



*Josh Stanislawski, Research Manager, oversees operation of the EERC entrained-flow gasifier that can be used for coproduction of power, hydrogen, fuels, and chemicals.*

## Growing infrastructure to support a world of opportunity

The University of North Dakota (UND) Energy & Environmental Research Center (EERC) has experienced tremendous growth in infrastructure in the past few years. This new infrastructure has provided significant opportunities to support projects throughout the world today and into the future. The new infrastructure has already resulted in over \$40 million in new contracts. Associate Director for Research Tom Erickson attributes a significant amount of this growth directly to the state-of-the-art space acquired through construction of the National Center for Hydrogen Technology® (NCHT®) building in 2007–2008.

“The number of demonstration units and other equipment has grown very rapidly in the last 2–3 years, and the

availability of new space within the NCHT building was the biggest driver,” said Erickson. “It gave us more space to put in more units, and it gave us the opportunity to expand programs that were waiting in the wings until we had the space to implement them. The NCHT building, funded through the North Dakota Centers of Excellence, was already full the day it was dedicated.”

One of the most exciting additions is the hydrogen-on-demand technology, which produces high-pressure hydrogen from a liquid alcohol feedstock at the time of fueling without the need for expensive compression and storage. This is currently being used with a hydrogen dispenser in a pilot-scale hydrogen refueling station demonstration at the EERC. Future

commercial systems will be capable of full integration with existing gas station infrastructure, reducing the overall cost to support a future hydrogen economy.

A major area of infrastructure growth has been in gasification, which converts a solid fuel into a synthetic gas (syngas) with a high hydrogen content. The syngas can be used to produce electricity, natural gas for sale, liquid fuels, or

*Continued on page 2*

### Inside

Cummins generator.....	3
Mercury-selenium .....	4
Transitions .....	6
Every day is different .....	7
Sundby retires .....	8

chemicals. The EERC greatly enhanced its gasification capabilities through the development of three new systems: an entrained-flow gasifier (EFG), a high-pressure fluidized-bed gasifier (FBG), and an advanced fixed-bed gasification (AFBG) system.

“Prior to having the NCHT building, the best we could do was to ‘shoehorn’ systems into other places, which didn’t make them easily used. Because there is now a dedicated area with these three gasifiers, it has allowed us to put in other supporting equipment that the units can share for demonstration purposes,” said Erickson. “An example of this is the new Fischer-Tropsch (FT) production system, which can produce a variety of liquid fuels from the syngas of the gasifiers. We have the one FT unit, but it can be demonstrated on any of the three gasification technologies.”

The pilot-scale EFG has been used to gasify various feedstocks ranging in quality. The entrained-flow gasification technology is currently being commercially deployed by a variety of entities, including Shell, GE, and ConocoPhillips, which have all been clients of the EERC. Because of

the high temperatures employed in EFG operation, very little tar or hydrocarbon is generated, and the product gas has been successfully cleaned to nondetectable limits of contaminants.

The pilot-scale high-pressure FBG has already been used to gasify a range of fuels including lignite, subbituminous coal, petcoke, both untreated and treated biomass, and various mixes of biomass and coal. This system is very unique for its ability to operate at high pressures to allow for research and development of the next generation of commercial gasifiers. The FBG is capable of operating at pressures up to 1000 psig.

The AFBG unit is a unique gasifier type for use in smaller, distributed applications (less than 5 MW) and



Todd Deibert (left), Technology Development Operator, and Erik Moe, Research Engineer, work on the AFBG, which produces the syngas used in the Cummins generator (see next article).

can convert a range of high-moisture biomass, like forestry, agricultural, and industrial biomass waste—as well as a range of coals—into clean syngas. The system is very flexible to allow for use with biomass fuels, all while achieving near-zero effluent discharge. This system is being used as the development unit for a variety of commercialization opportunities being pursued with EERC commercial clients (see “EERC and Cummins . . .” in this issue for more on this system).

A coal feeder and suite of back-end pollution control devices are shared among the EFG, FBG, and AFBG, allowing flexibility in operation without requiring excessive maintenance or capital cost for testing. This is extremely advantageous to our clients in providing flexibility and lower overall costs of operation. Pollution control devices include a transport desulfurizer, hot-gas filter vessel, fixed-bed sorbents and shift catalysts, and water-cooled quench pots to remove contaminants and increase syngas hydrogen content.

Pressurized syngas exiting the gasifiers can also be routed to several back-



The architects’ rendering of the west side of the NCHT building, with the planned addition shown on the right.



Erik Moe, Research Engineer, EERC; Dustin Lindstrom, G-Drive Application Engineering for Cummins Power Generation; and Nikhil Patel, Project Manager, stand beside the Cummins electric generator.

## EERC and Cummins produce CHP technology

The EERC, in partnership with Cummins Power Generation, Inc., is conducting a project combining biomass gasification with combined heat and power (CHP) production to demonstrate the production of heat and power from high-moisture biomass. Cummins Power Generation of Minneapolis, Minnesota, a world leader in the design and manufacture of power generation equipment, provided the electrical generator for the project.

The Cummins generator, which normally runs on natural gas, has been

modified to run on syngas produced by an EERC-developed AFBG unit. The AFBG can convert a range of fuels, such as forestry, agricultural, and industrial biomass waste; animal waste; waste plastics; and railroad ties or cable poles as well as a range of coals, into clean syngas, containing a mixture of carbon monoxide, hydrogen, methane, nitrogen, and carbon dioxide. The Cummins and EERC technologies will be integrated to work as a distributed CHP technology, catering to the need for utilizing opportunity fuels whose energy value would otherwise have been lost. This

combined technology will be tested for its tolerance to fuel variability and its ability to maintain a constant energy output.

“The AFBG is unique in its proprietary design to provide flexibility in converting high-moisture, high-inorganic, and fast-devolatilizing fuels into clean syngas,” said EERC Research Scientist and Project Manager Nikhil Patel, who is the inventor of the AFBG and is further developing the technology in partnership with a broad range of EERC personnel. “The AFBG is able to maintain the required uniform high-temperature zone to produce clean syngas. As a result, the scrubber system can achieve near-zero effluent discharge with inert residue as the only by-product.”

The demonstration project will produce enough energy for one home, but the process has a variety of applications. This combined technology could help industries, farms, and many waste-producing facilities meet or exceed their own energy needs while utilizing “opportunity” fuels that are easily available and normally would incur disposal costs but could generate electricity on the order of 500 kWh or potentially higher. Excess “green”



Ismael Chang, Applications Specialist Mechanical for Cummins Energy Solutions Business, assists with the start-up of the syngas-powered engine.

Continued on page 8



Laura Raymond, Research Manager, and Nick Ralston, Research Scientist, take a moment to confer as they finalize their travel plans.

## Mercury–selenium connection

Research Manager Laura Raymond and Research Scientist Nicholas Ralston’s work has been generating a lot of attention recently. They are proving that the selenium that is abundant in seafood potentially counteracts the adverse effects of methylmercury exposures to those eating seafood. This past year alone, Raymond and Ralston have presented aspects of their work in internationally recognized journals and at conferences throughout the United States, including Alaska and Hawaii, and in Australia.

“The research area of assessing benefits versus the risks of eating ocean fish is really taking off,” said Raymond. “There is so much information showing that avoiding fish consumption is more harmful than any perceived risks from mercury exposure.

It is clear Americans need to start eating more fish.”

In 2004, the U.S. Environmental Protection Agency and U.S. Food and Drug Administration issued an advisory stating that pregnant women or those women who planned on becoming pregnant should limit their consumption of fish in order to lessen their methylmercury exposures.

While mercury is a naturally occurring element found primarily in minerals, rocks, and fuels, when it is disturbed, it is often released into the air and transported by prevailing winds, eventually falling to the Earth’s soil or water where a portion becomes methylated by bacteria. The methylmercury is then taken up by aquatic plants and animals.

Fish that eat these organisms build up methylmercury in their bodies. As larger fish eat smaller fish, the methylmercury is bioaccumulated up the food chain. When we eat fish, we ingest their methylmercury.

With the objective of investigating dietary selenium’s influence on mercury toxicity, Ralston and Raymond, with backgrounds in nutrition, came to the EERC in 2002 and began their research.

“We knew that an important component—selenium—was not being considered in seafood mercury risk assessments,” said Ralston. “Mercury appears to have only caused harm when it was present in higher amounts than selenium. Fortunately, ocean fish are some of the richest sources of selenium in our diet.”

After the joint advisory recommended that women lessen their consumption to 12 ounces of fish a week, Raymond and Ralston noted that this could negatively impact intakes of important nutrients as more and more people were reducing their fish consumption. They then began looking into the importance of omega-3 fatty acids obtained from ocean fish and the ramifications of limiting the main omega-3s (eicosapentaenoic acid [EPA] and docosahexaenoic acid [DHA]) in our diet.

“Once we began to connect the importance of omega-3 fatty acids with our selenium research, the magnitude of the issue became clear,” said Raymond. “The omega-3 fatty acids of DHA and EPA can only be obtained from fish, and they are absolutely essential for brain and eye development and cardiovascular health.”

Raymond went on to say that the United States has some of the lowest DHA levels in breast milk when looking at over 30 countries, even lower than many poverty-stricken countries.

Low omega-3 fatty acid intakes can also have an effect on depression, attention deficit/hyperactivity disorder, hyperactivity, and violence, in addition to intelligence quotient (IQ) and visual acuity.

“EPA and DHA are important for brain and cardiovascular health. Heart attack risks drop significantly if you have enough of these omega-3 fatty acids in your diet. However, since some of these studies were done using whole fish, we can’t say these benefits are just from the omega-3s; they could be due to other nutrients that are also present in fish,” said Raymond.

Since Ralston and Raymond’s work in seafood consumption has been receiving such great attention, they have been invited to write three book chapters and multiple manuscripts describing the importance of selenium

in counteracting mercury toxicity. Ralston emphasizes, however, that freshwater fish are not necessarily as rich in selenium and omega-3 fatty acids as ocean fish, and further work needs to be done in this area. They are now expanding into aquaculture-related issues with others at the EERC to study algae that produce those important omega-3s.

In addition to the travel related to their research, Raymond has traveled considerably to work on a public television documentary that is being developed with Charlene Crocker, Research Scientist; Dan Daly, Research Manager; and Sheila Hanson, Marketing Research Manager. The documentary is part of a National Oceanic and Atmospheric Administration-funded outreach project that will clarify the risks and benefits of fish consumption. The documentary

is scheduled to be released in late spring on Prairie Public Television, which serves North Dakota, South Dakota, Minnesota, and Manitoba, Canada, and will be available later for other public stations throughout the United States and Canada.

The recent recommendation from the U.S. Department of Health and Human Services and the U.S. Department of Agriculture as well as the research of Raymond and Ralston and others clearly states that eating fish is vital to our health (see sidebar and related Web site). The old adage that “fish is brain food” continues to pass the test of time.

–Trish McGuire



Nick Ralston prepares samples for the Cell and Tissue Culture Laboratory centrifuge.

## U.S. Department of Health issues new advisory

The recent release of the Dietary Guidelines for Humans 2010 by the U.S. Department of Health and Human Services and the U.S. Department of Agriculture states that “moderate evidence shows that consumption of about 8 ounces per week (for adults) of a variety of seafood, which provides an average consumption of 250 mg per day of EPA and DHA, is associated with reduced cardiac deaths among individuals with and without preexisting cardiovascular disease.” It goes on to say that the nutritional benefits, especially for fetal development as well as early childhood growth, far outweigh the health risks. More information can be found at [www.health.gov/dietaryguidelines/dga2010/DietaryGuidelines2010.pdf](http://www.health.gov/dietaryguidelines/dga2010/DietaryGuidelines2010.pdf).

# Transitions



**Stephen Hawkinson** has been promoted to the position of Lead Building Services Technician at the EERC. In the absence of Mark Kobe, Supervisor

of Building Services, Hawkinson assumes supervisory duties and assists in performing inventories; preparing and tracking supply, work, and equipment repair orders; training new employees; and assigning job duties in addition to his regular Building Services assignments.

Hawkinson attended college in Inver Grove Heights, taking electrical and computer engineering courses. He is currently a student at Northland College in East Grand Forks and plans to transfer to UND to complete a degree in Electrical Engineering. He has worked for EERC Building Services since 2009.

“Mark Kobe has provided great leadership and training. I hope that I can do the same someday,” said Hawkinson.



**Jonathan LaBonte** has been hired as a Research Scientist in the Oil and Gas Group at the EERC, where he assists in the characterization of geologic

formations within the Williston Basin and performs risk assessments and develops risk management plans for geologic CO<sub>2</sub> storage projects. LaBonte is currently working in Steve Smith’s Applied Geology, Geochemistry, and Geomechanics Group.

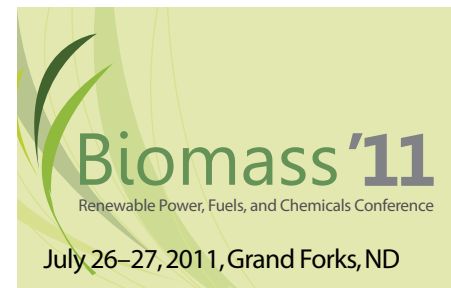
LaBonte received his B.S. degree in Environmental Geology and Technology from UND in May of 2004. His interests and expertise include mineralogy, geochemistry, geomorphology, lab and field testing, researching the potential for carbon dioxide storage within geologic formations, and developing and performing risk management plans for geologic CO<sub>2</sub> storage projects. Previously, LaBonte was a Storekeeper at the EERC.

“I am excited about the new challenges of this position and being

able to learn and evolve as a person because of it,” said LaBonte. “I am somewhat sad to not be working with the people in the Purchasing Group any longer, but the Oil and Gas Group members have all been extremely welcoming.”

–Sandy Van Eck

## Upcoming events



July 26–27, 2011, Grand Forks, ND



October 24–27, 2011, Arlington, VA

*Continued from page 2*

end systems, one of which is the FT reactor, capable of making more than a gallon a day of liquid from syngas. FT technology is being pursued as a commercially viable method of producing domestic fuels from coal, natural gas, and biomass at very large scales. This liquid can be upgraded to make diesel, jet fuel, alcohols, and other products. Because the entire FT unit is compact and skid-mounted, it can be readily moved to any of the different gasification systems located at the EERC or moved by truck to an off-site gasifier.

The Partnership for CO<sub>2</sub> Capture (PCO<sub>2</sub>C), in partnership with 16 EERC

clients, designed and built a solvent-based postcombustion CO<sub>2</sub> capture system adjacent to the EERC’s existing combustion test facility (CTF). Carbon capture technologies are rapidly being advanced for future deployment on full-scale coal combustion systems. This new system takes the flue gas developed from the existing pilot facility and captures up to 98% of the CO<sub>2</sub> from the gas stream. Retrofits were also made to the CTF to allow CO<sub>2</sub> capture through oxygen-fired combustion.

“This new equipment was built for existing, client-funded programs, and it continues to give us the infrastructure

and the opportunity to use that equipment with future clients. Our capabilities are second to none,” said Erickson. “This infrastructure supports future work and continued job growth.”

“We’re not stopping or even slowing down our infrastructure additions,” said Gerald Groenewold, Director of the EERC. “In fact, we’re adding over 18,000 square feet to the NCHT, which will include a 75-foot-tall, six-level high-bay demonstration area for even larger demonstration systems.”

–Sandy Van Eck



The EERC maintenance team includes (from left) Randy Knutson, Al Olson, Doug Heisler, Tedd Halvorson, and Dennis Pazderic.



In the heaterless Bobcat, Doug Heisler clears the parking lot.

## Every day is different

During an early morning winter snow storm, when most EERC employees are still snuggled warmly in their beds, one staff member is roused from his.

“UND Facilities Management calls Doug Heisler, Technology Development Operator, at 3:30 a.m.,” said Dennis Pazderic, EERC Facilities Maintenance Coordinator. “Doug comes in to work at 4:00 a.m. to clear the parking lot. Doug is so handy that he can switch the Bobcat® from the coal bucket (smaller one) to the king-size bucket or sweeper in about 2 to 3 minutes.”

Heisler is one of four core employees who

assist with maintenance issues at the EERC. Others include Al Olson, Master Electrician; Tedd Halvorson, Technology Development Mechanic; and Randy Knutson, Research Specialist.

“Because of all of our skills and abilities, I like to say we can fix or repair anything,” said Pazderic.

And that’s a good thing. At any time of the year, day in and day out, inside or outside, the team, who are sometimes assisted by other staff and student employees, perform a multitude of duties, including office and conference setups and teardowns; painting; sheetrocking; heating, ventilating, and air-conditioning tune-ups and repairs; unplugging drains; fixing office lighting and broken windows; yard work and flower beds; and keeping the parking lot and walkways clear of snow and ice.

“Ed Koble, UND Grounds Superintendent, and his team assist us with the snow removal,” said Pazderic, “as does Mark Kobe, EERC Building Services Supervisor, who shovels the walkways from the building out.”

It’s definitely a team effort when it comes to making sure that the EERC and its surroundings reflect the high professional standards of the EERC. During the spring, summer, and fall seasons, the EERC’s well-groomed appearance includes flowers blooming, shrubs trimmed, and the grass mowed. During the winter, the walkways and parking lot are cleared.

“We really don’t know what each day will bring,” said Pazderic. “Sometimes we give Butch Riske (Technology Development Operations Supervisor) a hand. We are sometimes called on because of our ability to repair. We have the skills of, what I call, a good farm background.”

–Trish McGuire

energy could be sold back to the power company through the grid, which would provide a financial benefit.

Another advantage of a CHP system compared to a typical internal combustion generator operating on fossil fuel is its improved emission profiles. Variations in biomass can affect the performance and stack emissions in a typical internal combustion generator. This project will also demonstrate that the integration of the AFBG and the engine generator will overcome biomass limitations and achieve environmentally acceptable emissions.

The gasification process is also able to produce the desired syngas composition for other distributed applications such as hydrogen or methane, chemical and liquid fuels, or FT liquid production. The CHP will cater to process energy requirements to make it independent of the grid.

The EERC has run the Cummins generator on syngas and natural gas to ensure the baseline performance. Over the next several months, additional syngas testing using the generator will take place using multiple feedstocks, including wet wood, turkey litter,

municipal waste, and other opportunity biomass fuels. Emission levels will be determined and fine-tuned.

“We are extremely pleased by the level of commitment Cummins Power Generation has made to this project,” said EERC Director Gerald Groenewold. “A system such as this will provide a first step toward providing commercial entities the motivation to utilize opportunity fuels for energy generation.”

—Sandy Van Eck



## Joyce Sundby retires

Joyce Sundby, Personnel Assistant, retired from the EERC this spring. She witnessed many changes in her 31 years here, and her expertise and knowledge will be missed. Sundby started when the EERC was the DOE Grand Forks Energy Technology Center, which after defederalization in 1983 became the UND Energy Research Center (1983–1987), the UND Energy & Mineral Research Center (1987–1989), and finally the EERC (1989).

An open house with a short program was held in the EERC Discovery Hall lobby to honor Sundby on February 10. With many members of her family in attendance, she was given accolades and wished well by colleagues and serenaded by the EERC Choir.

“She will really be missed—not just by me but by everyone here,” said Sue Bartley, Human Resources Manager.

—Sandy Van Eck

*Brianna enjoys the retirement party thrown for her grandmother, Joyce Sundby.*



*EERC Director Gerry Groenewold presents Sundby with a special farewell on behalf of the EERC.*

## EERC EDGE

The EERC Edge is published for employees of the Energy & Environmental Research Center at the University of North Dakota. Send comments and story suggestions to Sandy Van Eck, Editor, (701) 777-5023 or svaneck@undeerc.org.

Energy & Environmental Research Center  
15 North 23rd Street, Stop 9018  
Grand Forks, ND 58202-9018  
(701) 777-5000  
www.undeerc.org

© 2011 University of North Dakota  
Energy & Environmental Research Center

Permission is granted to copy and distribute information for noncommercial use, as long as the content remains unaltered and credit is given to the EERC. To commercially publish any of the materials included in this publication, please contact the EERC to obtain written permission. Write Derek Walters, EERC Communications and Outreach Manager, 15 North 23rd Street, Stop 9018, Grand Forks, ND 58202-9018. Unless credited to others, photography is by Paul Gronhøvd.