
Biofuels from Algae?
In Virginia?

The "Ideal" Biofuel would:

- ***Produce the most energy on the least land***
- ***Require the least added inputs***
  - ***i.e. energy, water, nutrients, etc.***
- ***Not increase food prices***
- ***Not increase water / air pollution***
- ***Be cost competitive with petro-fuels***

Algae

"Word Association"

- *Green*
- *Slimy*
- *Nuisance*
- ***Resource?***

Algae
"A New Perspective"

- ***Excellent Biofuel***
  - *Fastest growing biomass*
  - *Less land required*
  - *Several biofuel options*
    - *Biodiesel (high oil content)*
    - *Butanol (direct gasoline replacement)*
    - *Hydrogen*
    - *Ethanol*
    - *Bio-gas*

- ***Significant Environmental Benefits***
  - *Actually cleans the water it uses*
    - *Removes nutrients & other pollutants*
    - *Adds oxygen*
  - *Consumes CO2*

Energy Output Potential

Corn Ethanol

- *200 – 400 gal./ac./yr.*
- *84,000 BTU/gal.*
- *17M – 34M BTU/ac./yr.*

Algae Biodiesel

- *2,000 – 5,000 gal/ac./yr.*
- *119,000 BTU / gal.*
- *200M – 600M BTU/ac./yr.*

Gallons of Oil per acre

Soybeans	*48*
Safflower	*83*
Sunflower	*102*
Jatropha	*175*
Rapeseed	*127*
Oil Palm	*635*
*Microalgae**	*1,850*
*Microalgae***	*5,000 – 15,000*

*Microalgae with lower oil content
**Microalgae with higher oil content
Source: Biodiesel From Microalgae - Yusuf Chisti (2007)

% of agricultural land required to fuel U.S. transportation

Soybeans	650%
Canola	240%
Jatropha	154%
Coconut	108%
Oil Palm	50%
Microalgae	2-5%

Source: *Biodiesel From Microalgae - Yusuf Chisti* (2007)

Other "Algae" Advantages

- ***Can be grown on non-agricultural land***
- ***Uses less water than conventional crops***
- ***Can use brine or sea water***
- ***Produces other useful by-products***
  - *Fertilizer*
  - *Animal feed*

Can "couple" with other Enterprises

- ***Industrial & Municipal Wastewater***
  - *Alternative treatment processes*
  - *Nutrient assimilation*
- ***Power Plants***
  - *CO2 source (carbon credits)*
- ***Agriculture***
  - *Recycle wastewater and nutrients*
  - *Algae Farming?*

Algae Bio-diesel Cost Estimates

- ***$1.40 - $4.40 / gallon***
- ***$60 - $120 / gallon per barrel of oil (Equivalent)***

Virginia "Algae Attributes"

- ***Good climate***
  - *Sunshine & moderate temps*
- ***Lots of nutrient enriched water***
  - *WWTP's*
  - *Tidal Rivers & Chesapeake Bay*
- ***Lots of power plants*** *(CO_2 sources)*
- ***Lots of potential biodiesel customers***
  - *Military, truckers, airlines, home heating*

So What's Happening?

ODU Algae Bio-diesel Research
(HRSD - Virginia Initiative Plant)

- *Identify “oil rich” native algal species*
- *Optimize algae production using wastewater*
- *Convert algae to bio-diesel economically*

Hopewell Regional WWTP
(Pilot Project)

- ***Scale up ODU algae research***
- ***Nutrient Removal Savings***
- ***Partnering with an "Algae Farmer"***

Virginia's 1st Algae Farmer
(Jes Sprouse)

Prince George County, Virginia

Algal Turf Scrubbers
(Dr. Walter Adey – Smithsonian)

Susquehanna River Proposal
(3,000 acres of Algal Turf Scrubbers)

Restore Upper Chesapeake Bay???

- ***Remove 7.5 million lbs. N / yr.***
- ***Remove 3 million lbs. P / yr.***
- ***Add 300 million lbs. of O_2 / yr.***
- ***Produce 10 million gal. of biofuel***
- ***Produce 2.3 million lbs. of hydrogen***
- ***Cost about $120 million / yr.***

DEQ
Algae Development Strategies

- ***Allocate some WQIF money***
  - *Innovative Treatment Technology*
  - *Hopewell WWTF Project*
- ***Evaluate "Nutrient Assimilation Credits"***
  - *Ches. Bay Nutrient Trading Program*

Questions?