August 1, 2006 Oils Utilization Breakout Discussion

Todd Werpy, DOE Co-chair, asked the group to consider their discussion focus. Participants agreed to discuss 2012 goals the first day, and 2030 the second, due to the potential for new crops inherent in the 2030 goal.

Determine how oils utilization pathway can produce cost-competitive biofuels by 2012.

Soy oil:

The group discussed the President's Advanced Energy Initiative and the Biofuels Initiative. The $1.07 per gallon goal for cellulosic ethanol by 2012 has been determined as the cost-competitive point for that fuel. Participants were asked to consider this price point for biodiesel or green diesel.

The group started its discussion by considering biodiesel compared to traditional petroleum diesel. In order to be competitive, they agreed that any biobased diesel product should aim for an equal price to the rack price of petroleum diesel, in the market considered at that time. In addition, the group stated that biodiesel use is more efficient than ethanol in terms of miles/gallon. Any other cost considerations, including price per pound of raw biobased material (traditionally 22 cents), would have to consider the petroleum diesel rack price. The group considered that additional value from oilseed crops will be found in meal or oil segments of production, though the costs inherent in co-producing a large amount of protein could depress that market, affecting the overall crop value. The Oils pathway summary flow chart was examined, and the group agreed to address the top half of the diagram for today's technologies, and goals for 2012. It was stated that biodiesel from certain feedstocks is already being produced at the rack price of petroleum diesel, but that overall oilseed production should aim for this equity goal, without any subsidies.

In order to achieve the goal, the biooil price target was determined to be $.20 to $.25, and the biodiesel price per gallon $2 to $2.25. The group took into account that conversion costs may vary in the next half-decade. This assumes that crude petroleum will cost at least $40 per barrel, which is a competitive assumption with current EIA estimates. If industry cannot produce enough volume of biooil, demand may increase the price, increasing the overall cost of biodiesel. Additional losses could be incurred on extra meal produced. The oil-meal ratio may change over time, but farmers are not paid based on yield, though they do select crops based on yield. Changing oil yields would also not produce a significant decrease in extra protein. Participants suggested extra meal could be used to co-produce value-added ethanol, though the ethanol would face trade barriers in Europe, due to tariff laws.

Corn oil:

To contribute to the overall 2012 goal of 7.5 billion gallons of biofuels, the group considered biodiesel an addition to ethanol. Current corn oil possibilities include 1.5 billion biodiesel gallons/year, and 6-9 billion gallons by 2012. That equals 3.1 to 3.2 billion bushels of corn. Dry mill extraction of oil, and fractionation to make biodiesel, are current technologies, but are not applied to corn oil, which is a byproduct of current starch ethanol production. Applying the technologies would raise costs.

Canola oil:

Participants agreed that all stages of the value chain must be profitable, including crop yield, to keep costs down and achieve the goal. Winter canola in a 1 in 4 rotation can replace wheat and produce oil. Increased acreage, and molecular breeding, could further increase yield. Infrastructure does not yet exist to break the cycle of monoculture, but the canola crop performs better overall.

Animal Fats:

The participants asked that Table 6 of the Oils pathway summary be updated to show the derivation of its numbers, using information from the National Renderers' Association for accurate data. They agreed that animal fats and certain recycled greases receive different subsidies, and have to deal with shrink or varied treatments in production. In addition, the current feedstock provides only a finite amount of material for biodiesel production.

Alternative Crops:

Participants agreed that the 2012 goal would not be achieved with any significant contribution by alternative crops (such as algae), which would enter the picture for the 2030 goal. Table 4 of the Oils pathway summary was considered too conservative. Many assumptions made were based on older data. For example, cottonseed is not very significant in today's market, but could be used more in the future, instead of fed to dairy cattle.

Barriers

The participants discussed barriers to several segments of the current Oils pathway summary flow chart. For crushing and extraction, lost energy was a barrier. Solvent extraction expellers waste oil in the process, though co-products are already exploited, enabling further step-change improvements. Sometimes oil does not require extraction. The pathway diagram was changed for this segment. For extraction/isolation, oil seed meal was defined as protein, carbohydrates/sugars, and cellulose.

Other barriers of oil production were discussed throughout the day. Oil content of crops varies widely by geography. Oil yield can take away from protein values. Large amounts of protein co-product are considered a barrier to cost competitiveness, due to the need to

develop uses. Different feedstocks produce different protein content. Markets won't pay for added corn oil content, unless dry mills evolve to isolate the germ. Infrastructure for the oil crop is lacking. Animal feed replacement poses a problem. Hair and other impurities in animal fats and greases cause problems with sulfur.

(see oils pathway diagram)

R&D Needs

The participants discussed R&D needs to achieve the 2012 goal for oils utilization, agreeing that: low-cost separation for soy beans is necessary; catalysts need uniform development; that industrial applications for meal should be developed; that extra meal could be used in chemicals production; that hulls are useful for cattle feed; that pretreatment enzymes could be developed to help cattle digest cellulose and to separate cellulose in high-yield crops from protein; that infrastructure could be developed; that uses for glycerol and soap stocks from biodiesel refining should be found; that collection infrastructure and contaminant elimination for waste greases should be developed; that glycerol production and use needs research; that meal pricing should be improved; and that fractionation technologies need development.

(Policy Needs and Federal Role discussion was focused entirely on the report-out slide).

The group agreed that diesel produced by hydrocracking, instead of transesterification, is called “green” diesel, instead of biodiesel.

Provide OBP with a realistic volumetric target for biodiesel produced from oils, and a feasible strategy for meeting the target within the 2030 timeframe. Identify and define one interim target for the pathway to meet in 2020.

Volumetric Goals

The group discussed 2030 volumetric goals by pathway: corn, soybean, canola, and animal fats.

Corn:

The group agreed that the 2030 goal requires 15-25 billion gallons of ethanol. From today’s numbers of 4.1 billion bushels of corn grain, 2030 corn grain yield should be estimated at 7.7 billion bushes. They assumed high-value (enhanced oil) corn, producing about 2.3 billion gallons of oil from corn grain alone. For biodiesel, the group set the goal at 22.1 billion gallons, with the possibility to increase due to better enzymes. Currently, the market only deals in commodity corn, not allowing for increased market value from increased oil yields, or contracting to farmers for oil supply. Fractionation technologies could be improved. Ethanol produced from corn starch is more lucrative than fuels produced from oil, but the intrinsic value of oil per gallon is higher than that of the starch component of corn. Separating oil out will cost money, affecting the value. Wet mills remove corn starch, but dry mill technology is necessary to extract oil and such value-added co-products as DDG.

(see separate spreadsheet for volumetric goal calculations)

Soy:

It was stated that the genetic yield gain of soy has historically been 1.4 percent. Between 1960 and 2005 the soy yield gain was doubled. For 2030, the group agreed that 5 billion bushels’ yield, and additional 1.5 billion bushels from the current 3.5 billion bushel base, could be expected. The group would like an academic to extrapolate current seed and oil companies’ projects to obtain solid information on yield gains. Anticipated step changes from molecular breeding, breeding for frost-resistance, etc., would justify a large growth estimate and an aggressive goal. Food supply needs affect soy oil availability for fuels, though food use of soybean oil is not expected to increase much past 21 billion pounds from 18 billion currently. Soybean food applications have changed significantly in the past few years, due to issues with transfatty acids and changes in the oil profile. The goal assumes the food use is extracted from the feedstock, and oil yield then measured. Soy is also a commodity, and farmers are not paid for oil content. The group estimated 3.2 billion to 6 billion gallons of biodiesel should be produced from soy in 2030.

(see separate spreadsheet for volumetric goal calculations)

Canola oil:

The group discussed whether canola is a rotational crop, depending on winter or spring planting, and the availability of appropriate acreage, including CRP. Future yield increases from hybrids could proide an additional ten percent of oil each year, which, when combined with additional acreage, and black locust or other pest issues, would affect the volumetric goal. It was agreed that approximately 1.4 to 1.6 billion gallons of biodiesel from canola could be produced, based on current data.

(see separate spreadsheet for volumetric goal calculations)

Animal Fats:

An increase in available fat feedstocks is not anticipated, unless US beef exports increase. It was noted that Table 6 of the oils pathway summary did not show adequate data for animal fats. Some fats are still diverted to animal feed uses. The group suggested obtaining more correct data from the National Renderers' Association. Animal fat prices are constantly increasing, and nothing in this market is wasted. Based on current market trends towards leaner meat, animals may be butchered at a younger age, decreasing available fats. More information on this market is necessary for a better goal estimate.

Other future oil crops:

(Cottonseed, peanut, safflower, linseed, sunflower…)

The group agreed that cottonseed has potential for increased oil market share, but that the other oils category will continue with very small market share. Palm oil imports could be diverted to food uses while domestic oils are used for energy-secure fuels. However, import predictions are not reliable due to tax issues, and palm oil especially cannot be used for fuel nationwide, due to its ease of saturation.

Future Crops:

The group discussed alternate oil-producing crops, such as castor, which does currently produce oil for fuel uses. The need for an oilseed crop that is also a legume highlights a future barrier that constant nitrogen fertilization needs might create. Some participants believe nitrogen use and application will become more efficient, including applied technology for timely application, eliminating any barrier. Others believe nitrogen production using high-cost natural gas will prove a bottleneck, but GTL technology may mitigate the costs. Increased greenhouse gas emissions, such as NOx, will put pressure on producers for cleaner crops. Triglycerides could be produced without nitrogen application. Some future algae crops could produce both nitrogen and triglycerides. Some

participants didn't believe CRP lands will be opened to energy crops, and thought that more fuels would come from fermentation processes, not oils, necessitating more algae, yeast, and bacteria advances.

The participants mentioned Jatropha, an oil crop which is not frost tolerant, can be grown on marginal land, and must be hand harvested (raising labor costs). It can be triple-harvested, and some varieties are producing oils in Texas, but current pesticides cannot be used on it, and it cannot be planted near other crops. Specific harvesting equipment for Jatropha would have to be developed.

A perennial oilseed crop would have high value, but new annual crops would not be worthwhile compared to corn, soy, and canola. Marginal acreage would be the best place for new annual crops. Palm could not be grown in most of the U.S. Sustainability efforts and alternative rotations for current crops could increase yields. Tall oils from wood production were considered unstable, but valued for the combined fiber and oil harvest. It was suggested that chemical companies could be built around tall oil extraction from the southern yellow pine crop. Algaes could be grown in shallow water or salt water, but the ASP report makes more specific extrapolations for the crop.

The combined alternative oil crop estimate was based on issues with nutrient supply and land use. This includes available acreage for alternative crops. Current estimates are based mostly on abandoned farmland in the Northeast, not including desert, swamp, and other marginal lands. The group agreed it is difficult to esimate future volumetric production in this area.

Overall Volumetric Goal:

Based on discussion of corn, soy, canola, animal fats, and alternative crop oils, the group combined the 2030 estimates to provide a goal of 7.5 to 15 billion gallons. For biodiesel, this number is close to the 30 x 30 overall goal. Participants decided that this figure should represent all biodiesel substitution, including green diesel and biodiesel, from conventional crops.

Potential Ethanol from co-products:

The group wanted to include consideration of possible ethanol production from oil crop co-productions. Based on a ratio from their 2012 goal, the group thought production of ethanol and other carbohydrate-based fuels could be doubled to 5 billion by 2030. However, they agreed that this estimate could vary based on the base numbers' accuracy.

<u>Barriers</u>

The group added some barriers to oilseed production increases for 2030, including higher-cost nitrogen, urban sprawl decreasing available acreage, and constant variety in

disease, fungus, insects, and weeds which decrease production. They agreed that infrastructure needs improvement for 2030 as well as 2012.

(plus cards from Day 1)

R&D Needs

The group added some R&D needs based on the second day's discussion of additional barriers. More efficient nitrogen production and use; the development of better herbicides, pesticides, and fungicides; genetic engineering for fungus/disease-resistant crops; genomic sequencing of pests for better anti-pest research; process intensification for green diesel technologies; addition of high-oil crops; development of a perennial oil-producing crop for growth on marginal acreage; development of new triglyceride sources and stable biobased jet fuels; and overall worldwide process intensification were all recognized as necessary target areas.

(plus cards from Day 1)

Policy

The group asked for implementation of the following additional policies to achieve 2030 goals: incentives for green diesel production without enabling corporate double-dipping on domestic/export biodiesel production/sale; engineering of plants to meet DOD needs; utlization of biobased materials to replace some non-fuel petroleum uses, viewing chemicals at the same strategic level as fuels; and support for a sustainable economy not based on petroleum imports. The group discussed the negative effect of agricultural tariffs and subsidies on the fuel market for feedstocks, and advocated mandates instead of subsidies.

Federal Role

Additional Federal Role discussion included: requests for continual support of land grant universities and agricultural extensions; DOE coordination with DOD needs; genome sequencing of pests; and an examination of the international trade balance in relation to energy security.