

PROMOTUM

Next Generation Biofuels – Trends, Opportunities & Pitfalls

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THE OPPORTUNITY

Starting in 2010, the US Government Renewable Fuel Standard mandates the blending of cellulosic ethanol into motor fuel. The RFS which has already caused a substantial overhaul of fuel infrastructure is about to trigger a massive second wave of construction. From now until 2022, it is estimated that 300 to 1000 new manufacturing facilities will be built at a total cost of up to \$300B. If the Obama administration escalates the RFS, as is likely, the number of facilities and expenditure will increase. This of course does not include the market for other renewable fuels, which may see commercialization soon. By any measure, financings, public offerings and M&A activities around next generation biofuels will be significant.

THIS REPORT

In late 2008, PROMOTUM interviewed about two dozen executives at leading biofuels startups and major oil companies. PROMOTUM also reviewed existing analyst and US Government Agency reports and conducted an online survey of ~ 300 scientists, engineers and business people working in the biofuels industry. The resulting 40 page report and 80 page appendix is summarized here.

STATE OF THE BIOFUELS NATION

Even with the current ease in gasoline prices there is much debate about whether the world has reached peak oil production. True or not the oil industry will continue to supply the vast majority of our motor fuel into the foreseeable future. The industry is large. In the US alone oil infrastructure includes 200,000 miles of pipeline; 150 refineries; 170,000 retail gas stations and \$300B of concrete and steel in the ground. Despite our continued dependence on oil, biofuels' share of the motor fuel market will continue to grow. Through at least 2022, the US Government has mandated increasing amounts be blended into diesel and gasoline. Currently, the vast majority of these fuels are corn ethanol and biodiesel from soy. These fuels, particularly ethanol have been associated with questionable energy balances and GHG emissions savings. Perceptions that biofuel programs have escalated global food prices has created political pressure to roll back mandates. Meanwhile, technologists point to inherent limitations of ethanol as a fuel. So, what are the fuels and processes of the future? What companies will spearhead these changes and when are they likely to occur?

Trends, Opportunities & Pitfalls

- Biofuels are closing in on 10% of the nation's gasoline supply and will become increasingly important to the US economy. Starting in 2009 government renewable fuel mandates include significant carve outs for cellulose derived biofuels with yearly escalations. In spite of current over capacity in the traditional biofuels sector, the mandates will precipitate a large second wave of ethanol facility construction. Unlike the first wave based on food grains, new cellulosic biorefineries will have geographic dispersal beyond the mid-western corn belt. Facilities will be smaller, 50 million gallons per year or less, with capacity determined by feedstock availability and transportation constraints. Over the next 13 years, more than 1000 cellulosic biorefineries could be constructed. Such a buildout represents an unprecedented reliance on technology never previously operated at commercial scale. This will create problems and opportunities. Companies with early bankable processes will command large margins as the volumetric cellulosic biofuel mandates for 2009 through 2012 are unlikely to be met. First movers will derive additional advantages from the economic crisis in the form of barriers to entry, with newer players scrambling for capital. The boom in commercial cellulosic ethanol facility construction has begun, but will not hit stride until 2010. Engineering & construction and equipment manufacturers will be the first to benefit.
- Despite public urgency over global warming issues major oil companies continue to under invest in biofuels. During the six year run up in oil prices ended in 2008, global oil demand grew by 900,000 bbls/day. At the same time fully one third of that demand was met by growing supplies of biofuel. Yet, oil companies with major US presence were slated to spend \$130 billion for exploration in 2009 and approximately \$1 billion on biofuels development. Responses of individual companies have varied with Shell and BP making modest investments. Exxon, the largest US oil company and the world's largest non government owned oil company remains the laggard.
- Cellulosic ethanol will be the first next generation biofuel to reach commercialization. Some 30+ pilot and demonstration facilities currently operate in the US. Butanol, however is a superior fuel. It can be used at 100% concentration without vehicle modification or changes to existing infrastructure. When compared to ethanol it has many other favorable characteristics including higher BTU content and up to 11% blends are already approved by the EPA. British Petroleum has steadily if quietly built its butanol value chain by partnering with DuPont for fermentation and systems biology expertise and with Verenium for enzymatic processing of feedstocks. Look for major announcements from BP with regard to the construction of butanol manufacturing facilities in late 2009 to early 2010. It is likely BP and butanol companies like Gevo will license their technologies and that ethanol plants will be retrofit to make butanol as soon as 2010.

- Currently there are more than 50 venture backed algae companies. Non food grain fuel feedstocks contain relatively little chemical energy in the form of sugars or oils. Costs associated with growing, harvesting and transporting them limits harvestable acreage to a radius of ~50 miles and ultimately determines the size of potential biorefineries. Consequently, investors have shown sustained interest in algae, aquatic plants that use carbon dioxide as a carbon source and can potentially provide 10 to 100 times as much bio-oil as terrestrial plants. However, the obstacles to algae cultivation beyond bench scale are significant. Early leaders in the field have found maintaining cultures of high oil producing species and providing light and carbon dioxide expensive. Going forward processes which more closely resemble farming and not pharmaceutical fermentation are more likely to be successful. Even so the possibility of an algae bust remains high.
- Applying industrial biotechnology approaches remains a potential game changer, but plotting a specific time line to success is difficult. DuPont demonstrated that systems biology can be used to produce commodity chemicals. The company's benchmark Bio-PDO process is currently operating at commercial scale and is expected to yield the first billion dollar non-pharmaceutical biotechnology derived product. Amyris Biotechnologies and LS9, Inc. are the leaders in synthetic fuels. Amyris has a pilot facility scheduled to begin operation in 2009 and a production facility slated for 2010. Despite ambitious plans, current product concentrations are low and orders of magnitude improvement are necessary. But as they say, watch this space.

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