GRASS BIOMASS

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Overview

One of the most exciting renewable energy potentials emerging for farm development is grass and other herbaceous bioenergy crops such as corn (see "Corn Biomass" chapter).

The most common use for dedicated grass energy crops will be as a pelletized fuel for burning in light industrial appliances and pellet furnaces. However, grass can be converted to energy in several ways, as market conditions demand:

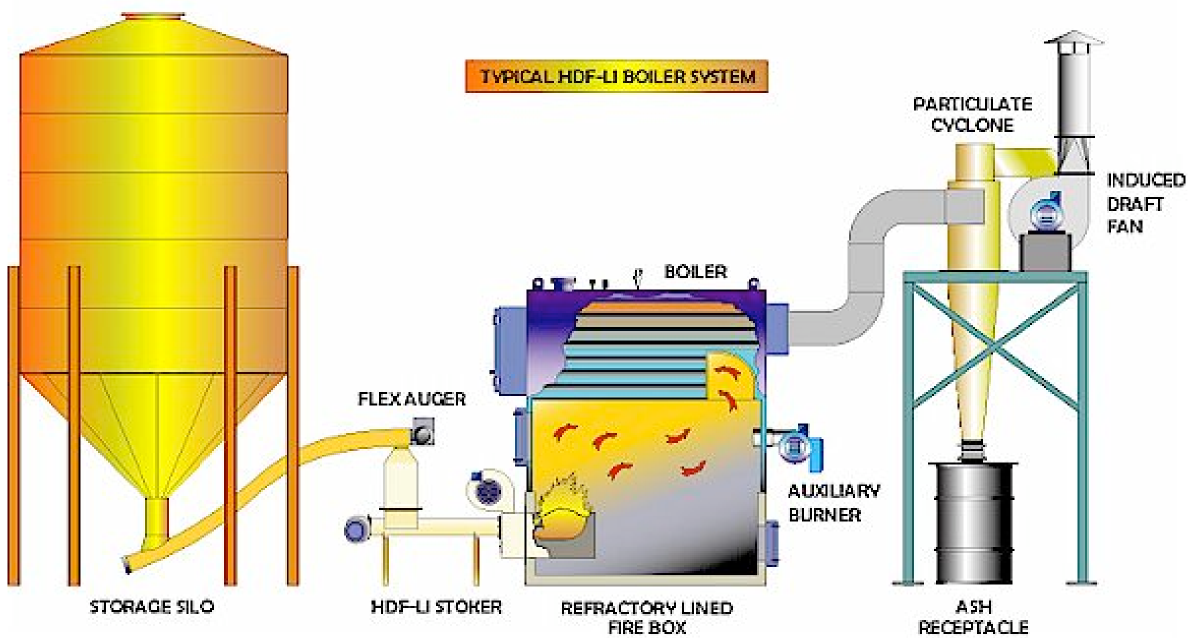
- pelletized and combusted to produce for heat on a commercial scale
- pelletized and combusted to produce electricity or combined heat/power
- biodigested to produce methane gas, electricity, or liquid methanol
- processed to create ethanol (see "Cellulosic Ethanol" chapter).

With waste wood products, such as sawdust, experiencing increasing demand, supplies are currently tight. Grass is an energy feedstock that can potentially be produced in reliable quantities with greater price stability. It's a relatively easy, inexpensive, and low-risk perennial crop, and for energy use can be readily combined with other biomass materials like corn or waste paper. While it can grow on marginal soils, to make any meaningful yield and profit it should be grown on first-quality lands.

Reed canary grass

Since most varieties can be planted, harvested, and stored using implements that farmers usually have on hand, it requires minimal investment in new equipment. Grass crops could offer farmers an opportunity to diversify revenue sources while helping to protect the natural environment: Each new crop absorbs as much carbon from the atmosphere as the burning of the last crop produced, making its use as a fuel virtually carbon neutral.

Consideration of grass as an alternative fuel is relatively recent in the U.S., so more research needs to be done to determine yields, energy gain, and cash value. Pelletization is required to burn it at meaningful volumes, and this processing is not yet readily available. Nor is there a marketing system in place for sale to end users. However, development of peletized biomass fuels and technologies is accelerating, and grass has the potential to play a major role in the biomass energy market.



The boiler system above is an example of a 500K Btu system with stoker and ash collection units that allow it to handle a wide range of biomass fuels, including grass. Graphic courtesy of Solagen, Inc.

Crop grass varieties

Most research on grass as a dedicated energy crop has focused on reed canary grass, switchgrass, and giant miscanthus. As perennials, all three require less energy and financial investment – once established -- than annual row crops.

Reed canary grass is a cool-season perennial native to North America. According to Prof. Jerry Cherney of Cornell University, it's extremely tolerant of both drought and wet conditions. In 2005, his research team planted 80 reed canary grass collections in five locations to test yields. Working cooperatively with grass breeders in Iowa and Wisconsin, they hope to generate a strain with superior energy yields and adaptability to all agricultural soils.

Switchgrass has been well studied as an energy crop, and a number of pilot programs are underway. It's a warm-season perennial native to the Great Plains and Eastern U.S., and has been shown to adapt easily to marginal soils with minimal fertility and management requirements. New research at the University of California shows that, in addition to its use as a fuel for combustion, switchgrass works well for ethanol production, with many advantages over corn.

Giant miscanthus is now being grown commercially in Europe for combustion in local area power stations. It's tall – 12 to 14 feet -- and studies at the University of Illinois show yields of as much as 15 tons per acre, profitable at current energy prices if grown for four or more years. Test fields at Cornell University (New

York state) suggest that it can grow in a climate comparable to Vermont's, but further trials are needed to determine climate viability.

Richard Webster adjacent to one year's growth of stems in a 3-year old Miscanthus x giganteus stand on the University of Illinois South Farms, Urbana, IL. In Central and Southern Illinois, our typical annual yields for stands of 3 years and older are around 17 t/acre (highest 26 t/acre) of dry matter. Note: We dry a sub-sample of the actual harvest to constant weight at 80 C so that we can express the harvested yield as dry weight. Credit: Emily Heaton and Steve Long, University of Illinois.

Grass energy potential

Grass captures more Btus in less time than any other energy crop, with energy yields as high as 14 to 1 (14 energy units produced per unit of energy invested), compared to biodiesel at about 3.4 to 1, ethanol at 1.34 to 1, and fossil oil at .85 to 1 (a net energy loss). The energy content of grass pellets is 88% to 95% that of wood pellets, but grass may produce a higher net energy gain.

Heat: For direct combustion heating, one ton of grass pellets produces about fourteen million Btus, equivalent to about 100 gallons of #2 heating oil. As a point of reference, the average house requires about 138 million Btus per year – equivalent to about 10 tons of grass pellets.

Ethanol: Studies at Auburn University show that switchgrass produces 100 gallons of ethanol per ton, with a net energy gain per acre equivalent to about 11 barrels of oil -- about seven times that of corn.

Electricity: Like any biomass heat source, grass can also be used to generate electricity, and modular biopower systems are now in the final stages of development for commercial sale by several companies. Two pounds of pellets typically produce about 1kWh of electricity and 2kWh of thermal energy. Like any other system, these generators attain maximum efficiency in CHP applications, where residual heat is recaptured and put to use.

Economics

While grass is a low-maintenance crop once established, it does require effort and a cash investment to start a crop. Revitalizing long-dormant fields to establish plantings typically requires two or three years. According to the University of Illinois study, establishing a high-yielding miscanthus crop costs about $640 per acre for the first two years.

Production costs for establish energy grass crops are about the same as feed-grade hay at $35 to $40 per ton. Farm gate prices paid for dedicated grass energy crops are expected to be in the $65 - $85 per ton range. Top quality feed hay, yielding about three tons per acre and selling for between $200 and $430 per ton, will earn between $600 and $1290 per acre. At $300 per acre, pellet grass does not yet compete with even the bottom range of high quality feed hay.

However, at present prices, grass appears to have more profit potential than other energy crops. For example, using best lands, soybeans will yield 50 bushels per acre with a price of $6 per bushel, a gross income of $300 per acre, minus $200 per acre cost, for a net to you of $100 per acre. By comparison, the same acreage will produce five tons of grass. Sold to a pelletizing plant at $60 per ton, the gross would also be $300, but the growing cost is a lot less, leaving a higher net. And demand for pellet fuel is growing at more than 15% yearly, with more than 500,000 tons used in the Northeast in 2006. Most of the wood pellet supply is brought from Canada, adding to its cost and exporting money that would be better retained locally. The value of Vermont-produced biomass is expected to rise, and new higher-yielding grass strains promise greater profits.

Grass crops in Vermont

Recent interest in grass has led to several test projects, including a test burn at Shelburne Farms in 2006. In 2006, working with the Grass Energy Collaborative, Vermont Technical College began exploring the possibility of planting grass and installing a grass-fueled boiler at its Randolph campus. Pelletized biomass heating systems will be installed in several Vermont schools this fall, and Biomass Commodities Corporation expects to produce over 100 tons of mixed biomass pellet fuel from Vermont feedstock sources for the 2006 heating season.

The biggest obstacle to profitable grass farming in Vermont today is the lack of centralized processing. The best economics are achieved in plants with production capacities on the order of 100,000 tons per year and construction costs in the millions of dollars. In the future, new technologies are likely to make smaller systems more feasible, but these are not yet available at a scale appropriate for a typical Vermont farm.

While there are hundreds of thousands of tillable land in Vermont – potentially enough to supply many processing and generation facilities -- most farmers have limited open land. And though grass grows on marginal soils, allowing unused acres to produce some cash, truly profitable yields are only gained from the best soils. You should carefully consider the value of grass if it requires a trade-off with other crops.

Though the time is not quite here for profitable farm production of dedicated grass energy crops, we recommend you follow news about grass strain development, processing and generating technology, and regional construction of processing facilities.

Questions to consider

1. How much unused or underused open land do I have?

2. Where is the nearest pelletizing facility? Is it cost effective to transport baled grass to the facility?

3. With my acreage, how many tons can I grow? At that volume, what is the sale price point at which I would make a reasonable profit? As energy prices rise, what's the best point for me to enter the grass market?

4. Are there other, more profitable uses for the land I would put grass on? Is grass competitive with, for example, high quality hay?

Resources

1. Grass Energy Collaborative
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• GEC is a good clearinghouse for information on grass energy crops. A copy of GEC's 42-page working paper is available on request or for download at www.jockgill.com .

2. U.S. Department of Energy
Oak Ridge National Laboratory
Biofuels Feedstock Development Program
www.ornl.gov (go to "search" field and type "switchgrass," "biomass," etc.

• A good source of current information on federal research programs into grass energy and lists of contacts and resources.

3. Resource Efficient Agricultural Production (REAP)
www.reap-canada.com

• Up-to-date information on biomass energy, pellet fuels, new technologies for energy conversion, and grass research.

4. Cornell University
College of Agriculture and Life Sciences
www.grassbioenergy.org

• Recent research results, answers to frequently asked questions, and an extensive list of additional resources.