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Perspectives

A newsletter covering the research, demonstration and education projects of the Iowa Energy Center

Biodiesel – A Fuel for Today and the Future

Biodiesel is taking a more prominent position in the world of fuels, primarily as a renewable source of fuel for diesel engines such as trucks and buses. Researchers are also finding uses for biodiesel as a heating fuel and in the production of lubricants. In all of its uses, biodiesel demonstrates substantial benefits to the environment, economy and safety.

For Iowa, biodiesel looks to play a prominent part in the future of converting biomass to fuels and chemicals. This issue of *Perspectives* will focus on several aspects of biodiesel and biomass energy conversion, including the biodiesel pilot plant at the Center's BECON (Biomass Energy CONversion) facility in Nevada, Iowa.

A Cleaner Alternative

Biodiesel is a cleaner burning, alternative diesel fuel that is nontoxic, biodegradable and virtually sulfur free. It is produced from reactions that take place when vegetable oils and animal fats are mixed with alcohol. The fuel can be manufactured from a wide variety of fats and oils from both plants and animals. Soybeans are currently the most common feedstock used in producing biodiesel.

One of the most exciting benefits of biodiesel is that it can be used as a direct substitute for diesel fuel in

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Spring Compressed Air Challenge™ Training Courses

The Iowa Energy Center is hosting two sets of Compressed Air Challenge™ training courses this spring. The courses will be held May 8-10 in Ames at the Iowa State University Scheman Building and May 22-24 on the Kirkwood Community College campus in Cedar Rapids.

At each site there will be two courses offered. The first is a one-day course, titled *Fundamentals of Compressed Air Systems* and the second, *Advanced Compressed Air Challenge*, is two days long. Both of these courses are designed for facility engineers, maintenance supervisors, equipment distributors and engineering consultants.

The *Fundamentals* course takes a systems based approach to compressed air management. Students will learn how to calculate the energy cost of compressed air in their facility; improve their compressed air system's efficiency and reliability; identify inappropriate uses of compressed air; and establish a baseline by which to measure improvements in compressed air performance and efficiency. They will also learn how to match their system's supply to actual production requirements for pressure and flow; and find and fix leaks, including how to establish a leak prevention program.

The *Advanced* course is an intensive two-day training that provides the most up-to-date, in-depth technical information on trouble shooting and implementing improvements to industrial compressed air systems.

Students will learn how to collect and use the data and tools necessary to assess the efficiency and cost-effectiveness of a compressed air system; how to develop and use a system profile; and how to address point-of-use issues including air quality, highest point-of-use pressure requirements, and high-volume intermittent applications. Students will gain an understanding of complex control system strategies, aligning the supply side to demand side operation, and implementing a system maintenance program.

The Compressed Air Challenge is a voluntary collaboration of industrial compressed air users; manufacturers, distributors and their associations; facility operating personal and their associations; energy efficiency organizations; and utilities. All are committed to promoting the benefits of smart compressed air use. The Iowa Energy Center is a founding member of this national organization.

The cost for the courses is $225 per person for the *Fundamentals* course, $495 per person for the *Advanced*. There is an early-bird discount of $40 per course or $100 discount if you register for both courses before April 25. Additionally, there will be a random drawing to give one registration away in each course.

To learn more about the technical content of the course, contact the Iowa Energy Center's Industrial Project Manager, Bill Haman at 515-294-4710 or whaman@energy.iastate.edu. You can also visit the Compressed Air web site at www.knowpressure.org. To register for the course contact Karen Good at 515-294-6229.

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The Iowa Energy Center was created by the 1990 Iowa Energy Efficiency Act. Its mission is to help Iowans reduce their reliance on imported fuels and nonrenewable resources and to increase efficiency in all areas of energy use. This is accomplished in part through a competitive grants program which sponsors energy efficiency and renewable energy research and demonstration projects.

To be added to the Center's mailing list call 515-294-8819 or e-mail iec@energy.iastate.edu. Online versions at www.energy.iastate.edu.

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a standard diesel engine without any significant engine modifications. Biodiesel also maintains the payload capacity and range of diesel. These features make converting to biodiesel economically viable, especially when the other benefits of the biofuel are factored into the equation.

Safety

To begin with biodiesel is safer to use than petroleum diesel. The flash point for biodiesel in its pure form is more than 300°F versus about 125°F for regular #2 diesel. This is a substantial safety benefit in places such as mines where diesel equipment is often used and fire danger in high. Biodiesel can dramatically reduce that concern. Biodiesel's higher flash point also makes it safer to transport.

Environment

The fact that biodiesel is a renewable fuel is perhaps its greatest environmental benefit. It can be produced from a wide range of materials including designated crops like soybeans or waste materials like restaurant grease. When biodiesel is used in a conventional diesel engine there is a sizeable reduction in unburned hydrocarbons, carbon monoxide and particulate matter. It works well with new technologies and potentially can increase the engine life of equipment because of the reduced carbon output.

Biodiesel exhaust is also less offensive. The use of biodiesel and biodiesel blends results in a noticeably less offensive exhaust odor, which can be a real benefit in confined spaces. In fact, equipment operators have compared it to the smell of French fries. Since biodiesel is oxygenated, diesel engines more completely combust biodiesel than petroleum-based diesel.

The Downside of Biodiesel

Biodiesel does not perform well in cold temperatures. When temperatures fall near or below freezing (32ºF), biodiesel fuels form small, solid, waxy crystals that stick together to form bigger ones. These larger crystals block fuel filters and plug fuel lines.

According to a press release from the U.S. Agricultural Research Service (ARS), researchers have been working to address this problem. At the ARS they are developing a three-step winterization process that involves mixing additives, chilling the fuel and filtering out solids. In laboratory tests, researchers have produced biodiesel fuels capable of starting engines at temperatures as low as 5° F, making them comparable to petroleum-based diesel fuels.

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Biodiesel Blends Good News for Cold Winter

As the country battles winter's bitter temperatures and tight supplies of home heating oil and natural gas, researchers are finding ways to stay warm using biodiesel fuel.

To demonstrate the effectiveness of blending biodiesel with heating oil, a dozen buildings and two dairy barns on the 7,000-acre Henry A. Wallace Beltsville Agricultural Research Center (BARC) have been heated this winter with a "B5" biodiesel blend. B5 is a blend of five percent soy-based biodiesel and 95 percent heating oil. The farm is part of the U.S. Department of Agriculture's Agriculture Research Service (ARS).

The ARS Deputy Area Director, John Van de Vaarst said, "Our goal is to demonstrate that it (biodiesel) can work as a home heating oil, and to raise awareness in the government that it is an option to stretch out the heating oil supply this year and in the future."

"We chose a B5 blend for heating to reduce potential clogging of the boilers' fuel filters and strainers with sludge which has settled in the storage tank over the years," continued Van de Vaarst. "Biodiesel has excellent solvent properties that clean the tank and accessories. But, a higher blend could cause clogging."

According to an ARS press release, higher concentrations of biodiesel, up to 100 percent can be used for both residential and industrial heating, however, B5 to B20 blends are more likely to be widely used, at least initially.

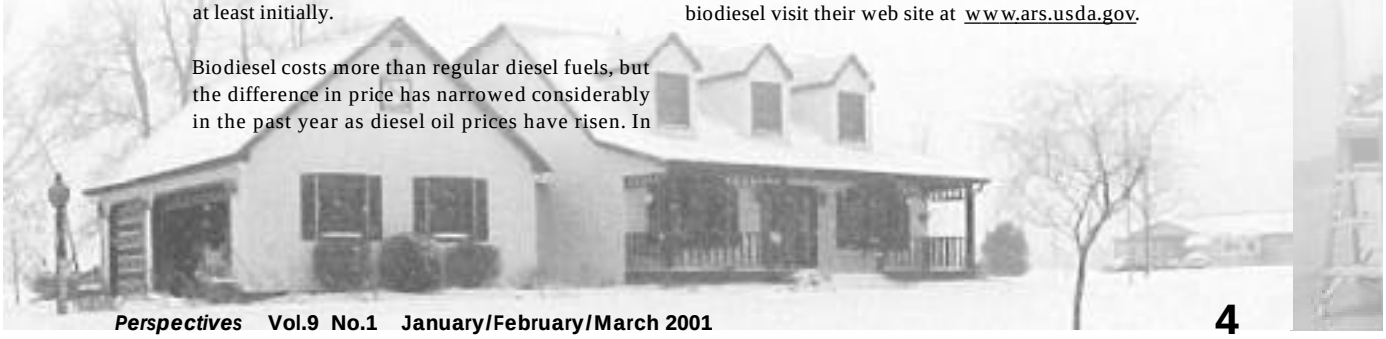
Biodiesel costs more than regular diesel fuels, but the difference in price has narrowed considerably in the past year as diesel oil prices have risen. In January, the wholesale cost of diesel was 93 cents per gallon, while B20 blend cost $1.09 and B5 blend cost 97 cents.

The price gap has narrowed as the winter progressed and the demand for heating fuels increased and petroleum-based supplies of heating fuels dwindled. Additionally, there is no cost to modify existing heating systems to use the biodiesel blend. Biodiesel performs similarly to conventional petroleum distillate fuels, with the added benefit of cutting harmful emissions and reducing air toxins.

Already the ARS is using the B20 blend, 20 percent biodiesel and 80 percent petroleum diesel, in a diverse fleet of 150 diesel snowplows, tractors and other vehicles. A 1993 study by the ARS showed that while biodiesel and home heating oil perform similarly, biodiesel burns cleaner.

Agricultural Research Service Administrator Floyd Horn said ARS decided to lead the way in using biodiesel to run vehicles and heat buildings because it has many payoffs for the country. "Farmers sell more soybeans or other oilseed crops, hopefully at a higher price; we conserve petroleum; and we get cleaner air," said Horn. "The U.S. Department of Energy's National Renewable Energy Laboratory estimates the cancer-causing potential of biodiesel exhaust is 94 percent less than that of petroleum diesel."

For more information on the ARS's work in biodiesel visit their web site at www.ars.usda.gov.



Biodiesel Pilot Plant at BECON

Over the past five years, considerable research has been conducted to investigate the properties of biodiesel, its performance in engines, and to provide the supporting data needed to satisfy the Environmental Protection Agency's Fuels and Fuel Additives Registration Program. The Iowa Energy Center has supported some of this work along with the National Biodiesel Board, state soybean promotion boards and many other private and governmental groups.

The Iowa Energy Center's BECON (Biomass Energy CONversion) facility in Nevada, Iowa now features a biodiesel pilot plant. The lead researcher on the biodiesel plant is Iowa State University professor Jon Van Gerpen.

Virtually all of Van Gerpen's work has focused on the use of methyl soyate, the ester produced by reacting soybean oil with methanol. The result of the research is that biodiesel is now fairly well understood by manufacturers and fleet managers. The greatest current need in moving biodiesel to market is to demonstrate existing technologies to potential plant operators and fuel consumers, and to develop new technologies that could reduce the cost and improve the value of biodiesel.

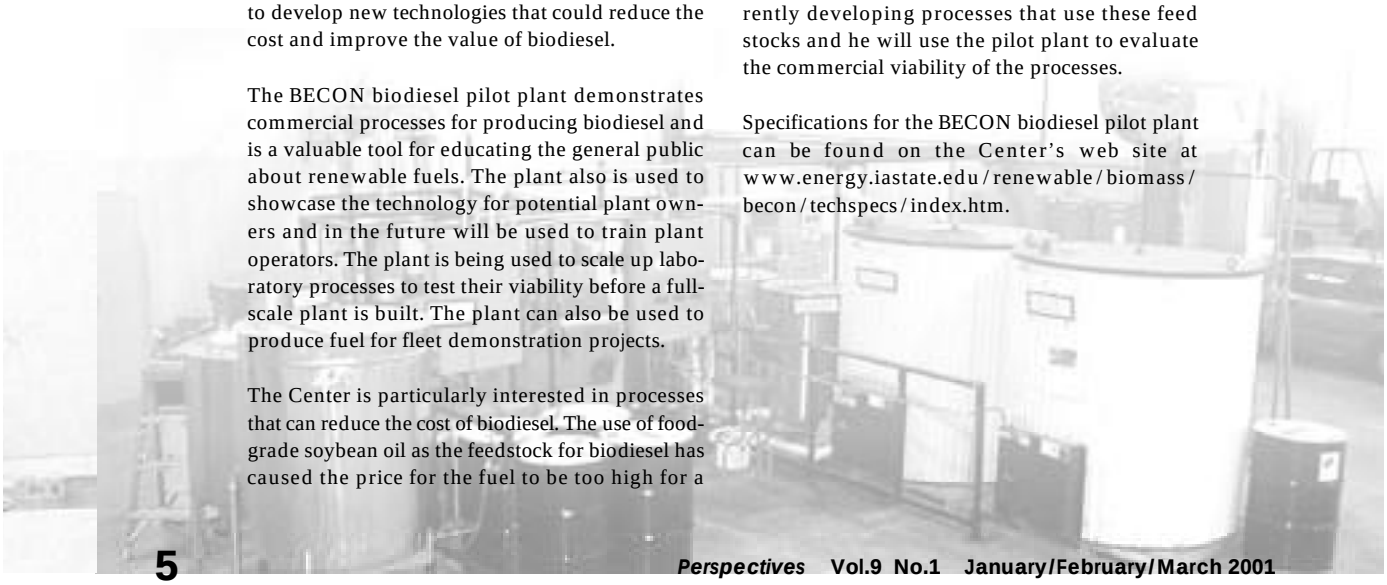
The BECON biodiesel pilot plant demonstrates commercial processes for producing biodiesel and is a valuable tool for educating the general public about renewable fuels. The plant also is used to showcase the technology for potential plant owners and in the future will be used to train plant operators. The plant is being used to scale up laboratory processes to test their viability before a full-scale plant is built. The plant can also be used to produce fuel for fleet demonstration projects.

The Center is particularly interested in processes that can reduce the cost of biodiesel. The use of food-grade soybean oil as the feedstock for biodiesel has caused the price for the fuel to be too high for a significant market develop without government mandates.

However, inedible oil from spoiled soybeans, waste oils and greases from restaurants and food service facilities, and beef, pork and chicken fat from rendering plants are all possible sources of lower cost feed stocks. These type of feed stocks are available at retail prices between $0.06-$0.10/lb, and are expected to drop lower as high-oil corn usurps its primary market as a calorie-booster for animal feed. The important differences between these low-cost fats and oils and food-grade soybean oil are high free fatty acid levels and higher saturation.

According to Van Gerpen's research, the high free fatty acid levels will cause more waste if traditional alkaline catalysts are used to produce biodiesel. However, acid-based catalyst routes are available. Higher saturation can actually provide a superior quality biodiesel (higher cetane number and lower emissions) although the pour point of the fuel is higher. These problems can be overcome with additional development work. Van Gerpen is currently developing processes that use these feed stocks and he will use the pilot plant to evaluate the commercial viability of the processes.

Specifications for the BECON biodiesel pilot plant can be found on the Center's web site at www.energy.iastate.edu/renewable/biomass/becon/techspecs/index.htm.



World Biomass News:

energy conversion technologies to convert poultry waste more cost-effectively into organic fertilizer and energy. The companies, Harmony Products and DukeSolutions, announced they will jointly develop four biomass processing plants in the Southeast and Midwest by the end of 2001. Though the sites of three of these plants has not yet been determined, Iowa has been discussed as a possible choice.

Harmony Products uses an energy-intensive process to convert poultry manure into organic fertilizer. DukeSolutions uses a gasification process to convert some of the poultry manure into a gas similar to natural gas. The gas is then burned to create steam for the fertilizer production process which helps off set much of the energy costs.

The first plant is being built in Harrisonburg, Virginia and will process 10 tons of poultry manure each hour. The four new facilities combined could each process up to 100,000 tons annually, according to a press release from DukeSolutions. The companies are exploring expanding the waste streams the plants could accept to include industrial wastewater sludge from wastewater processing plants in the poultry industry and other animal waste streams.

For more information of this project visit www.dukesolutions.com.

Ethanol in China

China is turning to ethanol to help solve some of its energy and agricultural woes. In mid-December the country's Yanshan Petrochem Refining Division announced it had developed an ethanol blend that met China's new national gasoline standard. All ethanol-blend gasoline in China is required to meet the national fuel standards for 93 octane gasoline. The ethanol blend is being put to road tests which are expected to be finished by February.

The government officials in China say the development of ethanol-blend gasoline will help the country reduce huge stockpiles of grain in state warehouses and help reduce the environmental impact of vehicle transportation in China.

Poultry Waste and Energy

Two companies are joining together to use bio-mass

Renewable Energy From Cows and Landfills

Cow manure is being converted into energy in Iowa. Alliant Energy Corporation announced it will be working with Top Deck Farms in Westgate, Iowa, to produce electricity from livestock manure.

A biomass digester will convert the manure from 700 dairy cattle into methane gas, which in turn will fuel a reciprocating engine to produce electricity. Top Deck Farms will use about one third of the electricity generated and sell back the remaining power to Alliant Energy. The facility will produce enough electricity to power roughly 50 homes in Iowa. Top Deck is one of a growing number of livestock producers in Iowa and across the country who are looking to profit from animal waste.

Alliant also has two other biomass conversion projects in the neighboring state of Wisconsin. Alliant Energy and Wisconsin Power and Light joined forces to construct a new landfill gas-electric generating facility in Berlin, Wisconsin and a new methane-powered generation facility at Superior Glacier Ridge Landfill near Mayville, Wisconsin. Landfill gas is a renewable energy source created as a natural by-product of decomposing waste. The use of the landfill gas, or methane, reduces the release of greenhouse gasses to the environment. Methane is 20 times more potent than carbon dioxide as a greenhouse gas.

The Berlin project will produce 2.4 megawatts of energy and the Mayville project will produce anywhere from two to four megawatts of renewable energy. Combined, the projects are estimated to supply enough electricity to serve approximately 1,000 homes annually.

Sunflower Motor Oil Spurs Local Economic Growth

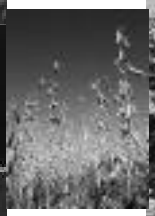
In Kiowa County Colorado, enterprising local sunflower farmers have found a way to add value to their crops by developing, manufacturing and selling sunflower-based lubricants that include a biodegradable crankcase oil, dust suppressant and drip oil.

Each of these environmentally-friendly, bio-based lubricants performed well in field tests and proved to have high performance levels. The oils are non-hazardous, reasonably priced and provide a renewable option to replace crude petroleum.

These products provide Kiowa Country farmers, as well as area residents in the rural area with an ideal scenario for improving their local economy by creating value-added agricultural products. Through the Colorado Initiative, a resource team will address economic development in the county and surrounding areas based on these lubricants. The project calls for increasing the number of sunflower seeds grown annually over the next several years. Using local resources, the seeds will be crushed into feed stock for lubricants. The feed stock will be processed at a local blending plant. The value of the finished product when it is sold at market price is expected to be seven to ten times more than the price of raw sunflower seeds.

Under this scenario, growers profit from the stability provided by growing demand, jobs are created and discretionary income increases. Related businesses and service will also respond to the opportunity to do business in the area.

For more information on this project visit the Kiowa County Growers web site at www.kiowacountygrowers.com.



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There is a problem that develops out of this winterization of biodiesel. Winterizing the fuel causes changes in the makeup of biodiesel fuels that can lead to lower cetane number, as well as a decreased stability during long-term storage. The cetane number, which is similar to the octane number of gasoline, is one important way to measure biodiesel fuel quality.

Another downside to biodiesel is its cost, which is higher then petroleum-based diesel. This factor is quickly moving in favor of biodiesel, however, as the cost of oil rises and more regulations are placed on fuels.

According to Ward Lenz, an energy analyst for the Iowa Department of Natural Resources, "In our past experience, we were finding the cost of biodiesel to be around $2.50 per gallon. However, with more manufacturers popping up around the country, the Biodiesel Board reports that it can be available for $1.50 to $1.80 per gallon." In January the wholesale cost of regular diesel was about $1.55 per gallon.

Economics

There are numerous and varied economic benefits to biodiesel. The foremost is that biodiesel adds value to the feedstocks (soybean, oilseeds and animal fats). This in turn increases the number of manufacturing jobs, the tax base from plant operations and income taxes, and also increases investments in plants and equipment. If Iowa were to become a major exporter of biodiesel this could be a boon for the state's rural economy.

On the national scale, biodiesel helps to reduce dependency on foreign oil and it improves our nation's trade balance. It also reduces health care costs due to improved air quality and greenhouse gas mitigation.

On a local level, biodiesel clearly has positive implications for production agriculture in Iowa. A 1996 economic study published by the USDA Office of Energy predicted that a modest, sustained annual market for biodiesel (100 million gallons in the U.S.) would contribute approximately seven cents to the price of each bushel of soybeans produced.

Biodiesel looks to become even more economically viable as the federal government releases new low-sulfur emission regulations for diesel. Biodiesel easily meets the proposed regulations and it looks to be the environmentally sound option.

To learn more about biodiesel visit the National Biodiesel Board web site at www.biodiesel.org.

Up and Coming . . .

Design of Hybrid Electric Vehicles

When & Where: March 6-8, Detroit, Michigan
Sponsored By: Professional Engineering Education Center SAE International
For More Information: SAE Professional Development Division 724-772-7148 or profdev@sae.org

Greenprints: Sustainable Communities by Design

When & Where: March 14-16, Atlanta, GA
Sponsored By: Southface Energy Institute
Focus: The conference and trade show will focus on green building designs, products and practices, as well as broader energy efficiency, renewable energy issues.
For More Information: Southface Energy Institute, 404-872-3549, or www.greenprints.org

National Green Building Conference

When & Where: March 18-20, Seattle, WA
Sponsored By: National Association of Home Builders
Focus: This national conference focuses on residential home design, development, marketing, building and financing of homes that are "environmentally-sensible."
For More Information: 800-638-8556 or www.nahbrc.org

Building Energy 2001

When & Where: March 21-24, Tufts University, Medford, MA.
Sponsored By: Massachusetts Renewable Energy Trust and Northeast Sustainable Energy Association (NESEA)
For More Information: NESEA Building Energy Conference 413-774-6051 or www.nesea.org

The Need Project: National Energy Conferences for Educators

When & Where: April 15 registration deadline; July 7-11 in Albuquerque, New Mexico and July 14-18 in Williamsburg, Virginia
Sponsored By: Mineral Management Service, U.S. Department of Interior
For More Information: The Need Project 800-875-5029 at www.need.org

Forum 2001: Solar Energy: The Power to Choose

When & Where: April 21-25, Washington, D.C.
Sponsored By: American Institute of Architects-Committee on the Environment; American Society of Mechanical Engineers-Solar Energy Division; American Solar Energy Society; American Society of Heating Refrigerating and Air-Conditioning Engineers; Interstate Renewable Energy Council; National Association of Home Builders; Solar Energy Industries Association; Sustainable Buildings Industry Council
For More Information: FORUM 2001 c/o American Solar Energy Society 303-443-3130 or www.solarenergyforum.org

Building Expectations: High-Performance Buildings, High Quality Indoor Spaces

When & Where: April 26-27, Green Bay, WI.
Sponsored By: Wisconsin Focus on Energy; Energy Center of Wisconsin
For More Information: Energy Center of Wisconsin, phone 1-800-466-4631 or www.ecw.org

Up and Coming continued . . .

Alternative Transportation Solutions for Today & Tomorrow

When & Where: April 27-28, Iowa City, Iowa
Sponsored By: University of Iowa, Department of Urban & Regional Planning
For More Information: Nancy Ostrognai, 2003 Glendale Road, Iowa City, IA, 52245; phone 319-338-7690; or email April27_01@yahoo.com

Affordable Comfort 2001

When & Where: April 30-May 5, Milwaukee, WI
Sponsored By: Affordable Comfort, Inc.
Focus: Over 80 organizations, including utilities, public and private nonprofits, are represented at this week-long conference. Affordable Comfort focuses on improving the way old and new homes perform in terms of health, safety, durability and the reduction of energy use/cost.
For More Information: 724-852-3085 or www.affordablecomfort.org

Compressed Air Challenge in Iowa: Fundamentals and Advanced Training

When & Where: May 8-10 in Cedar Rapids, May 22-24 in Ames
Sponsored By: Iowa Energy Center and the Compressed Air Challenge
Focus: See story page 2
For More Information: To register, call Karen Good at 515-294-6229

If you have an energy-related event you would like to have included in *Perspectives*, please send the information at least two months in advance to: *Perspectives*, Iowa Energy Center, 2521 Elwood Drive, Suite 124, Ames, Iowa 50010-8263, fax the information to 515-294-9912 or e-mail iec@energy.iastate.edu.

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