

From Seed ... to Sky: Delmarva Energy Beet-to-Jetfuel Project



- *Project lead by University of Maryland Eastern Shore*
- *Study by Advanced Biofuels USA, September 2017 with a USDA Rural Business Development Grant*

Can Biofuels Be Economically and Sustainably Produced on the Delmarva Peninsula from High Productivity Energy Crops and Benefit Chesapeake Bay Nutrient Management?

That was the question asked by a public-private team that included University of Maryland Eastern Shore (UMES) and several cutting-edge Maryland-based biotech companies working on an innovative system.



The answer was: ***"Yes, especially advanced ethanol; and, with adequate tax credits and policy support, sustainable alternative jetfuel (SAJF or biojetfuel) for military purposes."***

Significant innovations that make this possible include the following.

- Use a high yield energy crop - energy beet - that is adapted to the Mid-Atlantic Coastal region.
- Produce over 100 million gallons/year of ethanol using only 10% of existing crop land in rotation.
- Take advantage of the mild Delmarva climate to have a long harvest season (4-5 months). This will increase yields by allowing some beets to continue to grow past the "normal" harvest day and reduces the costs of storing beets waiting to be processed.
- Increase biofuel yields at low cost by converting beet cell wall components to fermentation sugars without using expensive pretreatment.
- Produce as a co-product, high-nutrition animal feed with feed values equivalent to equivalent corn production, from beet protein residues.
- Use a portable, modular system to convert beets to biofuels. These modules would be barge mounted to use existing dockage sites of the Chesapeake Bay watershed (map at left) to transfer beets and fuels.

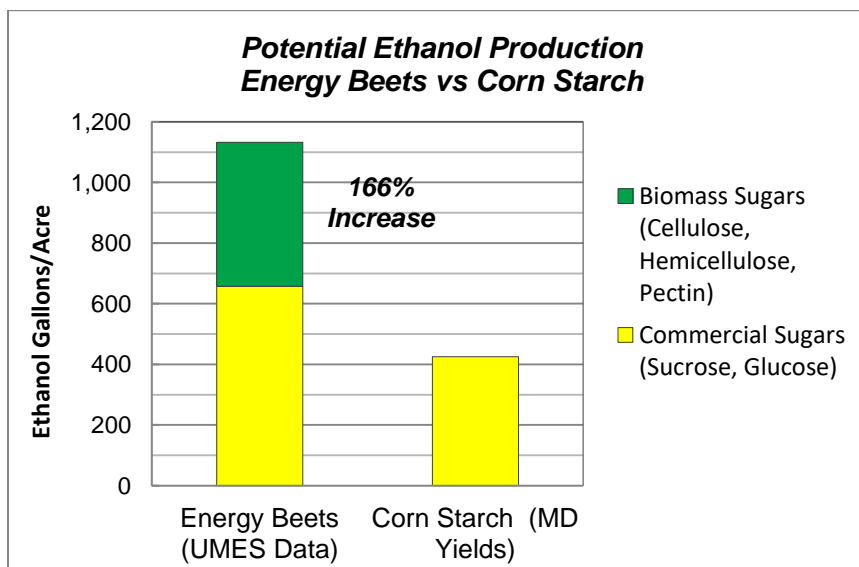


- This system will significantly lower biomass and biofuel transport costs below that of road or rail and minimize traffic increases on Delmarva roads.
- Use the phosphate capture characteristics of the energy beets to remove deep soil phosphorus accumulated from the use of poultry litter as a soil nutrient. This could significantly decrease Chesapeake Bay nutrient management costs.

Advanced Biofuels USA, a 501(c)(3) educational organization, performed an economic feasibility study based on 2016 crop and processing data from a test field at UMES for the US Department of Agriculture to address this economic question. Crop and biofuel input results were analyzed using USDA, DOE, and models developed by Ohio State University. Here are the key results.

Potential Biofuel Yields

- The average projected ethanol yield of candidate energy beet varieties **was over 1,000 gallons/acre.**
- **These yields were achieved at UMES test plots in 2016 without any nutrient inputs during the growing season.**
- Biojetfuel yields would be approximately 650 gallons/acre. This lower yield is due to ethanol to jetfuel refining which removes oxygen from the ethanol.
- Yields for both fuels would be more than 160% greater than for corn starch based production.



- These increased yields are in large part due to the sugars produced from energy beet biomass (42% of total) by the Atlantic Biomass non-pretreatment enzyme process.
- This advanced “biomass ethanol” could be eligible for federal cellulosic ethanol tax credits of \$1.01/gallon that was established by the 2008 Farm Bill. (Extension currently being debated by Congress.)

Market Impact

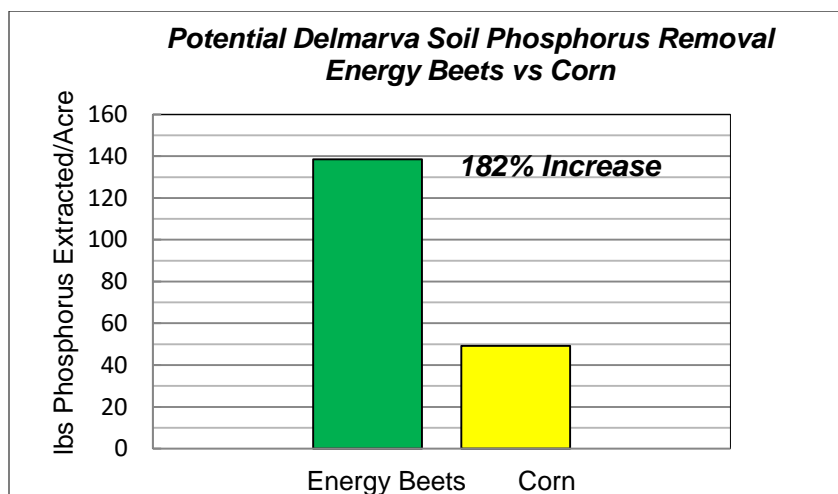
- These projected yields would allow energy beets, using about 10% of current Delmarva crop land in rotation, to produce over 100 million gallons/year of advanced ethanol.
- This advanced energy beet ethanol would be able to **replace the approximately 90 million gallons/year of ethanol (2015 data) that is barged annually to the Mid-Atlantic region for E10 (10% ethanol) transportation fuel.**

OR

- The energy beet biojetfuel would be able to **supply approximately 59% of the Navy aviation fuel supply of 146 million gallons/year at the Norfolk Naval facility.**

Nutrient Management: Soil Phosphorus Removal

- Comparative measurements on UMES test fields in 2016 showed the removal of legacy soil phosphorus by **energy beets was about 182% greater than that for corn** grown at the **same farm.**
- This quantity, if expanded to 10% of Delmarva farmland in rotation, would have a significant favorable impact on Chesapeake Bay nutrient removal objectives.
- **Bringing monetary value to these increases in phosphorus removal through state nutrient credit trading programs would provide increased income for Delmarva energy beet farmers and processors.**

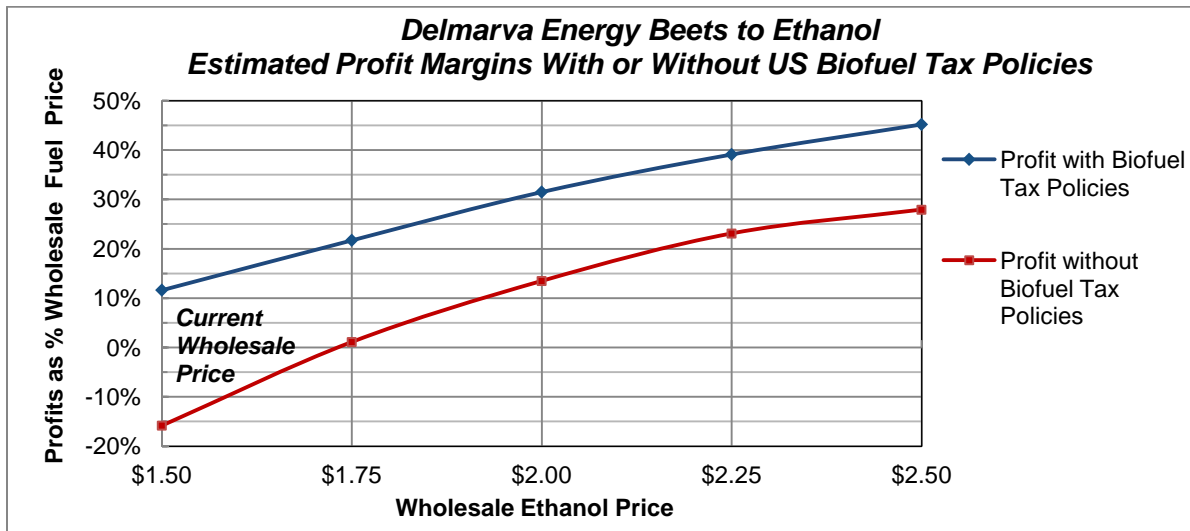


Profit Potential

Ethanol

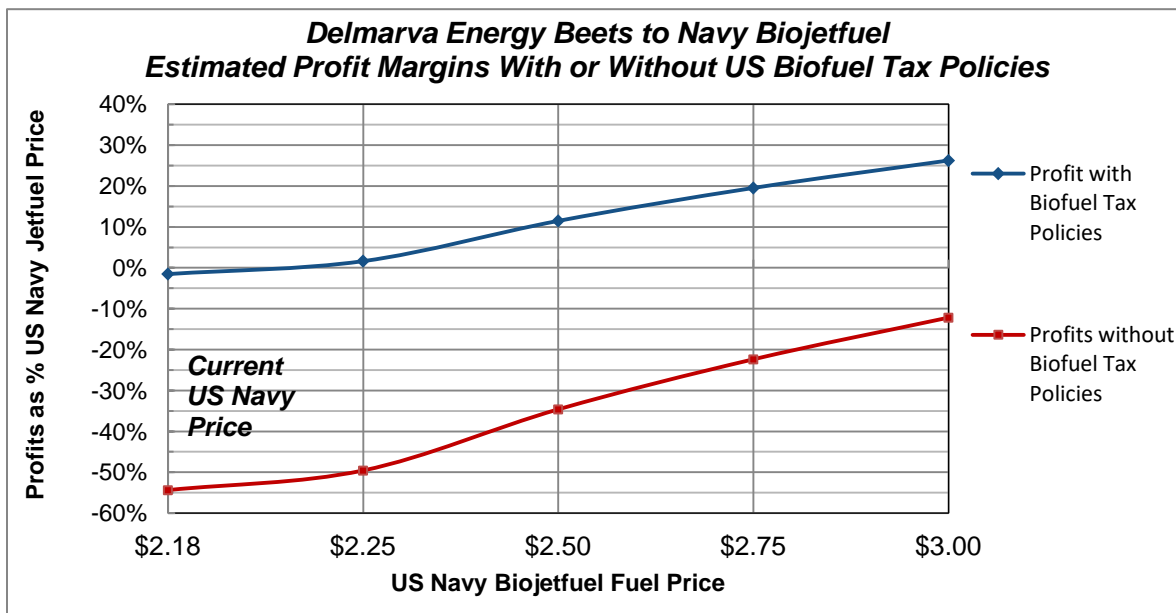
- Using DOE production cost estimates for ethanol and jetfuel, the early technology energy beet systems and crops that were tested **could profitably produce advanced bioethanol at today's prices with the cellulosic ethanol tax credit** (established by the 2008 Farm Bill and currently being debated by Congress) in place.

- **Without biofuel tax credits** for cellulosic ethanol, this early technology system would **break even at an ethanol wholesale price of about \$1.75/gallon.**



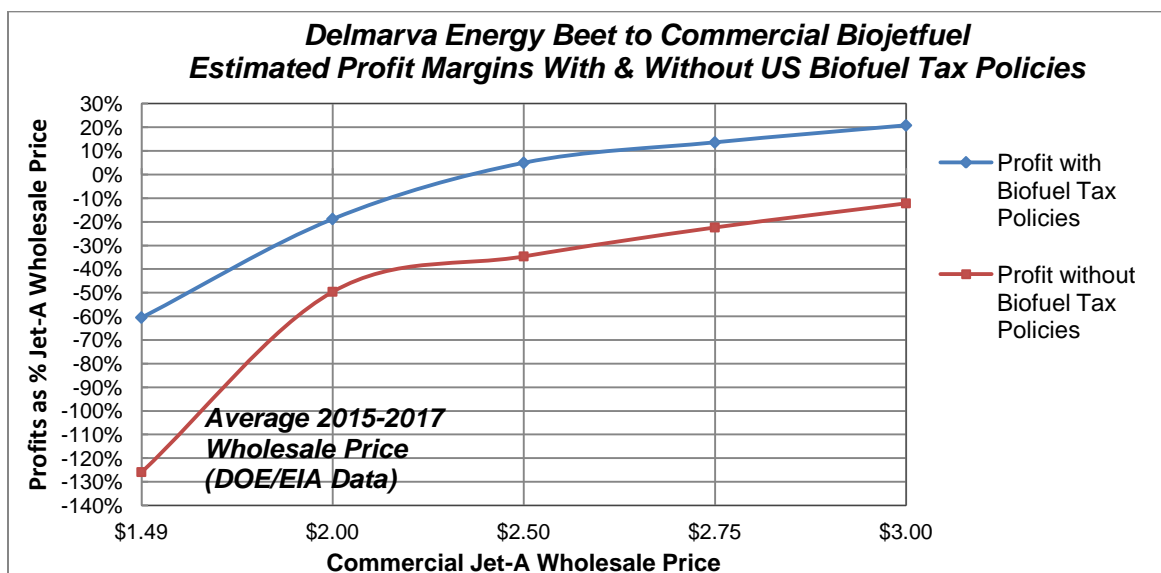
US Navy Biojetfuel

- Providing biojetfuel to the current US Navy based on a purchase price of \$2.18/gallon and with a renewable biofuel tax policy, **was near profitability with the 1st generation energy beet biomass conversion system.**
- However, **without these incentives, Navy biojetfuel would not be profitable until the fuel price was about \$3.37/gallon.**



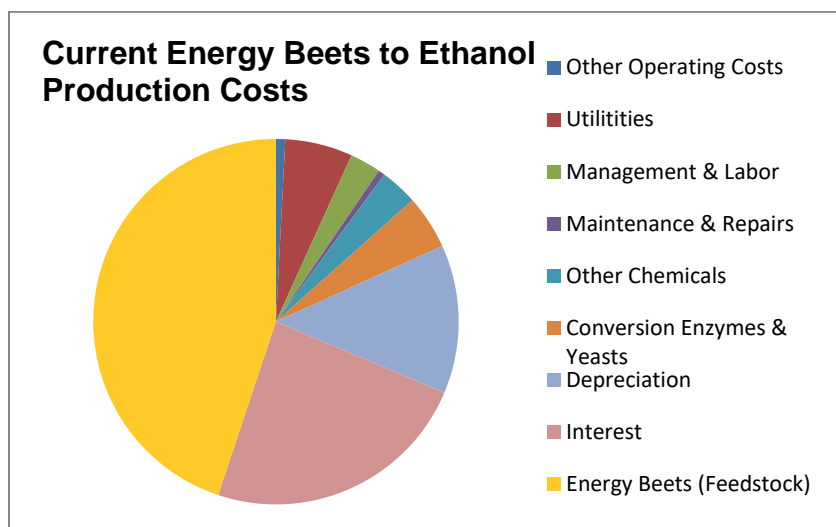
Commercial Biojetfuel

- Providing biojetfuel (Jet-A) to the airline industry, with prior renewable biofuel tax credits in place, has a breakeven **wholesale price of about \$2.38/gallon. This is 60 percent above the 2015-2017 average wholesale price of \$1.49.**
- However, **without these incentives, biojetfuel would not be profitable until the wholesale fuel price was about \$3.37/gallon, a 129 percent increase.**



Cost Reduction Recommendations

To improve the profitability of energy beet biofuel production, production cost reductions will be needed. As shown in the following table, the three production areas that could yield the greatest impacts on cost reductions are feedstock (which includes fertilizer, planting, and harvesting costs), production facilities (interest and depreciation), and enzymes. Cost reductions in these production areas should be pursued as a key part of commercialization R&D.



Specific processes with the greatest potential for cost improvements include:

- Reducing energy beet nutrient inputs.
- Reducing and simplifying beet harvesting and processing steps.
- Reducing energy inputs for sugar conversion, fermentation, and distillation steps.
- Reducing enzyme costs through improved enzyme performance and enzyme recycling.
- Reduce facility interest costs through co-op and other financing approaches.

Project Conclusions

- The near-term profit potential of ethanol production with or without federal tax incentives, ***argues for initially focusing on ethanol production within a system that could be expanded to jetfuel or other renewable chemicals.***
- ***The modular, decentralized, water-way based system proposed by the Delmarva energy beet team appears to be able to address this multi-product approach.***
- Additional revenue, including animal protein feed from energy beet residuals, should be a part of the overall business plan.
- Monetizing the nutrient reduction benefits of soil phosphorus removal should also be a part of the overall business plan.

Commercialization Recommendations

- The project team should work closely with the Delmarva agricultural industry and educational institutions to develop a system that builds on the strengths of the Delmarva culture.
- An integrated system such as a co-op should be used to: speed implementation, reduce transfer costs, and taxes within the crop to biofuel process, and increase profits to growers and processors.
- The project team should use a step-wise implementation process based on their prototype processing module. This will reduce initial capital demand and reduce downstream effects of problems found in prototype development and testing. In other words, do not use concurrent development.



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Full report available at:

<https://advancedbiofuelsusa.info/energy-beet-feasibility-study-finds-navy-best-potential-near-term-customer-for-alcohol-to-jetfuel-product/>

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