

BIO FUELS TECHNOLOGIES I
OVERVIEW OF WASTE-BASED SYSTEMS AND CROP AND FOREST
PRODUCTS-BASED SYSTEMS

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Introduction

Energy produced from biologically-based sources - including agricultural crops, crop residues, wood, and waste products - can be used to meet the Alternative Energy Portfolio Standard Tier I requirements. The two panels on Bio-Fuels Technologies will focus on the challenges and opportunities for significant energy being produced from the biomass resources in the United States and throughout the world.

Utilizing biomass as one of the solutions to our energy challenges is triggered, in large part, by the increasing prices for our traditional fossil fuels. Further, we are concerned that we may be exhausting our fossil fuels in the near-term future and we need to explore other sources to meet the energy appetites of the United States and other countries throughout the world.

Numerous major events since 2000 have impacted the energy situations that we are facing today, including:

- California energy crisis
- September 11
- fraud and collapse of Enron
- faltering U. S. economy
- congressional delay in passing meaningful energy policies
- war in Iraq
- record low storage volumes of natural gas and fuel oil
- improving U.S. economy creating more demand of energy
- blackout in Northeast in August 2003
- dramatic increases in energy use by China and India
- oil price exceeding \$70 per barrel
- threats from Iran
- Hurricanes Katrina and Rita.

These and other events have spurred us to more fully consider numerous alternative energy sources than before. These sources include solar, wind, geothermal, low-head hydropower, and biomass. Rosemary McAvoy, representing the Alternative Fuels Renewable Energies Council, will address the problems and opportunities faced by those trying to develop alternative fuels, dealing with such issues as siting facilities, environmental aspects, consumer education and advocacy.

Biomass

Biomass is defined briefly as organic matter of recent biological origin that can be converted to produce energy. Typical forms of biomass are agricultural crops, crop residues, and forest products. Actually, fossil fuels were created from organic matter that existed many millions of years ago; however, fossil fuels are

not considered biomass because they are not of recent biological origin. Generally, agricultural crops and crop residues are renewed on an annual or biennial basis. Forest products and forest residues are also considered biomass with a renewal on an every 30-40 year basis. Intermediate crops such as switch grass and small-diameter woody species are renewed somewhere between an annual basis and the 30-40 years for the traditional forest products. Methane captured from landfills and anaerobic digestion processes of animal manures is also considered a form of biomass.

Biomass energy or bioenergy is considered to be a sustainable form of energy because the natural resource materials renew themselves at a frequent rate so that the ability of future generations to utilize bioenergy is not impacted. Biomass is really concentrated solar energy or “green sunshine” because it is based on the solar-powered photosynthesis process during the growth and development phases of the plant materials.

Crop residues are often referred to as waste materials, and indeed, these materials can be utilized to produce energy sources now and in the future. However, it is erroneous to think of crop residues as being wastes. Crop residues that remain in fields serve very useful purposes including:

- Reduce soil erosion
- Increase organic matter
- Increase moisture holding capacity of the soil
- Reduce soil compaction
- Reduce need for pesticides and fertilizer
- Provide food and sanctuary for wildlife

Another misperception is that crop residues are free. There are significant expenses associated with using crop residues; these expenses include harvesting, packaging, transportation, storage, further processing, and handling.

Most biomass energy resources can be characterized as solid materials with low bulk density, high moisture content, low heat energy content, high oxygen content, high ash content, highly variable property values, and often difficult to handle compared to the traditional fossil fuels. Because of the low bulk density characteristic of most solid biomass, capacity limitations for transportation and storage are often dictated by volume rather than weight. These disadvantages are balanced by the fact that these resources are renewable, sustainable, often low cost, readily available, and less damaging to the environment when utilized.

Role of Agriculture

The agricultural industry in the United States and throughout the world has a tremendous role and responsibility in the development of biomass resources that can be processed into energy supplies. Normally we think of agriculture as

providing the food and fiber for the six billion people of this world. The production and processing of food and fiber for the ever-increasing global population remains the most important role and responsibility of agriculture. In addition, agricultural resources are used to produce chemical feedstocks for processing, production of pharmaceuticals, and production of fuel. Using agricultural resources to produce fuel has the added benefit of simultaneously improving environmental conditions.

Some may be concerned that diverting agricultural resources away from the production and processing of food will result in additional malnutrition and starvation problems throughout the world. It is recognized that malnutrition and starvation impact 800 million people each day (about 15% of the global population). This serious problem is not created by a shortage of food supply! Malnutrition and hunger are clearly traced to problems associated with inadequate distribution and storage systems and, in some cases, the absence of political wills and desires to feed the people.

Utilizing Biomass Energy

When we speak of using biomass resources as fuel, the four methods in which the fuel is generally utilized are:

- Direct combustion
- Production of fuel from crop seeds
- Cellulosic conversion of crop residues to produce fuel
- Methane production from animal manures

The simplest method of utilizing crops and crop residues to produce energy is through direct combustion. Successful systems are already in place for burning shelled corn in specially designed stoves, boilers, and furnaces. The production of these corn-burning units has tripled in just the past two years, and it is anticipated that in certain site-specific areas, this practice will continue to increase. Other direct combustion systems are based on burning crop residues such as corn stover, corn cobs, wood pellets, wood chips, and other forest-based resources. There are several pilot projects of growing low-diameter wood species to be harvested every third year after establishment for direct combustion for heat and/or the production of electricity.

The practice of utilizing field crops such as soybeans and corn to produce biodiesel and ethanol, respectively, is moving forward very quickly. Earlier this month, Governor Rendell announced that the first of 11 commercial biodiesel production facilities was now open for business in Pennsylvania. This first production plant will produce biodiesel fuel from virgin soybean oil with an anticipated capacity of two to three million gallons per year at this one facility. The facility will also be capable of producing biodiesel from used vegetable oils and grease from restaurants. There is continuing interest in using corn to produce

ethanol to displace the use of MTBE as an oxygenate in gasoline. At the present time, there are no ethanol plants in Pennsylvania but one or several are on the drawing boards at this time.

Cellulosic conversion of plant residues into ethanol and other fuel sources is still pretty much at the laboratory stage but within the next 5 - 10 years, there should be significant commercial production of ethanol and other fuels through cellulosic conversions of the crop residues.

The use of animal manures as an energy source has long been of interest. Anaerobic digestion systems to transform the animal manures to methane have been developed many years ago; however, recent advances have made the process easier to manage and more feasible on an economic basis. The methane that is produced can be utilized for: 1) direct combustion for heating and steam requirements at the site, and 2) generation of electricity to be used on-site or sold into the grid system. The expenses associated with generating electricity from methane are indeed significant, and other significant expenses are associated with tying into the grid system and maintaining system integrity. Utilization of the methane resource on-site is always advantageous and encouraged.

Mr. Dennis Roberts, representing C3F&E – Maine, Inc., will be describing systems that are being developed today for the efficient utilization of animal manures for production of methane. Mr. Roberts will be discussing how methane production along with other cash energy crops becomes part of an Integrated Rural Energy Model.

Benefits of Biomass Energy

Benefits of producing biodiesel and ethanol from agricultural grain crops include:

- Reduce dependency on imported petroleum
- Improve the environment and public health
- Increase our domestic rural economy
- Increase lubricity for engines with biodiesel
- Replace MTBE as an oxygenate in gasoline with ethanol
- Promote homeland security
- Increase energy sustainability

NREL (National Renewable Energy Laboratories) states that when biodiesel is substituted for petroleum diesel, there is a dramatic reduction by 78% in greenhouse gas emissions. The environmental impacts of biodiesel result in large reductions in carbon dioxide, the sulphur oxides, particulates, and odor, although there is a slight increase in the nitrogen oxides. Furthermore, as the soybeans (most common crop in U. S. for making biodiesel) are growing in the field each day, carbon dioxide is being sequestered out of the environment by the photosynthesis process into the soybean plants and oxygen is being released into

the environment. So, during the growth and development phases, the soybean plants are really scrubbing the environment for us.

Glen Cauffman, Manager of Penn State Farm Operations and Facilities, will be sharing with us his experiences of switching the fleet of farm tractors, harvesters, and trucks from diesel fuel to a biodiesel blend several years ago. In addition, he will describe the program of converting the hydraulic fluid from the traditional fluid to bio-based hydraulic fluids in all of the equipment used on 1,500 acres comprising one portion of Penn State's farming operations.

Technological breakthroughs in the future will enable us to more feasibly process crop residues and waste products from urban, suburban, and rural areas directly into ethanol and other fuel sources. Biomass energy will never become the only energy resource that our society relies upon, but biomass energy will become a very significant part of our energy portfolio.

Summary

It is extremely important to point out that while all of us are interested in producing energy from various alternative sources, we must recognize that the energy that is:

- most affordable
- friendliest to the environment
- supportive of the domestic rural economy
- totally sustainable

is the energy that *is not used* because of an effective energy efficiency program. While we can save a few percent here and a few percent there with various energy alternatives, we can easily save 30 to 35% through effective energy efficiency programs without sacrificing the comforts and conveniences that we have grown accustomed to over the years.

References

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