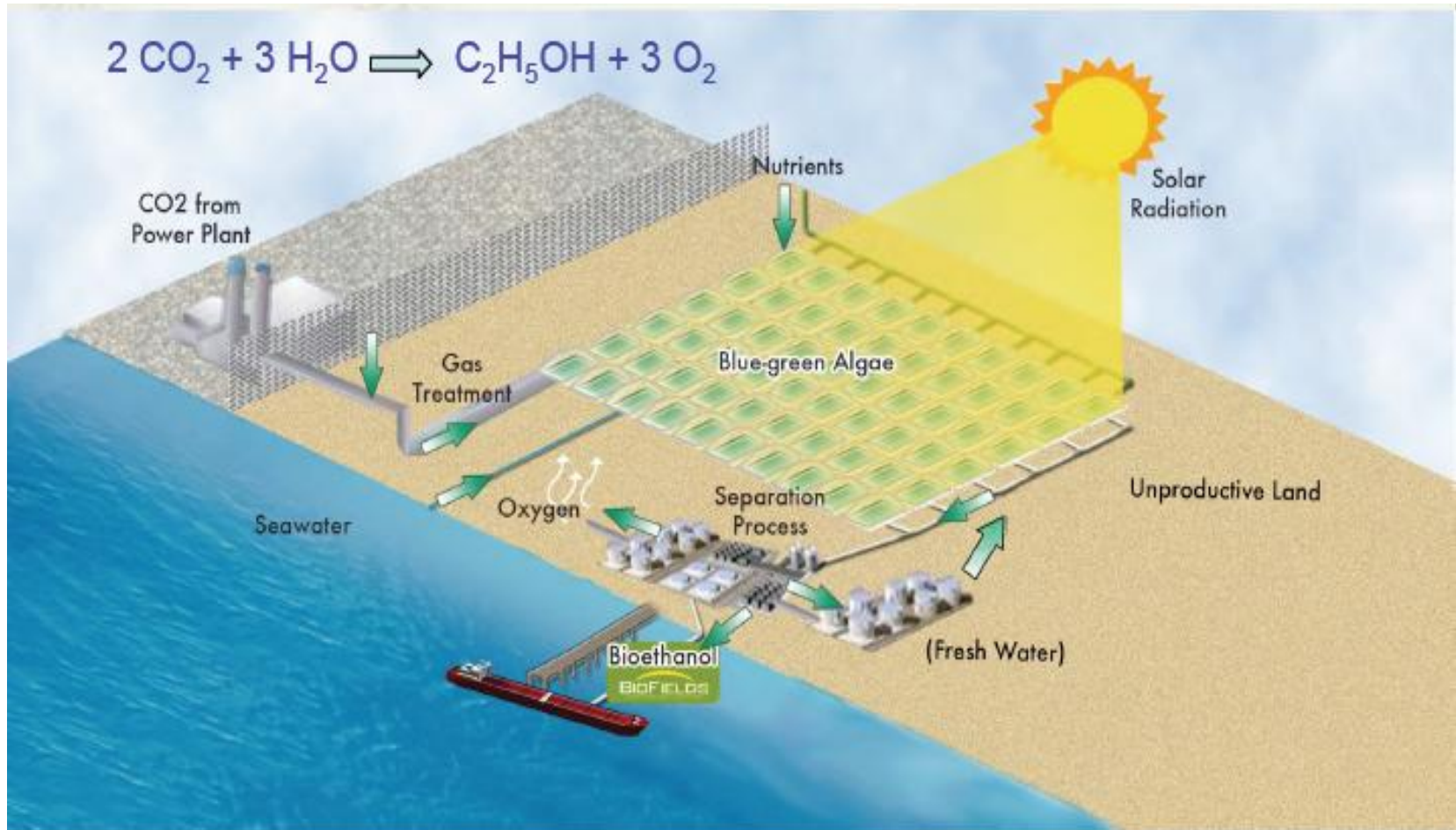
- Phycal company located in Cleveland
- Solix: using the system developed by Los Alamos National Laboratory
- Algenol Biofuels, Bonita Springs in Florida

Algenol Biofuels

- Algenol links photosynthesis with the natural enzymes that convert sugars directly into ethanol.



Biological Capture of Carbon Dioxide



Why Should We Switch to Advanced Biofuels

- Noticable reduce in carbon emissions
more than 138 million metric tons a year in U.S.
- Reduce dependence on foreign oil by more than
328 million barrels a year
- Sustainable and renewable future

Challenges

- Establish appropriate technology for the industrial- scale production
- Establish appropriate infrastructure
- Educate the public
- Convince the government



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