AGRICULTURE AND BIOMASS ENERGY

INTRODUCTION

Many farmers already produce biomass energy by growing maize to make ethanol. But biomass energy comes in many forms. Virtually all plants and organic wastes can be used to produce heat, power, or fuel. Biomass energy has the potential to supply a significant portion of America's energy needs, while revitalising rural economies, increasing energy independence, and reducing pollution. Farmers would gain a valuable new outlet for their products. Rural communities could become entirely self-sufficient when it comes to energy, using locally grown crops and residues to fuel cars and tractors and to heat and power homes and buildings.

Key words: Biomass energy, biogas, energy crops, biofuels, digester.

REZIME

Večina farmarja več koristi energijo iz biomase uzgojem kukuruza in preradom u etanol. Meščani biomasa je dostopna u različitim oblicam. Praktično sve biljke i organski otpad može se iskoristiti za proizvodnju toplote, snage i goriva. Energija iz biomase ima potencial za značajnim učescem u Američkim potrebama za energijom, s obzirom na revitalizaciju seoske ekonomije, rast energetske nezavisnosti i smanjenje zagađenja. Farmeri bi imali nov izvor prihoda od svojih proizvoda. Seoska udruženja mogu postati potpuno nezavisni, koristeći lokalne useve i organske ostatke za proizvodnju goriva za automobile i traktore i za zagrevanje domova i objekata.

Ključne reči: Energija iz biomase, biogas, energetski usevi, biogorivo, digestor.

Agricultural activities generate large amounts of biomass residues. While most crop residues are left in the field to reduce erosion and recyle nutrients back into the soil, some could be used to produce energy without harming the soil. Other wastes such as whey from cheese production and manure from livestock operations can also be profitably used to produce energy while reducing disposal costs and pollution.

– Energy Crops

Crops grown for energy could be produced in large quantities, just as food crops are. While maize is currently the most widely used energy crop, native trees and grasses are likely to become the most popular in the future. These perennial crops require less maintenance and a fewer inputs than do annual row crops, so they are cheaper and more sustainable to produce.

– Grasses

Switchgrass appears to be the most promising herbaceous energy crop. It is a high yielding crop and can be harvested annually for several years before replanting. Other native varieties that grow quickly, such as big bluestem, reed canary grass, and wheat grass, could also be profitable.

– Trees

Some fast-growing trees make excellent energy crops, since they grow back repeatedly after being cut off close to the ground. These short-rotation woody crops can grow up to 40 feet (40 x 30.48 cm = 1,219.0 cm = over 12 m) in less than eight years and can be harvested for 10 to 20 years before replanting. In cool, wet regions, poplar and willow are excellent choices, while in warmer areas, sycamore, sweetgum, and cottonwood are best.

– Oil plants

Oil from plants such as soybeans and sunflowers can be used to make fuel. Like maize, however, these plants require a more intensive management than other energy crops.

– Protecting the Land

With considerate practice and management, perennial energy crops can improve the soil quality of land that has been overused for annual row crops. The deep roots of energy crops enhance the structure of the soil and increase its organic content. Since tilling occurs infrequently, the soil suffers little physical damage from machinery. One study estimates that converting a maize farm of an average size to switchgrass farm could save 66 truck-loads of soil from erosion each year.

Perennial energy crops need considerably less fertilisers, pesticides, herbicides and fungicides than annual row crops. A reduced chemical use helps protect ground and surface water from poisons and excessive aquatic plant growth. Furthermore, deep-rooted energy crops can serve as filters to protect waterways from chemical runoff from other fields and prevent sedimentation caused by erosion.

Finally, perennial energy crops can create more diverse habitats than annual row crops, attracting a wider variety of species such as birds, pollinators, and other beneficial insects, and supporting larger populations. Furthermore, the long harvest win-

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Converting Biomass to Energy

The majority of biomass is converted to energy the same way it always has been - being burnt. The heat can be used directly for heating buildings, crop drying, dairy operations, and industrial processes. It can also be used to produce steam and generate electricity. For example, many electric generators and businesses burn biomass by itself or with other fuels in conventional power plants.

Biomass can also be converted into liquids or gases to produce electricity or transportation fuels. Ethanol is typically produced through fermentation and distillation, in a process much like that used to make beer. Soybean and canola oils can be chemically converted into a liquid fuel called biodiesel. These fuels can be used in conventional engines with a little, if any, modification.

Biomass can be converted into a gas by heating it under pressure and without oxygen in a "gasifier." Manure too can be converted using a digester. The gas can then be burnt to produce heat, steam, or electricity.

Other biogas applications are still in development, but show great potential. One promising technology is direct combustion in an advanced gas turbine to run a generator and produce electricity. This process is twice as efficient as simply burning raw biomass to produce electricity from steam. Researchers are also developing small, high-speed generators to run on biogas. These "microturbines" have no more than three moving parts and generate as little as 30 kilowatts, which could power a medium-sized farm. Several companies are also considering converting gasified biomass into ethanol as a less expensive alternative to fermentation.

Alternatively, biogas can be processed into hydrogen or methanol, which can then be chemically converted to electricity in a highly efficient fuel cell. Fuel cells can be large enough to power an entire farm or small enough to power a car or tractor.

An innovative experiment in Missouri provides one example of the possibilities. Maize is used to produce ethanol, and dairy cows are fed on the waste from this process. Cow dung fertilises the maize and is also run through a digester to produce biogas. A fuel cell efficiently converts the biogas into electricity to run the operation. The end products are ethanol, electricity and milk. All the waste products are used within the project to lower costs.

Biomass Benefits

A primary goal of the Energy Policy is to increase our energy supplies using a more diverse mix of domestic resources and to reduce our dependence on imported oil. The Office of the Biomass Program's activities directly supports the overall mission and priorities of the Department of Energy, Office of Energy Efficiency and Renewable Energy, and Energy Policy by contributing to the creation of a new bioindustry. According to the US Department of Energy, in 2002, fossil fuels, which are finite and nonrenewable, supplied 86% of the energy consumed in the United States. Even more alarming is that the United States imports over half (62%) of its petroleum and its dependency is increasing. Since the U.S. economy is so closely tied with petroleum products and oil imports, small changes in oil prices or disruptions in oil supplies can have an enormous impact on our economy - from trade deficits, to industrial investments, to the employment levels. As a domestic, renewable energy source, biomass offers an alternative to conventional energy sources and provides energy security, economic growth, and environmental benefits.

Biomass Today

In 2003 (and then for four succeeding years) biomass was the leading source of renewable energy in the United States, providing 2.9 Quadrillion BTU [METRICK EKVI VALENT 1 quad = 1.055 x 10^18 Joule] of energy. Biomass was the source for 47% of all renewable energy or 4% of the total energy produced in the United States Agriculture and forestry residues, and in particular residues from paper mills, are the most common biomass resources used for generating electricity and industrial process heat and steam and for a variety of biobased products. These are the organic by-products of food, fibre and forest production. In fact, 48% or 1.1 Quad BTU of biomass energy was consumed by the pulp and paper industry, solely using black liquor. The use of liquid transportation fuels such as ethanol and biodiesel materials and power currently derived primarily from agricultural crops, is increasing dramatically. Biomass Program research therefore currently focuses on residue harvesting, collection, and transport and other aspects of the feedstock interface between agriculture and forestry and biomass industries. In the long term, a mature biorefinery industry should command growth of dedicated energy crops. In 2003 ethanol produced from maize reached 2.81 billion gallons.

Ethanol and biodiesel, the primary biofuels today, can be blended with or directly substitute for gasoline and diesel, respectively. Biomass includes all plant and plant-derived material. Particularly for the sugar platform, knowing the properties of the biomass feedstock is critical for understanding the biomass as a chemical and energy source. For the present and near future, easily processed agricultural crops and low- or negative-cost industrial residues will likely dominate biomass feedstocks. In the mid-term, agricultural and forestry residues should provide the large volume to enable the biomass industry to expand to make more substantial contributions to the production of fuels, chemicals, substitute for gasoline and diesel. The use of biofuels reduces toxic air emissions, greenhouse gas built-up, and dependence on imported oil, while supporting agriculture and rural economies. Unlike gasoline and diesel, biofuels contain oxygen. Adding biofuels to petroleum products causes the fuel to combust more completely and reduces air pollution. Also, when fossil fuels, such as petroleum, are burnt, they release carbon dioxide that was captured by plants billions of years ago. This release contributes to the buildup of greenhouse gases that may cause climatic changes. On the other hand, carbon dioxide release from burning biofuels is balanced by the carbon dioxide capture by the recent growth of the plant material they are made of.
from. Depending on how much fossil energy is used to grow and process the biomass feedstock, this results in substantially reduced net greenhouse gas emissions. Biobased products that provide equivalents or alternatives to those made from petroleum and natural gas also contribute to oil import and greenhouse gas reduction, while enhancing biorefinery economics.

Biomass Program researchers have done considerable research on fast-growing trees and grasses, but the U.S. Department of Agriculture is now taking on primary responsibility for additional research in this area. Understanding resource availability is critical for planning of both, feedstock production and the development of biomass industry, and Biomass Program analysts are at the centre of assessment efforts.

Biomass is a sustainable feedstock for energy products that could enrich the future of the United States and the world. The effort by the Biomass Program focuses on the feedstock supply of lignocellulosic biomass such as maize stover, straw, or wood, that can be converted into energy products (i.e. fuels, chemicals, and power) through sugar or thermochemical platforms. Biomass feedstocks in the U.S. primarily consist of forest, mill and agricultural residues, urban wood wastes, and dedicated energy crops. Industrial residues such as black liquor from wood pulp ing, and animal manures can also be considered as biomass resources. The biomass potentially available depends on many considerations including, ease of collection and removal, transportation, sustainability or effects of removal, and desired characteristics.

**Available Resources**

Biomass Program analysts estimate that 512 million dry tons of biomass equivalent to 8.09 quads of primary energy could initially be available at less than $50/dry ton delivered (Walsh et al. 2000, 2003; Ugarte et al. 2003). Of this, 36.8 million dry tons (0.63 Quads) of urban wood wastes were available in 1999. In the wood, paper, and forestry industrial sectors, they estimate that 90.5 million dry tons (1.5 Quads) of primary mill residues were available in 1999 and 45 million dry tons (0.76 Quads) of forest residues were available at a delivered price of less than $50/dry ton. An estimated 150.7 million dry tons (2.3 Quads) of agricultural residues (maize stover and wheat straw) would be available annually. A joint U.S. Department of Agriculture and Department of Energy (Ugarte et al. 2003) estimated 188 million dry tons (2.9 Quads) of biomass could be available annually at delivered prices of less than $50/dry ton by the year 2008. A county-level database of potential energy crop resources is available at Oak Ridge National Laboratory and a county-level database of multiple resources will be available soon. State-level information can also be obtained at the EERE website.

**Collection, Storage, and Transportation**

The ability to cost-effectively collect, store, and transport biomass feedstocks presents many challenges. A biobased industry will require a safe and sustainable supply system. Research and Development in this area is designed to overcome the engineering systems barriers of collection, delivery and storage of agricultural residues.

**LITERATURE**

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