Energy From Agriculture:
New Technologies, Innovative Programs & Success Stories

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Executive Summary

As the technology for producing ethanol, biodiesel and other products improve, and the price of more traditional energy sources continues to rise, the market has become more willing to accept alternatives. The amount of energy derived from renewable resources in agriculture can only increase over time as the relative economics of alternatives improve.

With an increasing number of federal and state tax and production incentives for alternatives, agriculture is in a position to capitalize financially, and help nudge the U.S. along the road of securing energy from a variety of domestic sources.

***Energy From Agriculture: New Technologies, Innovative Programs & Success Stories*, reviewed current renewable energy technology—what can agriculture produce at what cost, discussed programs designed to further the business of renewable energy from agriculture, and featured individuals and companies with experience in renewable energy production.**

Ethanol and Other Products

Agriculture's largest contribution to renewable energy comes from ethanol. More recently, biodiesel production is beginning to surge. While corn and soybeans, respectively, are the primary feedstock for those products, new technology will allow the leafy and woody parts of plants (lignocellulosic biomass) to be used to produce ethanol. As a result, ethanol could be produced from corn residue, wheat straw, waste paper and wood.

Right now, it is estimated that the cost of producing a gallon of ethanol using this material is $1.39 to $1.49 per gallon—too high for economic viability. However, the National Renewable Energy Laboratory reports that with use of improved enzymes in the process, the cost per gallon will decrease. Vehicle fuel containing additives such as ethanol amounted to only 2.5% of the market in 2004, while biodiesel (containing mostly soy) constituted 0.6% of the diesel sold.

It is expected that new technology will soon be developed that will increase the amount of "dry biomass" that can be harvested and used. This includes not only crop

Alternative Energy in the Real World

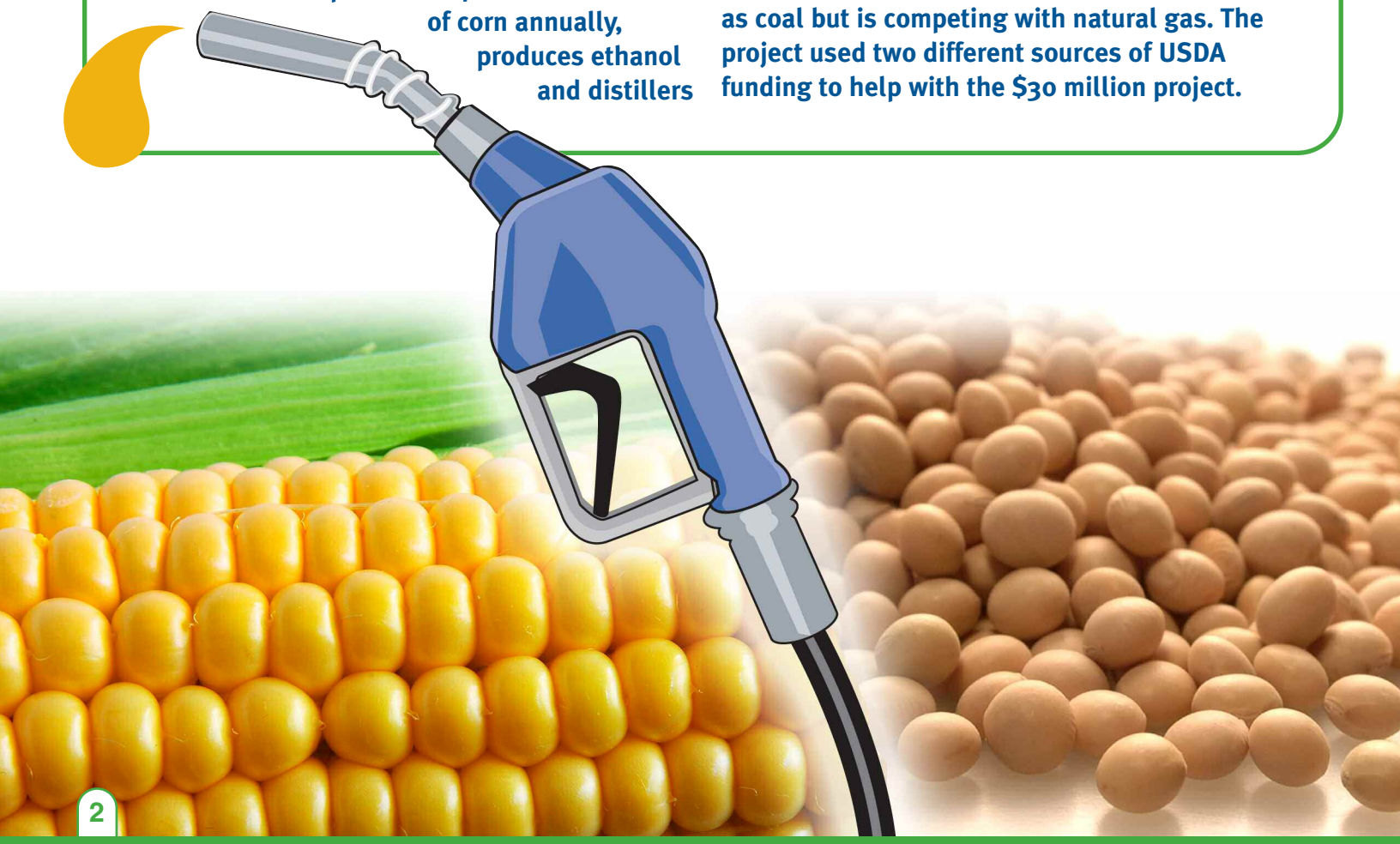
Among the presenters at this conference were several veterans of energy production using renewable fuels.

• *Vander Haak Dairy, Lynden, Wash.* The Vander Haaks have been using a methane disgester on their dairy since late 2004. The system processes the manure from 1,200 cows in the Vander Haak's dairy, as well as manure from other nearby dairies. The digester produces solids that are 99.5% pathogen free. Income is generated from power sales, carbon credit sales and tax credits.

• *AGRI-Energy of Luverne, Minn.* This cooperative began operation of its ethanol plant in 1998. The cooperative has 213 producer-members in 38 counties and three states. The plant, which processes 42 million bushels of corn annually, produces ethanol and distillers dry grain. The operation has been successful enough that the cooperative has invested in other ethanol plants in the United States. A $10,000 investment in the cooperative in 1998 has to-date returned nearly $60,000 in cash dividends to members.

• *Paul and Alice Neppel of Armstrong, Iowa.* The Neppels constructed a 1.5 megawatt wind turbine on their farm at a total cost of $1.62 million. They received a renewable energy grant for more than $400,000. The turbine produces enough electricity to power about 400 Iowa homes. The Neppels expect a return on their equity in 15 years.

• *Snowflake White Mountain Power Project, Arizona.* This project is using wood from forest waste and paper sludge to generate enough electricity to power 20,000 residences. Thus far the facility doesn't produce energy as cheaply as coal but is competing with natural gas. The project used two different sources of USDA funding to help with the $30 million project.



residues and perennial grasses but burnt-over or thinned timber.

While biobased transportation fuels will continue to be the main products made from renewable energy, other products, such as chemicals, natural fibers and electricity, can also be produced. Existing biobased products include adhesives, cleaning compounds and paints.

Ethanol production continues to ramp up. There are 92 plants now in operation in the United States, with 35 plants either being constructed or being expanded. In 2005, more than 4,000 million gallons of ethanol were produced. Production capacity is expected to reach 6,000 million gallons in 2006.

Biodiesel

Production of biodiesel increased five-fold from 1999-2004. The typical biodiesel plant using degummed soybean oil, produces a gallon for about $1.48. Biodiesel can also be produced using yellow grease, or trap grease, which is recovered from used cooking oil in food service operations. Yellow grease generally costs half the price of soybean oil. That price differential will likely narrow as the biodiesel industry bids up the price of yellow grease.

In the interim, the cost of biodiesel remains well above that of petroleum-based diesel. However, biodiesel blends have been able to compete with diesel fuel, due to a generous tax credit available to biodiesel blenders (See, *Help for Ethanol and Biodiesel Production*).

Estimates indicate that various federal and state biodiesel mandates, such as that in Minnesota, can increase biodiesel's fuel use to 500 million annually from the current 25 million gallons. However, according to USDA estimates, the U.S. market could only produce 300 million to 350 million gallons from yellow grease and soybean oil. To produce more would require the use of other feedstocks or imported oils.

Wind Power

There has also been a mini-boom in recent years in wind power, most of it generated by turbines on farms in the Midwest, the Great Plains and the West Coast. Production totaled 14.2 million megawatt-hours in 2004, up from 5.6 megawatt-hours in 2000. Still, wind power only accounts for 0.36% of total U.S. electricity production.

The increase in wind-energy production can mostly be attributed to government programs. For instance, the Public Utilities Regulatory Policy Act requires utilities to accept electricity generated by wind and other renewable sources. The federal Energy Regulatory Commission fosters greater access to the electrical grid for renewable energy. The federal Wind Production Tax Credit, which has been extended through Dec. 31, 2007, is 1.9 cents per kilowatt hour for 10 years of production.

In a cost comparison, wind-generated electricity can be produced on par with electricity generated by coal or natural gas-powered plants. All three cost less than nuclear power plants. Most wind turbines need a 10 mph wind to produce energy and cut off if winds exceed 50 mph.

The U.S. Department of Energy has set a goal of 6% of U.S. electricity from wind power by 2020. To achieve that goal, wind-generated electricity would have to increase more than 21 times from what was produced in 2004.

Methane to Electricity

According to the U.S. Environmental Protection Agency (EPA) there are 41 anaerobic digesters in operation in the U.S. on swine, dairy and poultry operations. Digesters break down organic wastes from animal waste, producing in the process energy and an organic compost.

Many of the digesters in use on farms came about as part of EPA's AgStar program, which provides

Energy By The Numbers

In 2004, the total amount of energy consumed in the United States was 99.6 quadrillion (quads) BTUs, of which:

- **39.8 quads were from petroleum products,**
- **23.0 quads were from natural gas,**
- **22.5 quads were from coal,**
- **8.2 quads were from nuclear power, and**
- **6.1 quads were from renewable resources.**

Of the 6.1 quads from renewable resources,

- **44% was from hydroelectric power,**
- **33% was from wood, black liquor and other wood waste,**
- **5% was from ethanol, and**
- **0.5% was from agriculture in the form of alcohol/ethanol, wind and other waste material.**

technical and financial assistance to demonstration sites. Among the reported benefits of digesters are electricity sales and use of digested solids for bedding or fertilizer. The smell of the resulting fertilizer is nearly nonexistent compared to most manure.

Unfortunately there isn't much data on the profitability of digesters. One study of a Minnesota farm indicated that, taking into account benefits from grants, interest-free loans and revenues from electricity, the farm achieved a 21% internal rate of return on equity. Considerably more data is needed.

There will come a time when biorefineries will be able to process the fiber from the whole grain and the leafy material from the stocks, and make better use of distillers dried grains and protein than is now possible. Also on the horizon are lignocellulosic biorefineries that can handle "green" crops, such as silage corn, kelp, switchgrass, hybrid poplar, and cornstover.

Weighing the Costs

Whether agricultural plant material, or biomass, is used in energy/electrical production is a function of what the cost is relative to other available sources of energy. The opportunity costs for alternative uses of the land and the labor involved have to be evaluated. For instance, agricultural biomass materials have a low energy density, which means they have a lot of weight and bulk given the amount of energy they produce.

Agricultural byproducts have an average heat content of 8.25 million BTUs per dry ton. Paper pellets have more than 13 million BTUs, and auto tires have more than 26.8 million BTUs. Bituminous coal, which is most commonly used for electricity production, has 25 million BTUs.

Recent huge increases in oil and natural gas prices are making the use of biomass more economically feasible. However, such products are really competing against coal in terms of economic viability. A strong prospect is that biomass can be used for electric generation, but in conjunction with coal as is done today in Denmark on a small scale.

There is also the possibility that other feedstock sources, such as forest residue, paper mill residues and urban wood waste, could be used along with crop residue and crops dedicated to fuel use.

Help for Ethanol and Biodiesel Production

Government legislation, programs and subsidies have helped expand the use of ethanol and biodiesel in the United States. U.S. ethanol use in 1990 was 900 million gallons. In 2004, ethanol production totaled 3.4 billion gallons; it is expected to increase to 5 billion gallons in 2006.

• New ethanol and biodiesel plants and existing plants expanding production are eligible for money from the Commodity Credit Corporation Bioenergy Program. This program pumps up to $150 million annually to plants that increase purchases of agricultural commodities from the previous year.

• The 1990 Clean Air Act established standards for vehicles such that ethanol became a viable alternative to reduce carbon monoxide emissions. The Reformulated Gasoline Program, begun in 1995, required cleaner-burning fuel in areas with the worst pollution. Many other cities voluntarily adopted this program.

• Ethanol has enjoyed an exemption from the Federal Excise Tax since the late 1970s. That exemption, now 51-cents-per-gallon of ethanol, continues through 2010. Some states, such as Minnesota, require biodiesel to comprise 2% of the state's diesel fuel and 10% of the state's gasoline must be ethanol.

• The American Jobs Creation Act of 2004 included a new tax credit for biodiesel of $1 per gallon for biodiesel made from virgin oils and 50-cents-per-gallon for biodiesel made from nonvirgin oil, such as yellow grease.