

Arizona  
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Wyoming

# Western BIOMASS Quarterly

NOVEMBER 1998

Clean energy from America's renewable biomass resources, including forest residue, wood and wood waste, food waste, agricultural crops and waste, animal waste, livestock operations residue, aquatic plants and municipal waste

This publication and others from Western are now available on Line. See page 8 for details.

## Wheat Straw — the Petrochemical Additive of the New Millennium?

Could wheat straw replace some of the petrochemicals and fillers used in the production of plastics? According to researchers at the federal Department of Agriculture's Forest Products Laboratory in Madison, Wisconsin, and Pinnacle Technology in Lawrence, Kansas, the answer is a definite yes.

After several years of research, Donna Johnson, a biochemical engineer and head of Pinnacle working with Forest Products Laboratory, has perfected a method of combining processed wheat straw — in essence, crop waste — with either polypropylene or polyethylene in the making of a variety of plastic products including

downspout splash guards, boat seat mounts, interior automotive panels, garbage pails, tool

### Wheat Straw Basics

In 1998, there were 63.6 million acres of harvested wheat in the United States. If 1/2 ton of wheat straw per acre was harvested, 31.5 million tons could be available for use as filler by the plastics industry and others such as ethanol producers (see related article on page 2).

The authors of the study estimated a ton of wheat straw could be sold for \$40-\$60 per ton, delivered to the plant.

At the time of the survey, the plastics industry in the two-state region — Missouri and Kansas — used 3.5 million tons of filler every year. If wheat straw was used to replace the filler, farmers could reap an extra \$140-\$210 million from the sale of straw that is normally left in the fields.

handles, flower pots and more. Agro-Plastic is what she's calling the straw-filled plastic.

As most Americans can attest, few products are plastic-free because of cost-performance advantages over competitive materials. The three largest markets for plastics are packaging, building and construction materials. Plastics are also used in electronics, motor vehicles, furniture, toys, leisure goods, housewares and medical products.

In 1994, world plastic production was 110 million metric tons and is expected to rise to 135 million metric tons by 2000.

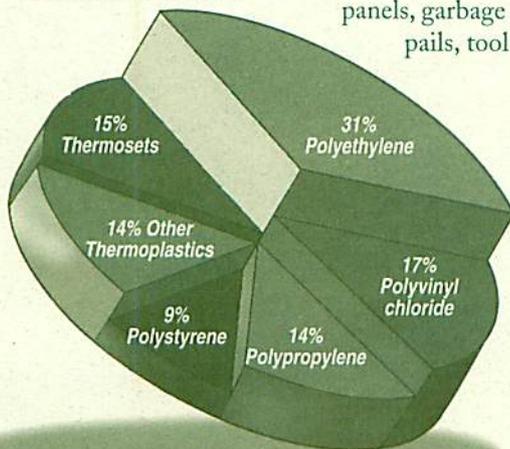
Plastics are generally divided into five major types. Nearly one of

every three pounds of plastic produced is polyethylene. The pie chart at left shows the breakdown of plastics production in 1994.

### Plastic Plus

Few plastic products use just plastic. Fillers such as calcium carbonate, mica and talc are commonly used to reduce costs, while increasing hardness, stiffness and impact strength of the end product. "Fillers such as fibrous

World Plastics Production 1994



Continued from page 1

materials have been used in the plastics industry for more than 90 years," Johnson said. "In 1907, the industry used wood flour, today they use glass and other fillers. In 1993, the total weight of fillers used in plastic production was 7.7 billion pounds. Just replacing a very small percentage of the fillers with wheat straw presents an exciting opportunity." One-third to one-half of the product can be filler according to Johnson.

Johnson and the staff at Pinnacle have spent years perfecting ways to incorporate wheat straw into the production of consumer goods using machinery commonly used by the industry. The process used to make the wheat-straw-blended plastic involves a multi-step process which removes water vapor. At the end of the production line, pellets of straw and plastic pile-up.

## Pros Beat Cons

The advantages of straw over other fillers augur well for the success of the new product. Less material is needed to make each item when straw filler is used. Pinnacle's tests of Agro-Plastic indicated that up to 20 percent more products could be produced by adding wheat straw as a filler component. Because less material is used, each item weighs less, which reduces shipping costs. From a manufacturing standpoint, there is reduced wear and tear on product molds with wheat straw filler.

Other aspects of using wheat straw as filler also can positively affect the

manufacturing process. According to Johnson, manufacturing temperatures can be reduced. "A lot of injection molded plastic production requires temperatures in excess of 400 degrees," Johnson said. "With Agro-Plastics those temperatures can drop to below 400 degrees, cutting manufacturing energy costs."

Johnson said test runs indicated products could be manufactured quicker. "In our tests, we were able to produce some products between 10 to 25 percent faster," Johnson said. One manufacturer participating in the test actually doubled production in the same time period when Agro-Plastic was used.

## Price Competitive

To be successful, any competing resource alternative must be cost competitive with existing resources. In the research conducted by Pinnacle, the firm found that a 55 cents per pound price for Agro-Plastic with between 30 and 50

## An Infinite Array of Consumer Products from Wheat Straw

Pinnacle Technology has crafted a variety of consumer product prototypes with the wheat straw petrochemical pellets including business card holders, brushes, bird feeders, downspout splash guards and the ultimate American consumer good — a one-piece stadium chair with a cooler base — every fisherman's dream chair.



One-piece stadium seat with a cooler base.



Downspout splash guard

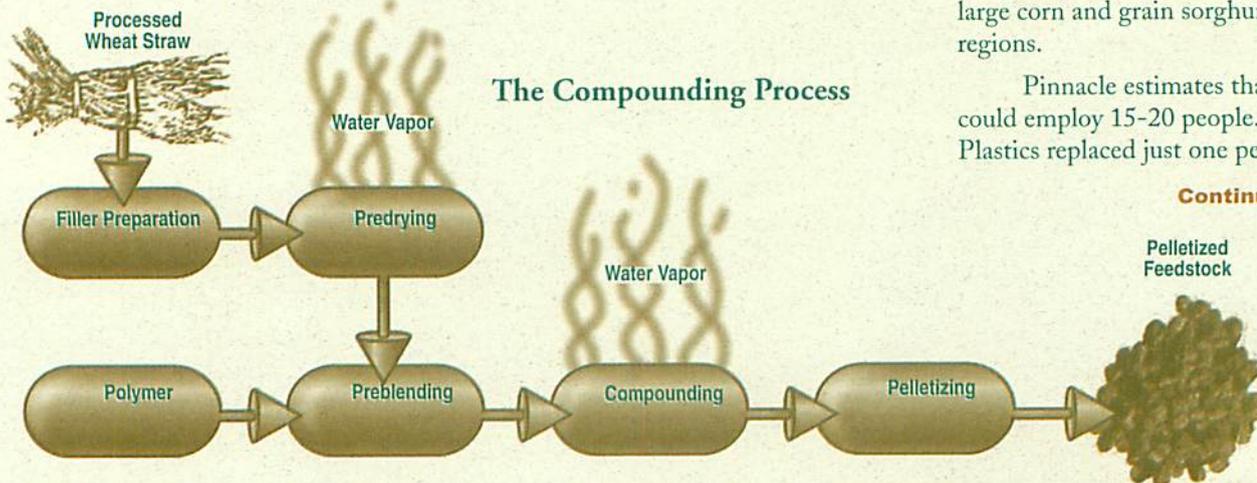
percent wheat straw composition would be cost comparable or less than the fillers currently used by plastics manufacturers in Kansas and Missouri.

## Rural Manufacturing Opp

If Agro-Plastic plants are located near the wheat fields in rural America, they could have a very beneficial impact on the economies of towns and villages as well as the farmers who sell the wheat straw to the plant. In many cases, the impacts would be similar to ethanol plants that are usually located in rural areas near large corn and grain sorghum production regions.

Pinnacle estimates that each plant could employ 15-20 people. If Agro-Plastics replaced just one percent of the

Continued on page 3



Continued from page 2

North American polypropylene market, 12 plants would be needed. If the technology were expanded to the polyethylene market, an additional 24 plants would be needed to supply just one percent of that segment of the plastics industry. Capturing only a very small part of the plastics market could lead to 36 plants totaling 540 to 720 employees.

Funding for the wheat straw research came from Western and the following state and federal sources:

- the Kansas Value Added Center,
- the U.S. Department of Agriculture's Phase I and II Small Business Innovation Research,
- the Kansas Department

of Commerce and Housing and;

- the Kansas Technology Enterprise Corporation.

An estimated \$385,000 has been invested by these five sources to make wheat straw a petrochemical and filler replacement a reality. Western's contribution to the research project funded a market assessment in 1996.

More information about wheat straw-based plastic can be found at Pinnacle's web site at [www.pinnacle.com](http://www.pinnacle.com) and in the "Agro-Plastic Market Analysis Final Report" at Western's web site, [www.westbioenergy.org](http://www.westbioenergy.org) or by calling Pinnacle at 785-832-8866. 🌿

## There's More in Straw than Just Plastics

In several months, Arkenol will break ground on an eight million gallon a year ethanol facility near Sacramento, California. But, instead of using grains, Arkenol will use more than 120,000 dry tons of rice straw as a feedstock. Arkenol hopes to have the facility operational by April 2000.

The plant will be located in a major rice-growing region of California where up until now vast quantities of rice straw were burned, resulting in air pollution. Now, however, new pollution regulations will eliminate burning as an option, posing problems for farmers.

Arkenol will be using a proprietary concentrated acid-hydrolysis process to convert the straw to ethanol and other byproducts such as citric acid and zeolites which are a type of silicates. Hydrolysis will break down cellulose in the rice straw into various components which then can be further processed.

Arkenol also converts other types of biomass — wood, waste paper, sugar cane wastes and crop residues — into more useful products at several other plants in the United States, Europe and South America.

For more information about Arkenol or the process it uses to convert cellulose such as rice straw, contact **Michael Fatigaiti**, director of project development for Arkenol, at 949-582-7430 or fax 949-588-3927.



## Arizona Waste-to-Ethanol Project Garners \$62,183



A project to assess and develop refuse-to-ethanol plants in Arizona was selected by Western to receive more than \$62,000. The project was one of several alternates for the 19 grant winners selected in April by Western.

The project is a partnership between the Civil and Environmental Engineering Department at Arizona State University and Genahol-Arizona, a firm with ten years of waste-to-ethanol experience. The partnership is expected to provide \$31,370 in matching funds for the project.

Specifically, the ethanol plant project will focus on:

- the market for recycled products from the proposed plants,
- the suitability of municipal solid waste for ethanol feedstock,
- potential locations for waste to ethanol plants,
- an analysis of waste to ethanol plant economics, and
- an evaluation of methane and carbon dioxide by-products.

For more information about the Arizona alcohol plant project, contact **Lori Gabriel** at the Office of Research and Creative Activities, Arizona State University, phone 602-727-6527 or email [lori.gabriel@asu.edu](mailto:lori.gabriel@asu.edu)

The funds for the Arizona project became available when Cyclus EnviroSystems was unable to obtain matching funds for a biochemical conversion system for the Orange County Sanitation District near Fountain Valley, California. 🌿

## Electric BioPower Marketing Opportunity

A number of public and private partners are seeking innovative utilities, power marketers or energy service providers interested in developing markets for electricity generated from renewable biomass sources produced in and around the Lake Tahoe Basin. Interested parties should have experience with green power marketing and contractual mechanisms.

The project partners are looking for an additional partner or partners willing to purchase and market green power from Lake Tahoe Basin biomass.

For more information, contact **Scott Haase** at NEOS Corporation, phone 303-980-1969, fax 202-8\980-1030, or email [shaase@neosdenver.com](mailto:shaase@neosdenver.com) 🌿



## University of California at Davis Department Extolled for Bioenergy Work

The Western Regional Biomass Energy Program recently honored a project spearheaded by Bryan Jenkins at the University of California at Davis' Department of Biological and Agricultural Engineering.

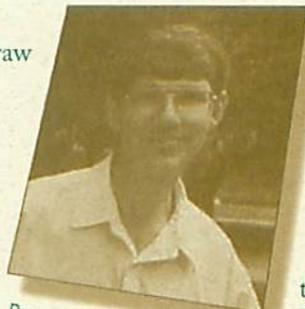
The project explored ways to use cheaper agricultural resources as fuel in biomass power plants. Currently, biomass to electricity plants in California spend nearly half of their operating expenses for wood fuel. If restructuring of the power industry lowers electricity costs, presently operating biomass power plants could become uneconomical and be forced to close. The question from the University team was simple: can readily available, cheaper resources be used without damage to the power plants?

### Four Years and More

Since 1994, the research team has

successfully removed alkali from biomass resources such as rice straw and used the fuel with wood in boilers. At two different power plants, rain washed rice straw blends of 10 to 20 percent have been mixed with wood to fuel boilers. More than 140 tons of rice straw were used with no problems of slagging or ash deposits in the boilers. Particulate emissions remained unchanged as well. More tests are scheduled using the alkali reduction methods.

These demonstrations have proven that other, less expensive, alternatives are available for biomass fuel. Researchers have estimated that as much as one-quarter of California's biomass resources could now be utilized in existing electricity boilers



Bryan M. Jenkins

once the alkali is removed from the agricultural wastes.

The biomass-fueled boiler tests involved others besides individuals at the University, and included staff from the University of California Cooperative Extension, Sandia National Laboratory, the California Energy Commission, the National Renewable Energy Laboratory,

Wheeler Environmental Systems, Woodland Biomass Power and Wadham Energy.

For more information on the University project, contact Bryan Jenkins, Biological and Agricultural Engineering, University of California at Davis, phone 530-752-1422. 🌿

## 85 Percent Ethanol Workshops in Phoenix



In May, the Arizona Department of Agriculture and its partners held two workshops to familiarize greater

Phoenix transportation fleet managers with the alternate fuel possibilities of 85 percent ethanol and 15 percent gasoline fuel blends.

Topics at the half-day sessions ranged from the latest local air quality conditions to ethanol costs and supplies to applicable state and national laws such as the *Energy Policy Act* and the *Clean Air Act*.

The Arizona Department of Agriculture was joined in the effort by Arizona's Departments of Administration, Environmental Quality, Transportation and Commerce's Energy Office as well as the Clean Fuels Development Coalition, National Ethanol Vehicle Coalition and Ford Motor Company.

The Department received \$10,000 from the U.S. Department of Energy's Western Regional Biomass Energy Program to defer the \$30,000 cost of the workshops. 🌿

## \$64,000 Added To Three Projects

Since January, Western has provided partial funding totaling \$64,000 for three projects, including two conferences.

Historically, Western has co-sponsored numerous conferences each year. This year, because the increased number of projects seeking funding from Western, only two conferences received funds — the Second Annual Aviation Conference on Alternative Aviation Fuels in Waco, Texas in February and the 1998 South Dakota Future Fair in Rapid City in January. The conferences received \$10,000 and \$8,000, respectively.



## Electricity From Straw, Grass and Shells in Texas

The remaining \$46,000 was added to the \$50,000 already earmarked for Cratech in Tahoka, Texas. The Cratech project builds on earlier research of biomass to electricity power plants. Using straw, grass, nut shells, and cotton gin trash as fuel, this project will complete development and test a one megawatt unit in Tahoka. Power plants such as the Tahoka prototype could eliminate waste products at food processors and generate electricity that could be used by the facility. 🌿

# From Western's Printing Press

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In the ten years since the regional biomass program was created by Congress, a number of reports, studies, and project descriptions have been produced by Western or specific project contractors.

Unlike Ashleigh Brilliant who said, "My sources are unreliable, but their information is fascinating," Western can attest to the reliability of the authors, the reports and studies as well as the

information contained in those reports.

Western is pleased to offer free copies of the following publications to *Quarterly* readers. Simply enter the quantity of items you want and mail or fax the form (mail: P.O. Box 95085, Lincoln, NE 68509; fax: 402-471-3064; no phone orders please) to Western's administrative offices.

Since quantities of some items are limited, the early bird gets the worm, or in this case, the information.

In each box, enter the quantity of publications.

## Evaluation of Business Plan Development Software Packages for Biomass Entrepreneurs

January 1993. This evaluation by the NEOS Corporation summarizes ten computer software packages on the market that are designed to create a business plan and evaluates eight of the packages. A table summarizes basic features of each package. 18 pages.

## Feasibility of Corn Residue Collection in Kearney, Nebraska Area

September 1993. The report by the University of Nebraska-Lincoln's Industrial Agricultural Products Center refines a 1990 multi-state biomass assessment. The 1990 study identified a 70-mile area around Kearney, Nebraska, as one of the top areas capable of supplying sufficient quantities of biomass to fuel a cellulosic fermentation facility capable of producing ethanol. The study reviewed the type of crops grown, annual corn yield, variation in yields, percent of land in production, number of farms and ownership, tillage practices and current residue uses. 55 pages.

## Overview of the National Renewable Energy Laboratory's Biomass Power Program at a Workshop on Renewable Energy and Energy Storage Technologies

October 1993. This graphic overview the nation's biomass energy program by Catherine Gregoire first provides a summary of current

biomass electricity production by state and projections of future production. A portion of the presentation reviews the different technological methods of producing electricity from biomass. The last segment of the review profiles the government's efforts to increase electricity production from biomass resources. 20 pages.

## Fuel Usage and the Health of Navajo Women and Children: Development of Clean-Burning Biofuel as a Replacement for Wood and Coal

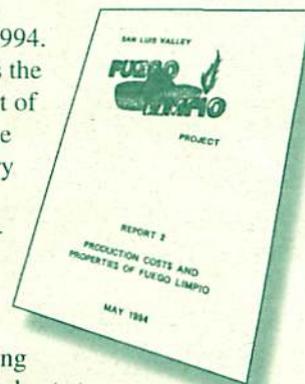
April 1995. This six month project by Schulz and Bragg examined ways to reduce the adverse health effects to older Navajo women and young children due to the reliance of polluting heat and cooking fuels. Secondary aspects of the study included assessing the feasibility of growing rootfuel to replace the dwindling supplies of wood and coal and making modifications to the heating and cooking systems. 47 pages.

## San Luis Valley Fuego Limpio: Report 1, Potential Demand for Fuego Limpio

June 1993. This is the first report of a two-phase study by Gary Beers of Environmental Property Assessments that evaluates using compressed wheat straw, called Fuego Limpio, as heating and cooking fuel. This report focuses on the results from a five-month trial by 23 participant families in south central Colorado. The study also estimates potential demand for compressed the wheat straw briquettes. 30 pages.

## San Luis Valley Fuego Limpio Project: Report 2, Production Costs and Properties of Fuego Limpio

May 1994. This is the second report of the two-phase study by Gary Beers of Environmental Property Assessments that evaluates using compressed wheat straw, called Fuego Limpio, as heating and cooking fuel. This portion of the study examines the feasibility of a commercial biomass densification facility in south central Colorado. The study estimates production costs for straw densification plants of various sizes, and identifies likely capital, fixed and variable costs. 53 pages.



## Selection Guidelines for Off-the-Shelf, Commercially Available Biomass Combustion Equipment, 1994

July 1994. This compilation of various brands and types of biomass combustion equipment was produced by Dave Dooling for the Southeastern Regional Biomass Energy Program. The guidelines categorize units by fuel type, heat output, by type of direct combustion — air or water, system specifications and manufacturers' addresses. 8 pages.

continued on next page

In each box, enter the quantity of publications.

### Report on Agricultural Residue Harvest and Collection

November 1994. This review of state of the art biomass harvesting equipment and collection technology was authored by J.A. Lindley and L.F. Backer of the Agricultural Engineering Department, North Dakota State University. The authors examine approximately 90 pieces of agricultural equipment for its suitability for biomass energy harvesting and collection in the western United States. The report addresses a number of collection methods including primary — for reasons other than energy such as grain harvesting — secondary and combining the primary and secondary harvest into one because of cost savings and other considerations. 210 pages.

### Biogas Production and Use as Fuel at Optimum Art Glass, Inc. in Eaton, Colorado

July 1992. This analysis of converting locally produced waste materials into a natural gas substitute that could be used by a local manufacturer was authored by Mishra and Associates. This report investigated the feasibility, process design, equipment specifications, cost quotations, economic analysis and permitting necessary to construct an anaerobic digestion plant to convert locally produced waste materials such as livestock or beer wastes into a natural gas substitute, or biogas. Optimum Art Glass planned on using the biogas to power furnaces that melt recycled glass bottles. The molten glass is then rolled into sheets of stained glass. 109 pages.

### Colorado Wood Residue Resource Assessment: Results of a Survey of Metropolitan Denver and Colorado Springs Secondary Wood Products Manufacturers

November 1993. The NEOS Corporation-authored survey profiles the 176 secondary wood

processors in the Denver and Colorado Springs regions. The findings quantify the type of wood residue produced, wood species used, quantity produced, and how the residues are disposed. 59 pages.

### Bioconversion of Feedlot and Dairy Waste for Energy

July 1995. This report chronicles the development and test of a pilot two-phase anaerobic digestion project in Utah that utilized mixed dairy industry wastes including manure, cheese whey and milk products for energy and fertilizer production while minimizing and reducing adverse environmental and pollution impacts. 43 pages.

### Anaerobic Digestion and Biogas Recovery and Utilization: A Workshop

October 1993. This report summarizes an Arkansas workshop at the Winrock International Institute for Agricultural Development on anaerobic digestion and biogas recovery and utilization. The authors of the report, Jim Wimberly and Fee Busby, both of Winrock, have succinctly chronicled the findings of the workshop sessions that focused on opportu-

#### What Is

**anaerobic digestion** *noun*: A biochemical process by which organic matter is decomposed by bacteria in the absence of oxygen, producing methane and other byproducts.

nities and constraints on widespread commercialization of the technologies. 43 pages.

### Ethanol Production from Mixed Waste Paper: A Pre-Feasibility Study

March 1993. This study by Economic Research Associates analyzes existing conditions and public policy for the ethanol and mixed waste paper industries; traditional and emerging ethanol production technologies; business development within the ethanol industry and policy roles for development and implementation of cellulose-to-ethanol technology. 70 pages.

### Ethanol Production from Municipal Solid Waste in Nebraska: A General Feasibility Study

April 1994. This Economic Research Associates' report builds on an earlier mixed waste paper study, but is more focused in scope. Among the issues explored include: whether sufficient waste paper resources exist locally to provide adequate levels of materials for a ethanol plant, whether the amount of ethanol produced would satisfy the demands of the publicly-owned vehicles in the region, economic projections of costs and operations and environmental and political considerations. 56 pages.

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## The World of Biomass on the Web

Western encourages readers to utilize these biomass resources. The Internet sites listed should not be construed as advocating or representing any position of the Western Regional Biomass Energy Program nor does Western guarantee the content or accuracy of any information available at these sites.

Readers without computers or access to the Internet are encouraged to visit their local library where Internet services may be available.

**The Alternative Agricultural Research and Commercialization Corporation.** This site details what this venture capital firm, a part of the U.S. Department of Agriculture, does. The site also lists how the firm makes investments in companies to help commercialize bio-based industrial products — non-food, non-feed — from agricultural and forestry materials and animal byproducts. [www.usda.gov/aarc](http://www.usda.gov/aarc)

**Biofuels Information Center.** This site is part of the National Renewable Energy Laboratory's Alternative Fuels Data Center. The site contains resources on biofuels as well as a search engine for reviewing databases and publications. A simple search for "biofuel" turned up 51 factsheets and publications spanning a six-year period. [www.afdc.nrel.gov](http://www.afdc.nrel.gov)

**Biomass Resource Information Clearinghouse.** This clearinghouse is jointly operated by the U.S. Departments of Agriculture, Energy and Commerce; the National Renewable Energy Laboratory, Oak Ridge National Laboratory; the Regional Biomass Energy Program; the U.S. Forest Service, the U.S. Environmental Protection Agency and the U.S. Census Bureau. [reddc.nrel.gov/biomass](http://reddc.nrel.gov/biomass)

**The Centre for Biomass Technology.** This site is a Danish network of four technological institutes that conduct biomass research and projects. You will find technical papers and newsletters on the use of wood, straw and other biofuels. While the web site is in English, not all of the research materials have been translated yet. [www.sh.dk/~cvt](http://www.sh.dk/~cvt)

**The Industrial Agriculture-USA Clearinghouse.** This national database offers access to information and resources in the area of alternative uses for non-feed, non-food agricultural products. The Clearinghouse is maintained by the Kansas Technology Enterprise Corporation. [www.ia-usa.org](http://www.ia-usa.org)

**The Kansas Technology Enterprise Corporation.** This site provides an overview of the services available from this comprehensive technology economic development network. The Corporation is designed to support researchers, inventors, entrepreneurs and businesses through each phase of the technology life cycle, from basic idea to a successful product. The services the Corporation provides are research, investment and business assistance. [www.ktec.com](http://www.ktec.com)

**Solstice.** This information resource on renewable energy, efficiency and sustainable development contains nearly one million pages of information and the site also serves as the host for more than 50 other renewable energy organizations. This site, operated by the Center for Renewable Energy and Sustainable Technology, contains information on a number of bioenergy projects. [solstice.crest.org](http://solstice.crest.org)

## WESTERN STATE CONTACTS



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The group focuses on regionally important biomass resources and the technologies needed to stimulate the conversion of biomass feedstocks to energy applications.

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The *Western Biomass Quarterly* is published by the Western Regional Biomass Energy Program. The *Quarterly* replaces the previously published *Biomass Bulletin* and *Biomass Digest*. Any comments regarding this publication should be sent to Western's administrative office.

## \$290,000 Available for Projects in 1999

The passage of the federal budget in October, cleared the way for new Western biomass grants in 1999. Based on early estimates, about \$290,000 will be available for grants in the 13-state region next year.

Last year, more than \$1,000,000 was available for projects. "The two-thirds decline in grant funds is due to several factors," Jeff Graef, Western's administrator, said. "Last year, Western was able to use unexpended funds from previous years to finance more projects. Unfortunately, those funds are gone and Congress did not increase funding for the regional biomass program."

### Deadline is January 15, 1999

The deadline for applications for 1999 funding is 4:30 pm, Central Standard Time, January 15, 1999, received in Lincoln, Nebraska. Western reserves the right to reject any or all late proposals without review. Applications must be received by mail or in-person. Electronic filing is not an option.

Most projects selected for funding will receive \$50,000 or less. Exceptional projects may garner up to \$75,000. However, all projects require at least dollar-for-dollar matching funds.

The detailed request for proposals will be sent in November to those who have previously expressed an interest in receiving a printed copy. For those with Internet access, a copy of the request can be found at Western's web site: [www.westbioenergy.org](http://www.westbioenergy.org)



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