Advanced Biofuels
A Truly Sustainable Renewable Future

Advanced Biofuels USA
www.AdvancedBiofuelsUSA.org
301-644-1395

Advocates for the adoption of advanced biofuels as an

- energy security,
- military flexibility,
- economic development
- climate change mitigation
- pollution control

solution.

Advanced Biofuels USA

501(c)3 Nonprofit
Educational Organization

Founded April 2008

Website:
www.AdvancedBiofuelsUSA.org

Frederick, MD

What Are Advanced Biofuels?

Ethanol is a biofuel, not the only biofuel.

Biodiesel
Renewable Diesel
Biojet
Biobutanol
Drop-in Hydrocarbons
Rocket Fuel
BioHeat ®
Cooking Fuel

Energy Beet Project in Delmarva/ Eastern Shore Maryland

Energy Beet Project in Delmarva

Initial goals of the project:

- Use a high yield (over twice yield of biofuel per acre of corn), low nutrient input crop that will reduce agricultural runoff into the Chesapeake Bay.
- Provide new opportunities for minority growers and entrepreneurs.
- Implement a decentralized processing system that will create good paying jobs in Delmarva.
- Address regional jetfuel markets not currently served by current biofuel production centers.
- Utilize Maryland developed crops, processing technology, and university agricultural expertise.

Energy Beet Project in Delmarva

Goals Identified during Project Development

- **Importance of Remediation Potential**
  - Reducing Chesapeake and Delaware Bay nutrient runoff
  - UMES Expertise in Nutrient Management, long term studies of legacy phosphate from years of use of poultry manure for fertilizer in the area
  - UMES Expertise in Plant and Soil Science Research

- **Focus on Animal Feed Applications**
  - UMES Expertise in poultry nutrition and physiology

Current US Sugar Beet Farming

Sugar Beet

Grows in cold, dry climates.

Requires extensive storage facilities. Traditionally uses sucrose for table sugar or for ethanol production .

Sugar Beet pulp

Animal feed or landfill

ADVANCED BIOFUELS USA

Energy Beet

Energy Beets
Derived from Sugar Beets to use less nutrients and grow in warm, moist climates.

Per acre, 2 ½ times as much biofuel as corn starch

ADVANCED BIOFUELS USA

Energy Beet Project in Delmarva/ Eastern Shore Maryland -- UMES 2016

First Ever Energy Beets Planting, Growing

Energy Beet Project in Delmarva/ Eastern Shore Maryland- 2016

First Ever Energy Beets Planting, Growing

Energy Beet Project in Delmarva/ Eastern Shore Maryland

First Harvest

Energy Beet Project in Delmarva/ Eastern Shore Maryland

First Harvest

1 Advanced Biofuel Problem
High Lignin = Biomass Recalcitrance

HIGH Lignin Feedstocks:

Grasses

- Switchgrass
- Miscanthus

Trees and Forest Waste

Agricultural Residues

- Corn Stover
- Rice Straw/Hulls
- Wheat Straw
- Sugar Cane Bagasse

LOW Lignin Feedstocks:

Energy Beets/Sugar Beets

Industrial Sweet Potatoes

Food Processing Waste/Residue

- Cassava
- Potatoes

Energy Beet Project in Delmarva

Key Partners

Atlantic Biomass, LLC

Plant Sensory Systems

UNIVERSITY of MARYLAND EASTERN SHORE

USDA

USDA Agricultural Research Service National Center for Agricultural Utilization Research in Peoria, Illinois

PURDUE UNIVERSITY

Vertimass

Transformative fungible biofuels.

What Will Advanced Biofuels Be Used For Tomorrow?

- Military Aviation Fuels

- Military Marine Fuels

ADVANCED BIOFUELS USA

Progress on Military Advanced Biofuels Use

The Great Green Fleet

US Navy: 50% Use Goal

Aviation and Maritime Fuel Purchases Began in 2015

ADVANCED BIOFUELS USA

Aviation Fuel Processes

- Alcohol to Jet (ATJ)
- Catalytic Conversion of Oil to Jet (CCOTJ)
- Catalytic Conversion of Sugar to Jet (CCSTJ)
- Catalytic Hydrothermolysis, Hydroprocessing to Jet (CH-HRJ)
- Direct Fermentation of Sugar to Jet (DFSTJ)
- Fischer-Tropsch Synthesized Paraffinic Kerosene (FT-SPK)
- Hydrotreated Depolymerized Cellulosic Jet (HDCJ)
- Hydroprocessed Esters & Fatty Acids (HEFA)
- Synthesized Iso-Paraffinic Fuel (SIP)

Certification: Continuing Our Progress

SIP
June 1, 2014

Sugar

Also Called DSHC

2015
2014
2013
2012
2011
2010
2009

Also Called HRJ or Bio-SPK

HEFA
July 1, 2011


Plant/Animal Oils

Drop-In Fuel Spec

ASTM D7566
Sept 1, 2009

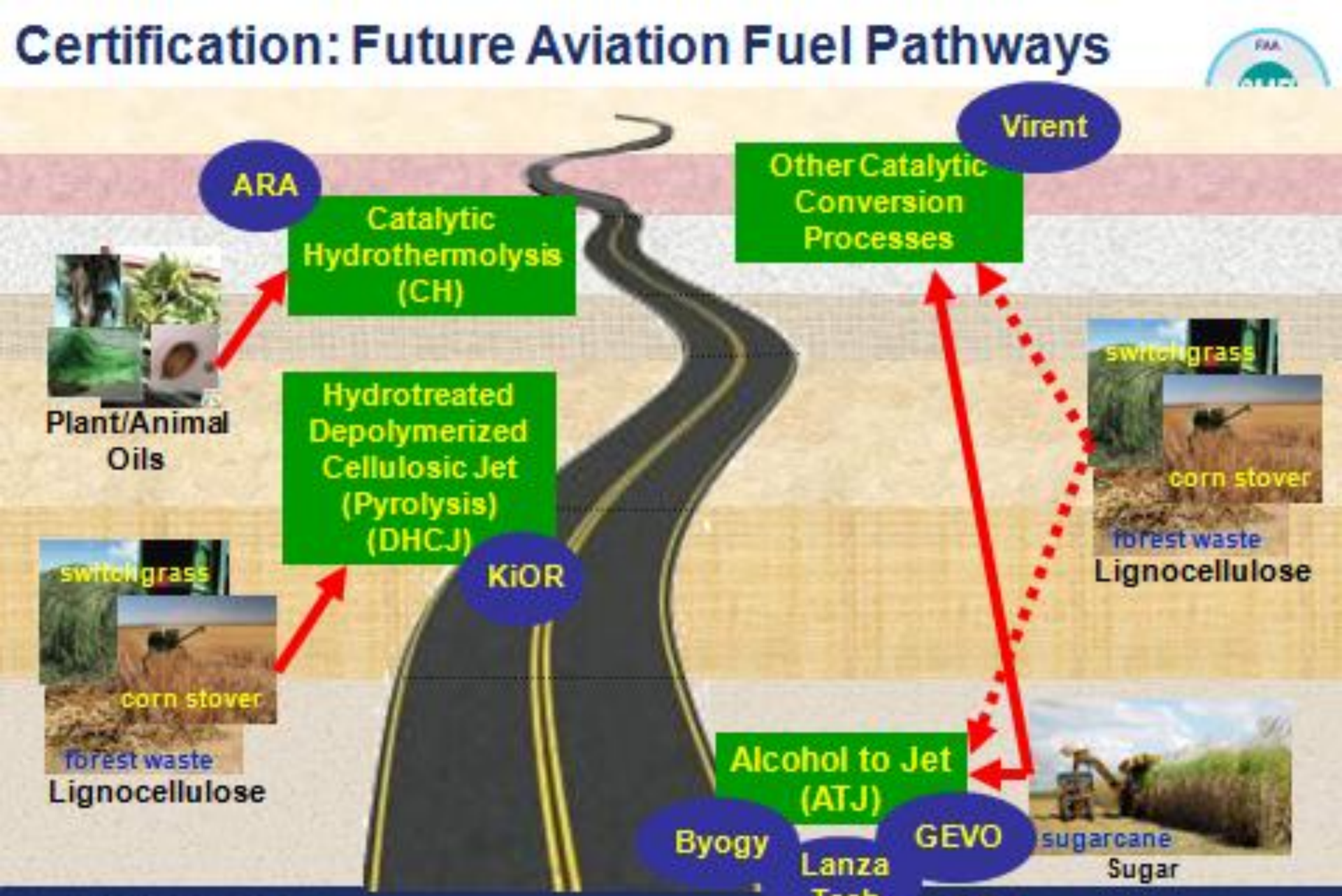
FT
Sept 1, 2009


Coal

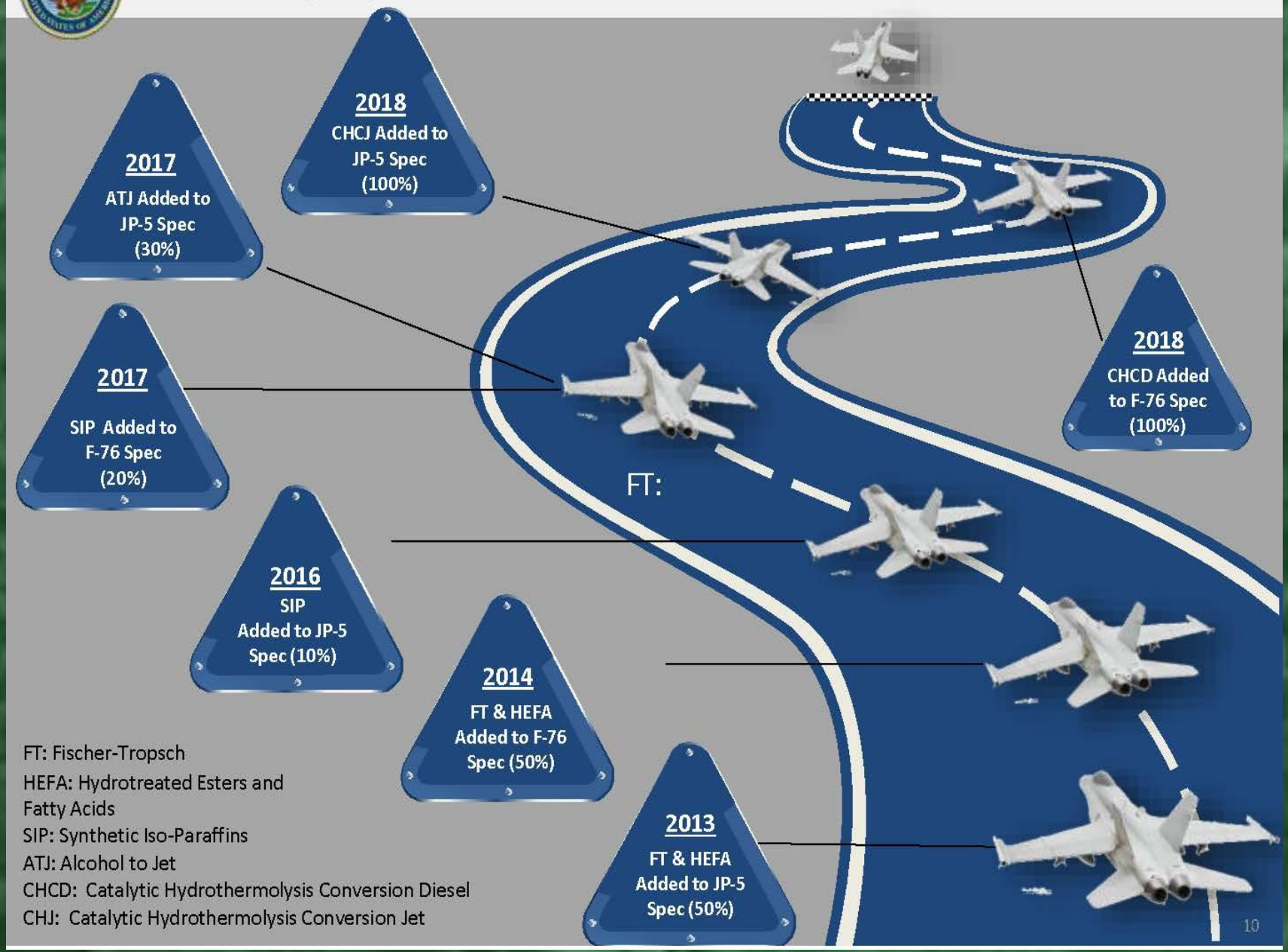

Biomass


Natural Gas

Certification: Future Aviation Fuel Pathways



Navy Synthetic Fuel Qualification Roadmap



FT: Fischer-Tropsch
HEFA: Hydrotreated Esters and Fatty Acids
SIP: Synthetic Iso-Paraffins
ATJ: Alcohol to Jet
CHCD: Catalytic Hydrothermolysis Conversion Diesel
CHJ: Catalytic Hydrothermolysis Conversion Jet

Energy Beet Project in Delmarva

Urgency:

- **Fruit/Vegetable industry demise** (over 40,000 idle acres)
- **Most economically depressed area on the East Coast**
- **Significant minority** population
- **Climate Change** consequences are evident—sea level rise, damaging storms

- **Unique access** to **rail transportation** to existing refineries with commitment to transitioning to renewables
- **Close to major jetfuel markets** (Norfolk Naval Base, DC, Philadelphia, Baltimore, New York)

Energy Beet Project in Delmarva

Goals Identified during Project Developme…

- **Importance of Remediation Potential**
  - Reducing Chesapeake and Delaware Bay nutrient runoff
  - UMES Expertise in Nutrient Management, long term studies of legacy phosphate from years of use of poultry manure for fertilizer in the area
  - UMES Expertise in Plant and Soil Science Research

- **Focus on Animal Feed Applications**
  - UMES Expertise in poultry nutrition and physiology

Energy Beet Project in Delmarva

Nutrient Management Data from 2016 Test Plots:

Wet Tons/Acre of Top 10 Yield Energy Beet Varieties
57
57
42
40.5
37.7
36.5
36
33.3
31.5
31.2
40.27

Potential Delmarva Ethanol and Bio-Jetfuel Per Acre Yields

Wet Wgt Tons/Acre	% Total Sugars	Tons Sugar/Acre	Gallons Ethanol/Acre@ 15.4 lb/gal (US DOE value)	Gallons Jetfuel/Acre @ 62% Ethanol (oxygen removed)
40	**21.8%**	**8.72**	**1,132**	**702**

Anticipated Phosphorus Uptake from Energy Beets Optimized for Eastern Shore Compared to Corn and Sorghum including P/Ton Conversion

	Tons/Acre	Lbs P/Ton	Lbs P/Acre
Corn	5.1	9.65	49.2
Sorghum	6.4	5.95	38.1
Energy Beets Average	23.9	3.46	82.8
Energy Beets Top 10	40	3.46	139

Delmarva Energy Beet Project

Biomass Yield Data: 2016 Test Plots

Wet Tons/Acre of Top 10 Yield Energy Beet Varieties
57
57
42
40.5
37.7
36.5
36
33.3
31.5
31.2
Average 40.2 Tons/Acre

Energy Beet Project in Delmarva

Potential Biofuel Yield Data: 2016 Test Plots

Wet Tons/ Acre	% Total Sugars	Tons Sugar/ Acre	Gallons Ethanol/Acre @ 15.4 lb/gal (US DOE value)	Gallons Jetfuel/Acre @ 62% Ethanol (oxygen removed)
40	21.8%	8.7	1,132	702

Delmarva Energy Beet Project

Nutrient Management Data : 2016 Test Plots

Potential Phosphorus Uptake from Energy Beets Compared to UMES Corn and Sorghum Fields

Crop	Biomass Tons/Acre	Lbs P/Acre	Energy Beet % Increase over Corn
Corn	**5.1**	**49.2**	
Sorghum	**6.4**	**38.1**	
Energy Beet Plot Used for Calculation	**23.9**	**82.8**	**68%**
Energy Beet Top 10 Average	**40**	**139**	**183%**

Energy Beet Project in Delmarva

Nutrient Management Credit Questions:

1. How to ***value*** potential Nutrient Management/Phosphorus Trading Credits—initial question raised during feasibility study.
   A. Certainly there was a P uptake benefit over other field crops (no fertilizer was added in test plots)
   B. How to measure that benefit?
   C. How to calculate that benefit?
   D. What are the markets?
   E. Is there "legacy" P in deep soil that energy beets take up? Does it matter?

2. Can annual agricultural crops participate in existing and developing nutrient management programs as non point sources?

3. For Delmarva project, since all fields in tidewater areas, would deliver ratio be 1:1?

4. Who would get the credits? Farmer? Landowner? Biofuel Producer? Shared?

Energy Beet Project in Delmarva

Nutrient Management Credit Questions:

1. How to ***value*** potential Nutrient Management/Phosphorus Trading Credits—initial question raised during feasibility study.
   A. Certainly there was a P uptake benefit over other field crops (no fertilizer was added in test plots)
   B. How to measure that benefit?
   C. How to calculate that benefit?
   D. What are the markets?
   E. Is there "legacy" P in deep soil that energy beets take up? Does it matter?

2. Can annual agricultural crops participate in existing and developing nutrient management programs as non point sources?

3. For Delmarva project, since all fields in tidewater areas, would deliver ratio be 1:1?

4. Who would get the credits? Farmer? Landowner? Biofuel Producer? Shared?

Energy Beet Project in Delmarva

More Nutrient Management Credit Questions:

5. Could value of credits be calculated by comparing the cost of removing the same amount of P by making changes to wastewater treatment facilities or building new wastewater treatment infrastructure to manage runoff from new residential or business/industrial development?

6. In addition to illustrating this as income/acre, the table on next slide illustrates potential net margins in terms of pounds of P removed using the Virginia concept of perpetual credits. How realistic is the value of the potential credit?

Energy Beet Project in Delmarva

Nutrient Management Questions:

Cost to Water Treatment Facility to Remove the Amount of Phosphorus Taken up by Energy Beets from Soil

Total Acreage	**116000**			
Corn Replacement	**Tons/Acre**		**Total Tons (116,000 acres)**	
Increase P Removal				
2016 Harvest	0.017		1,949	
40 Tons/Acre	0.045		5,184	
Average Tons	0.031		3,566	
Average grams/Ton			3,235,334,480	
10 mg/l to 1 mg/L removal rate	grams		Gallons for 1 ton Phosphorus Removal	Gallons Processed to Equal Energy Beet Removal
P reduction/gallon	0.03402		**26,666,226**	**95,100,954,734**
P reduction/liter (g)	0.009			Annual O&M Costs ($648/MG)
				$ 61,625,419
				Annual Payment per Acre
				$ 531.25

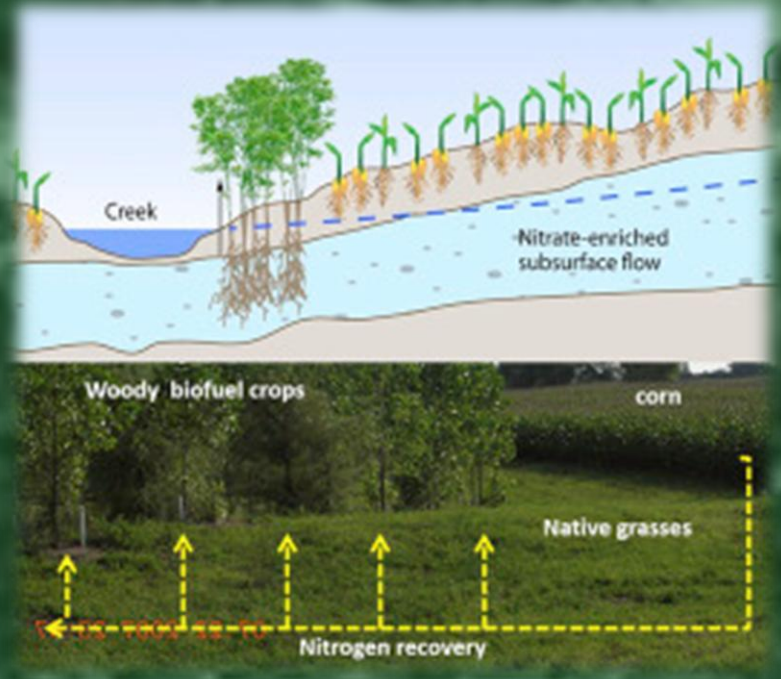
Energy Beet Project in Delmarva

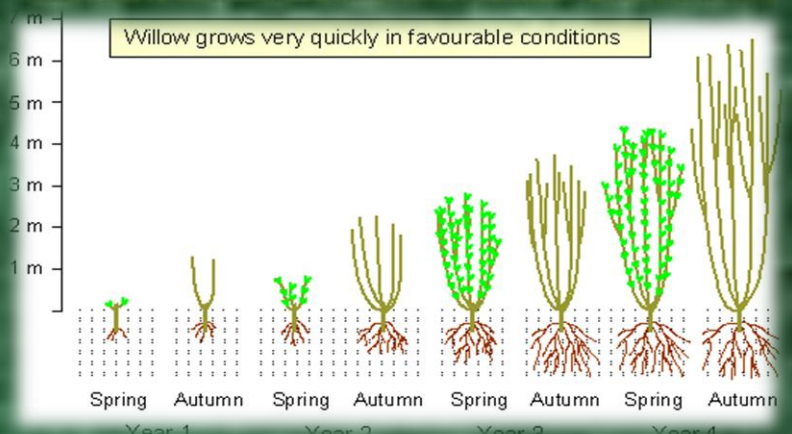
Policy-Issues and Nutrient Management Questions:

7. What policies exist regarding this type of valuation? Do any anticipate this type of annual crop nutrient remediation strategy?

8. Does the P have to leave the watershed? What if the P taken up by the beets locates in the co-product animal feed (poultry feed) that is used on the Delmarva?

9. What about crops like beets, grasses or coppiced poplar/willow that might be grown in landscapes to take up nutrients from runoff? How would they participate in a nutrient management credit trading program?





A Sustainable Renewable Energy Future

Joanne M. Ivancic, Executive Director
301-644-1395
JIvancic@AdvancedBiofuelsUSA.org

Energy Beet Project in Delmarva

Hood College Fredrick, MD

Energy Beet Project in Delmarva
UMES Princess Ann, MD

Energy Crops
The Future of Agriculture





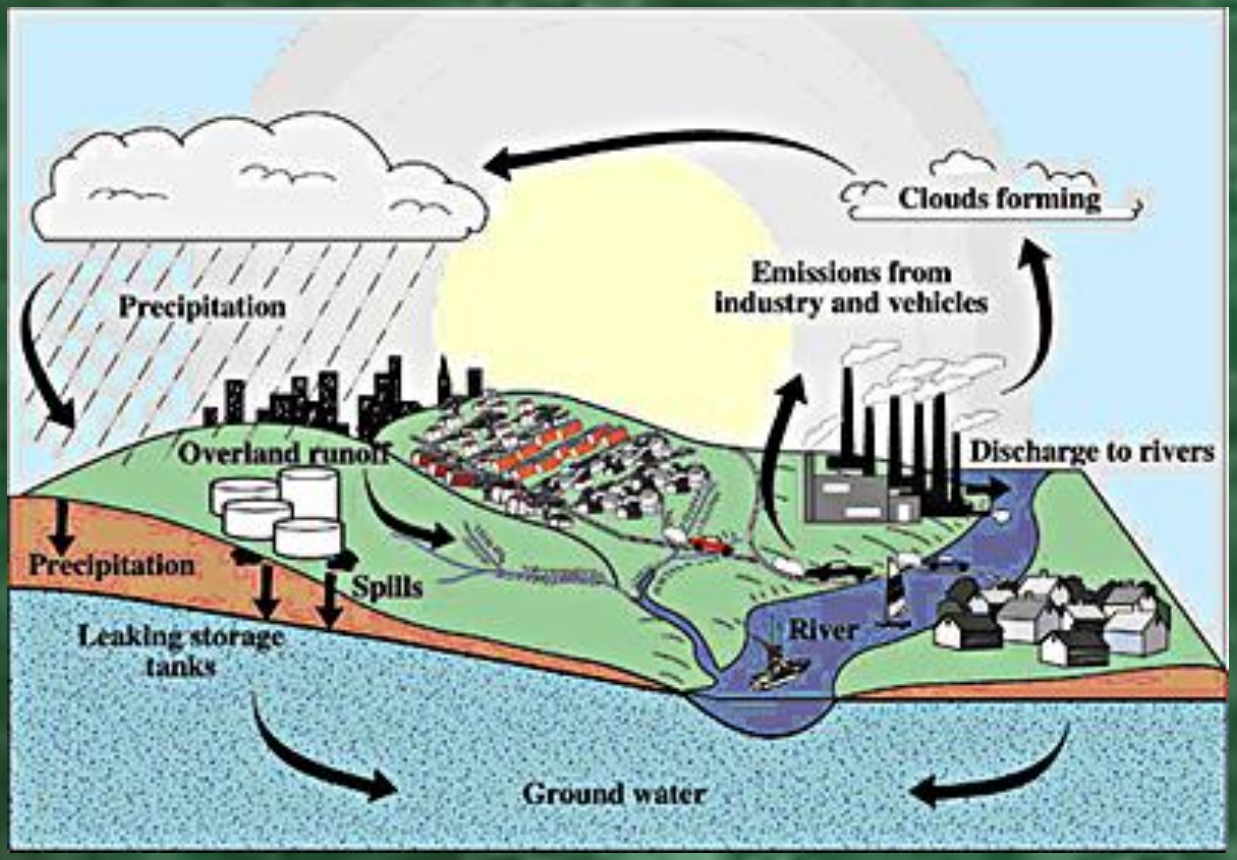


Benefits of Energy Crops
The Future of Agriculture

- Remediation
- Erosion Control
- Nutrient Management
- Loosen Soil Compaction
- Enhance Soil Carbon
- Food/Feed AND Fuel

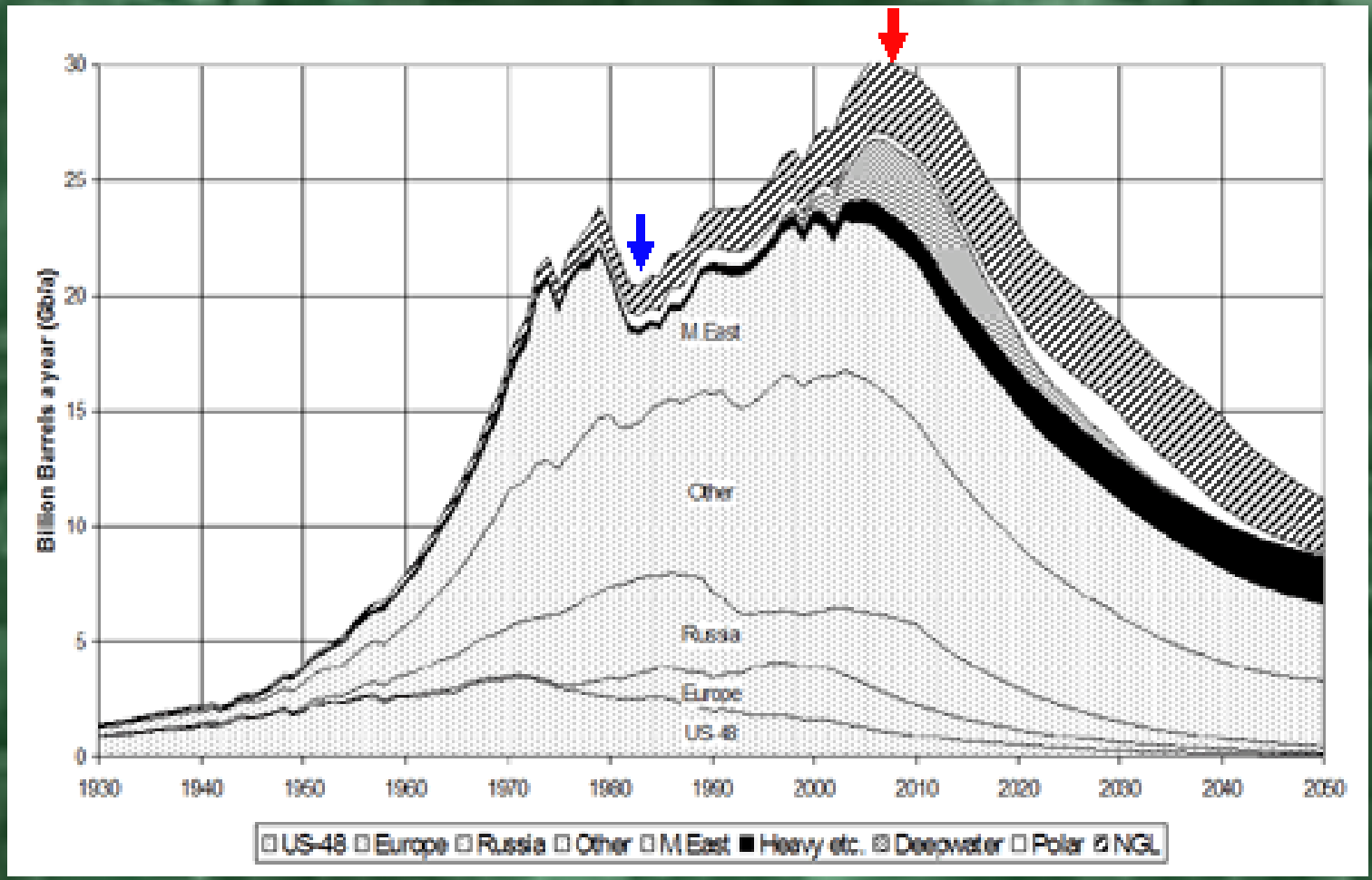
Why Replacing Fossil-Fuel Oil With Advanced Transportation Biofuels is Important—

Replaces MTBE as an octane enhancer.



Why Replacing Fossil-Fuel Oil With Advanced Transportation Biofuels is Important—

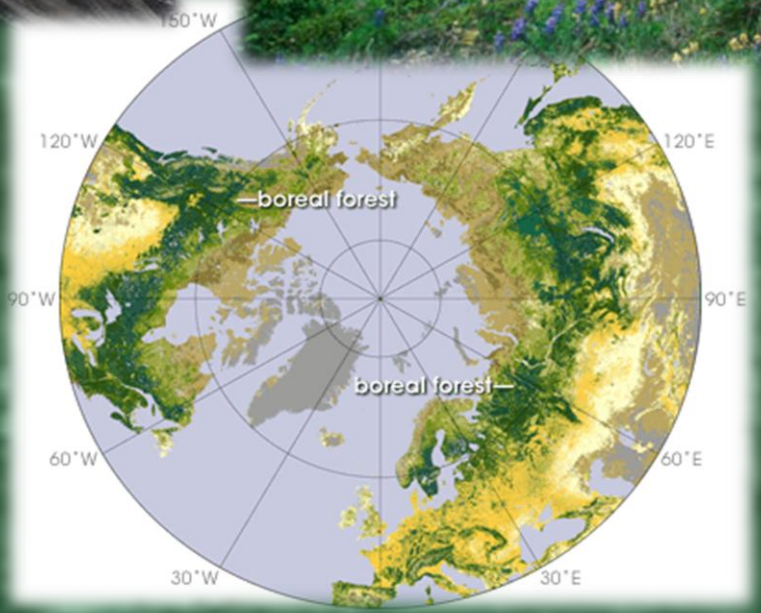
Peak Oil



ADVANCED BIOFUELS USA

Why Replacing Fossil-Fuel Oil With Advanced Transportation Biofuels is Important—

Before oil runs out, it becomes more difficult and dangerous to extract.



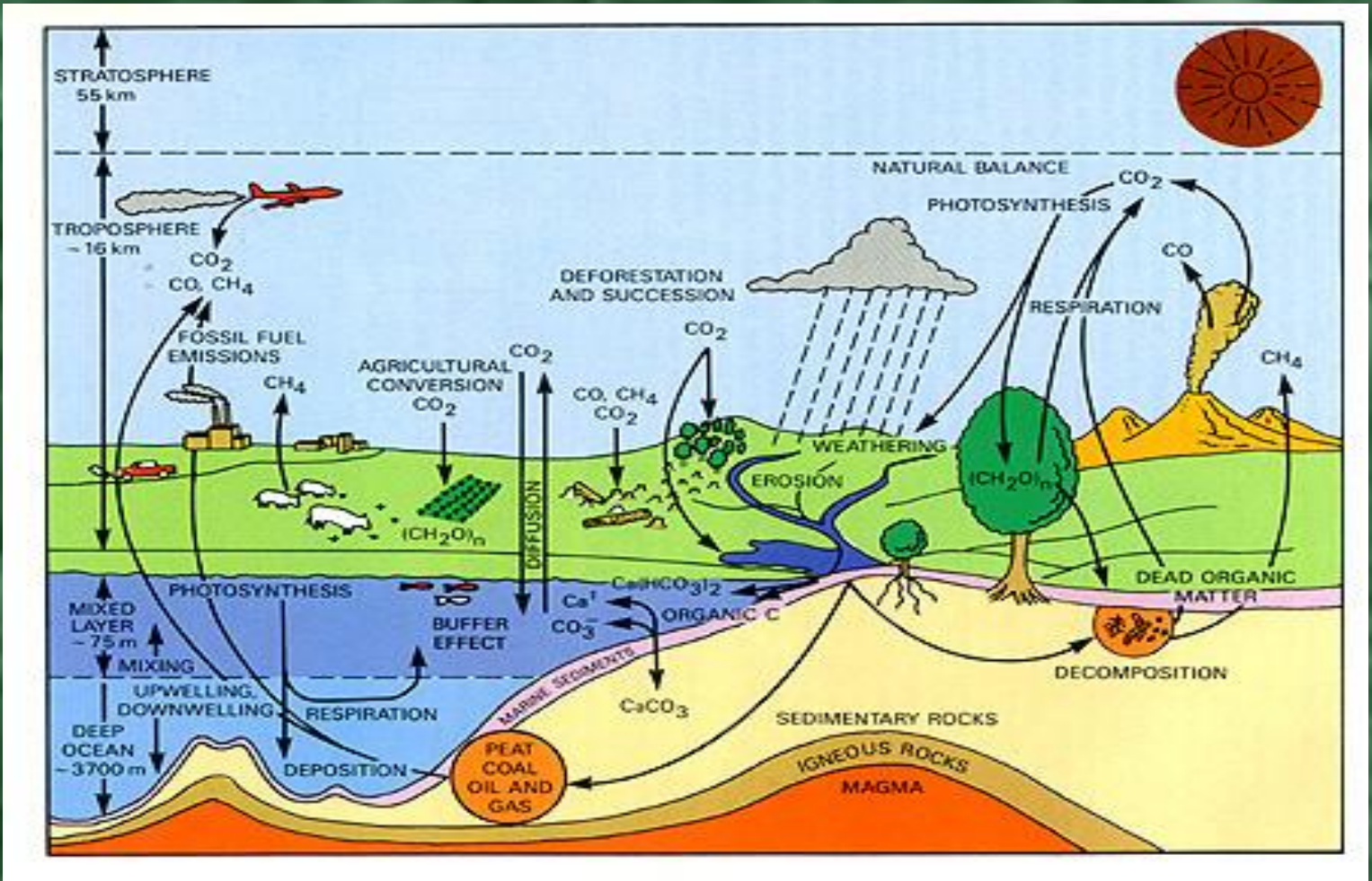
ADVANCED BIOFUELS USA

Why Replacing Fossil-Fuel Oil With Advanced Transportation Biofuels is Important—

Before oil runs out, it becomes more difficult and dangerous to extract.

ADVANCED BIOFUELS USA

Why Replacing Fossil-Fuel Oil With Advanced Transportation Biofuels is Important—

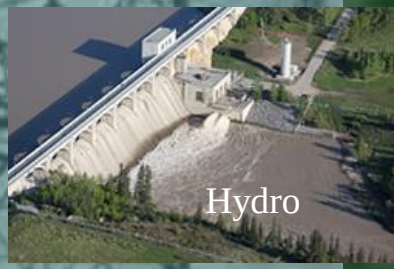


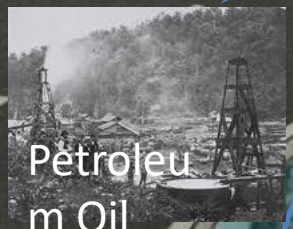
Part of a low life cycle carbon emissions climate change mitigation solution

The Road to Electric Vehicles

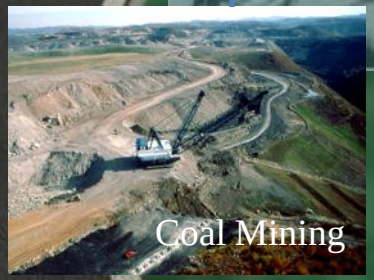
GHG Emissions

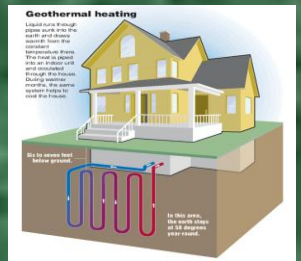
0.4%





GHG Emissions

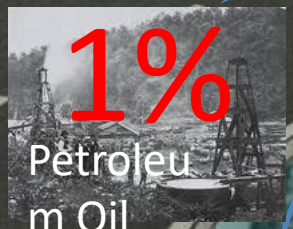




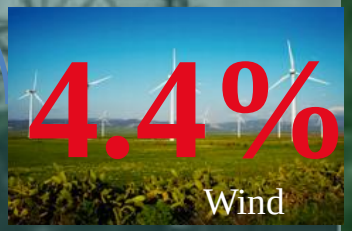
The Road to Electric Vehicles

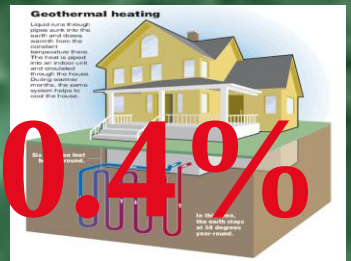
GHG Emissions

0.4%



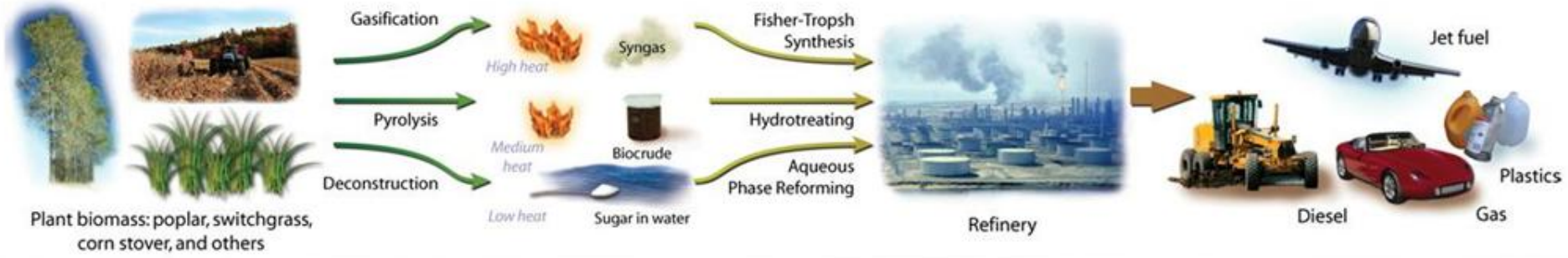
GHG Emissions





Other gas: less than 1%

Process Path: Biomass-to-Fuels and Products



Graphic by Zina Deretsky, National Science Foundation

ADVANCED BIOFUELS USA