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Current and Projected Costs for Biofuels from Algae and Pyrolysis

Posted by Robert Rapier on June 4, 2012 - 10:17am
Topic: Alternative energy
Tags: algae, biofuel, fischer-tropsch, methanol to gasoline, microalgae, pyrolysis [list all tags]

A reader recently called my attention to a new and very interesting presentation from the Department of Energy's Biomass Program:

Biofuels Design Cases

The presentation explored the question of whether the U.S. government is spending money on the right technology pathways. Costs were presented for biofuel produced from pyrolysis, algae, Fischer-Tropsch (FT), and methanol-to-gasoline (MTG) routes.

I want to share several slides from the presentation to give an idea of what the DOE thinks about the costs for producing biofuels via the various pathways. The first slide below shows the projected cost of production of biofuels via MTG, pyrolysis, and FT for the "Nth Biorefinery Plant" — which is defined as the projected fuel cost after a number of plants have been built and the learning curve has been mastered.

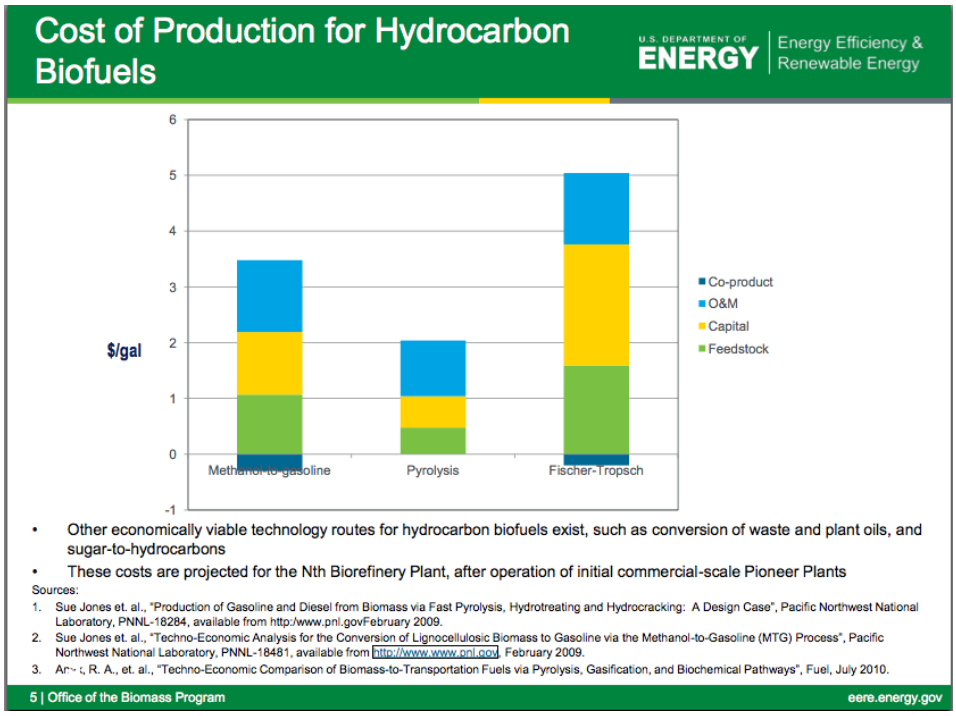


Figure 1. DOE projections of costs for biofuel from MTG, pyrolysis, and FT routes.

This slide projects a future best case scenario of about $3.50/gallon for the MTG route, $2/gallon for the pyrolysis route, and $5/gallon for the FT route. So if that is for the Nth plant, where do costs currently stand?

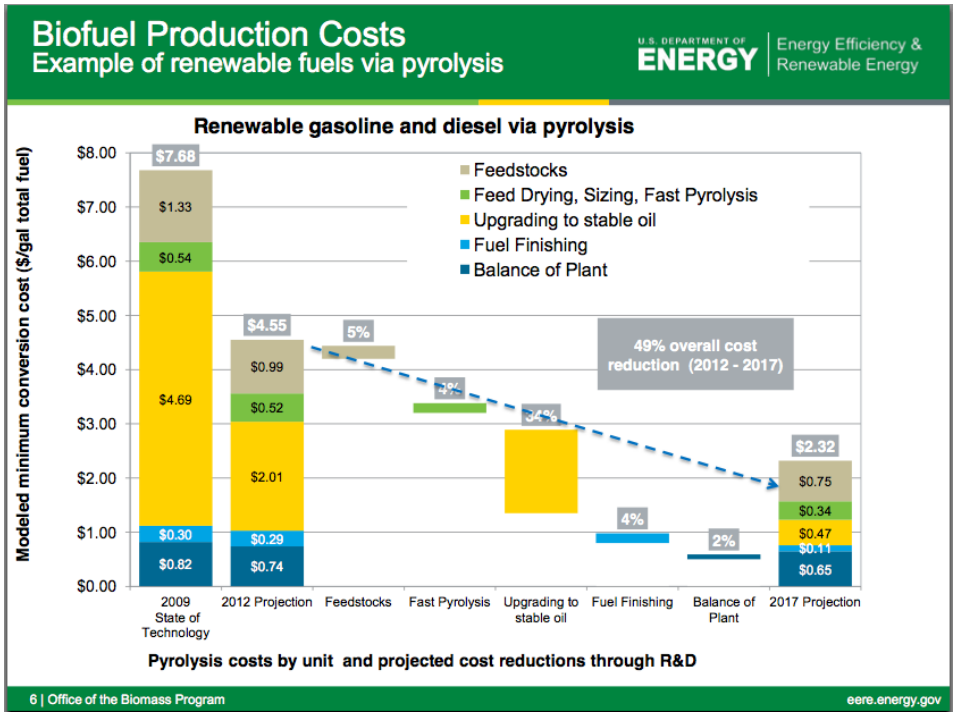


Figure 2: Projected cost reductions for biofuel from pyrolysis oil.

This slide shows that in 2009 they were estimating costs of production for biofuel based on pyrolysis of $7.68/gallon. By this year (2012) they projected the cost dropping to $4.55, and then over the next 5 years they project costs will fall to $2.32 (again, the Nth plant cost for pyrolysis was projected at $2.00/gallon). They project that the largest savings will come from the upgrading step.

So what do they say about fuel from algae?

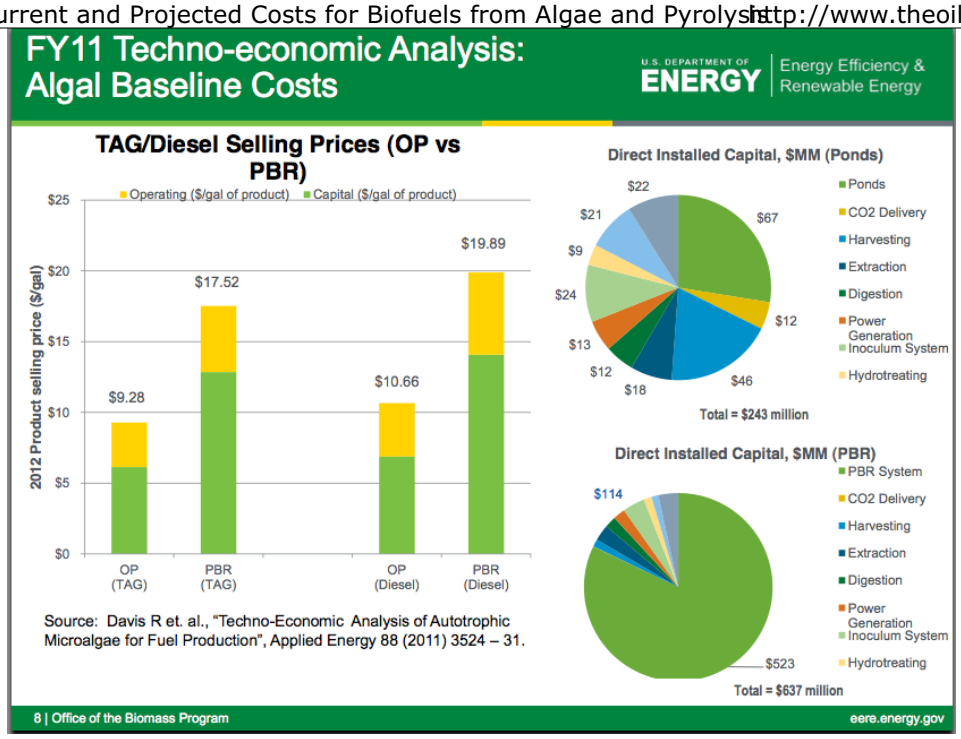
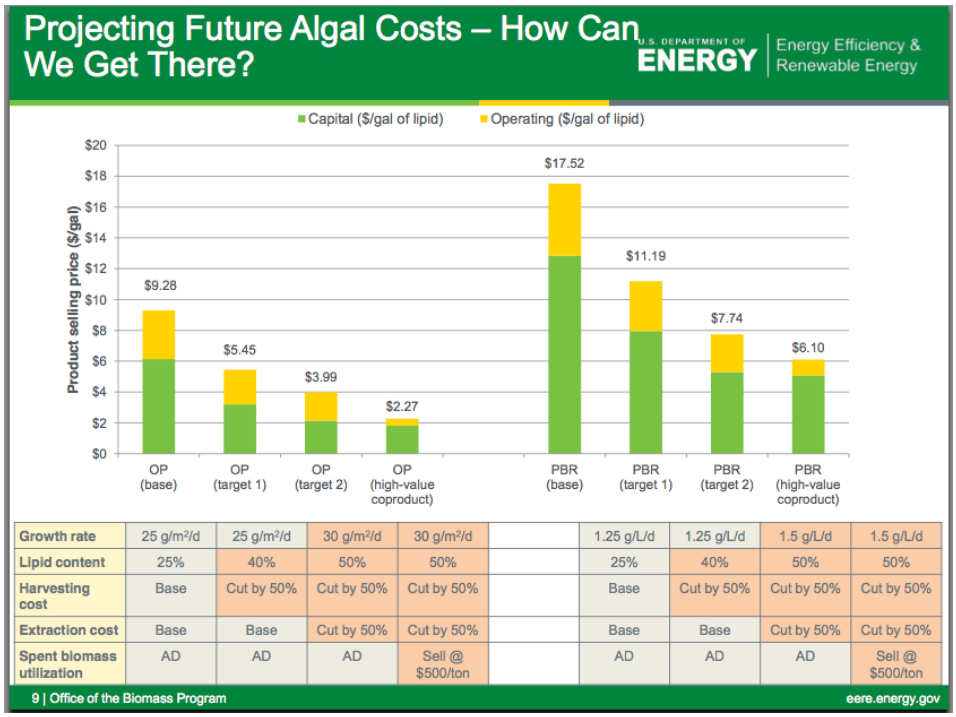


Figure 3: Baseline costs for algal fuel.

This slide shows the 2012 selling price for algal products in four categories: Triglycerides (TAG) from open ponds (OP) at $9.28/gallon and from photobioreactors (PBR) at $17.52/gallon, and then the finished diesel (which requires hydrotreating the TAG) at $10.66 from OPs and $19.89 from PBRs.

The following slide projects future algal fuel costs under a number of different scenarios:



Growth rate	25 g/m²/d	25 g/m²/d	30 g/m²/d	30 g/m²/d		1.25 g/L/d	1.25 g/L/d	1.5 g/L/d	1.5 g/L/d
Lipid content	25%	40%	50%	50%		25%	40%	50%	50%
Harvesting cost	Base	Cut by 50%	Cut by 50%	Cut by 50%		Base	Cut by 50%	Cut by 50%	Cut by 50%
Extraction cost	Base	Base	Cut by 50%	Cut by 50%		Base	Base	Cut by 50%	Cut by 50%
Spent biomass utilization	AD	AD	AD	Sell @ $500/ton		AD	AD	AD	Sell @ $500/ton

Figure 4: Projected future algal fuel costs.

In each case they assume various improvements over the base case, with the final case for both

open ponds and photobioreactors being one in which a high value coproduct is produced.

So what are we to make of these slides? First, as I have said in the past, I don't believe photobioreactors are the future of algal fuel production. Those artist renderings of futurist algae farms such as this one are pure fantasy in my opinion:

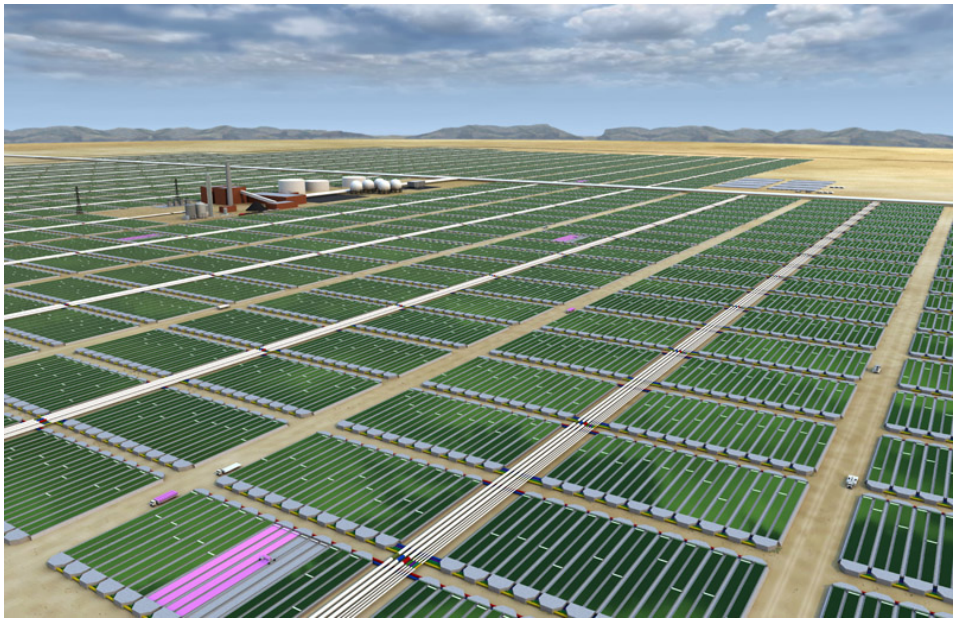


Figure 5: Computer-generated futuristic PBR farm.

In the most optimistic case the DOE could only get the projected cost of the fuel down to $6.10. More conservative assumptions would project that the fuel derived from PBRs will still be more than $10/gallon. As algae expert John Benemann noted here in a guest essay, "*The use of closed photobioreactors…is totally absurd.*"

Open ponds show more promise, but algae has been grown in open ponds for many years. Some areas that are specific to fuel production might see some significant cost savings, but other areas have already had decades to work on lower costs (e.g., harvesting). I suspect that Target 1 for open ponds might be achievable ($5.45/gallon) but lower than that will be challenging.

The fermentation route that Solazyme utilizes was not covered, but it would be interesting to see how that stacks up. The cost of converting the TAG to diesel should be about the same (~$2.40/gallon), but I know that Solazyme believes that their productions costs will beat both the open ponds and PBR routes.

But I think the real story from this presentation is the DOE's projections of the pyrolysis to fuel route. They clearly believe that this route can ultimately be competitive with petroleum. The technology currently exists to convert pyrolysis oil into transportation fuel, but it is fairly new and therefore should have room for some improvements. This is the type of route that KiOR is pursuing. A partnership between UOP Honeywell, Ensyn Corporation (those two formed a JV called Envergent) and Tesoro was awarded a DOE grant to build a demonstration facility based on pyrolysis at Tesoro's refinery in Hawaii.

The overall ranking in terms of future costs would appear to be: pyrolysis < MTG < FT < OP algal << PBR algal.

Link to Original Article: Current and Projected Costs for Biofuels from Algae and Pyrolysis