

# Energy Services **BULLETIN**

Western's monthly energy efficiency and renewable energy newsletter dedicated to customer activities and sharing information on energy services.

## Fuel cell study provides answers for OPPD, clean power for zoo

It is only natural that organizations dedicated to protecting the world's wildlife should take an interest in technology that protects the environment, too. With the help of Omaha Public Power District (OPPD), the Henry Doorly Zoo pioneered the use of a hydrogen fuel cell generator to power zoo facilities.

OPPD installed a fuel cell at the zoo's Lied Jungle in 2001 as part of a pilot project to learn more about the technology. "Some accounts were asking us about fuel cells, and we wanted to see if this was an option OPPD should be offering customers," said Senior Media Specialist Mike Jones.

### Good fit for partners

The Lied Jungle indoor rainforest provided an excellent setting for Nebraska's largest municipal utility to take an in-depth look at fuel cell operation, maintenance, reliability and availability issues. The world's largest indoor rainforest has 123,000 square feet of floor space housing cliffs, caves, waterfalls, lush vegetation and animals from Asia, Africa and South America.

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Before installing the fuel cell, the zoo relied on two 60-kW co-generation units to maintain the necessary climate conditions. The noisy units had frequent breakdowns and required a great deal of maintenance.

There were many reasons OPPD considered the zoo a good candidate for the fuel cell project. The Lied Jungle is a 24-hour load factor requiring a substantial amount of electricity. Also, the zoo is close to OPPD, making it accessible to district employees who must maintain the unit. Perhaps most importantly, said Jones, "OPPD and the zoo have a very healthy working relationship."

The fuel cell project is one of many OPPD has undertaken to help the zoo control its energy use. OPPD worked with the zoo to centralize its cooling operations into a single plant. The system produces ice at night, in off-peak hours, to meet cooling needs of several major zoo facilities during the day. Another project increased the zoo's energy efficiency by installing a computer system to monitor, analyze



**The 200-kw fuel cell OPPD installed at Omaha's Henry Doorly Zoo quietly powers the Lied Jungle indoor rain forest and heats water with captured waste heat. (Photo by the Henry Doorly Zoo)**

and control energy use throughout the zoo's campus. The partners are currently looking at increasing the zoo's electricity supply by installing a new circuit.

The initial power purchase agreement covering the fuel cell's generation kept things simple for the zoo. OPPD charged the zoo only for the electricity it consumed, while the utility owned, operated and maintained the unit. That arrangement continues today, four years after the conclusion of the pilot project. "We have been pleased and have learned much," Jones observed of the project. "OPPD will continue to operate the fuel cell for the foreseeable future."

### Utility operations

OPPD bought the fuel cell from

*See FUEL CELL STUDY page 2*

## Fuel cell study

from page 1

International Fuel Cells Inc.—now UTC Power—for \$800,000. A grant from the U.S. DOE's Fuel Cells program for \$200,000 helped offset the cost. After a great deal of study and review by OPPD engineers, a phosphoric acid fuel cell was selected for the test. "It was one of the only fuel cells big enough to meet the Lied Jungle's power needs, and to show how distributed generation might impact our bottom line," said Jones.

The unit also gave OPPD a different type of fuel cell technology to compare with a system the First National Bank of Omaha installed in 1999.

Training utility employees to operate and maintain the fuel cell was an important piece of the learning curve. OPPD sent five operations and maintenance technicians to UTC's headquarters in Connecticut for a five-day class that included hands-on training. "The cell is completely computer controlled, so it is essential that technicians are able to work with a laptop computer for operation and troubleshooting diagnostics," Jones said.

He added that most large utilities would have personnel with the basic skills and knowledge needed to work with the fuel cell. "Not everyone who works on the cell needed to attend the class," Jones noted, pointing to the natural gas issue as an example. "Our technicians already knew that the higher nitrogen content in the Midwest's natural gas mix could poison the fuel cell. The training class gave them the chance to see how that problem played out."

The problem itself was fixed by adding a nitrogen scrubber to the natural gas supply line when the fuel cell was installed. That was the first and last modification OPPD made to the unit. With only routine maintenance, the fuel cell has operated at 95 percent availability for the last three years. "It has so far performed as well if not better than expected in terms of efficiency and reliability," Jones said.

The zoo's fuel-cell system has been more successful, in fact, than some units OPPD tested with the now-defunct IdaTek. The 5-kW systems were proton exchange membrane-type fuel cells, one installed at Offutt Air Force Base outside of Omaha, and the other at a facility in Elkhorn, Neb. The smaller units just seemed to be less reliable than the zoo's 200-kW fuel cell, Jones recalled.

waste heat from its fuel cell to temper water for wildlife ponds, provide humidity and supply hot water for its restaurant. The more hot water a facility needs, the better the economics are likely to be. Adding the infrastructure to capture the waste heat adds to the installations cost, however.

Facilities with loads that require an uninterrupted power supply will need to install a backup generator—another expense—to supply power when the cell is down for maintenance or due to mechanical failure.

The power from fuel cells is much more expensive than from conventional power sources. OPPD estimates that a kilowatt-hour (kWh) from a hydrogen fuel cell costs about 15 cents, compared with as little as two cents/kWh from coal-fired units. Having a long-term contract in place for the natural gas supply could help to protect the system owner against price volatility.

Congress has begun exploring possible tax credits and other efforts that could bring down the cost of fuel cell generation. A carbon tax would also improve the equation for the emissions-free power source.

### Others follow

Even without incentives, the fuel cell's environmental benefits can outweigh the high cost for organizations that count conservation and education as a critical part of their mission. The American Zoo and Aquarium Association promotes ecological responsibility, and the Wildlife Conservation Society and other zoo operators are adopting sustainable practices.

See *FUEL CELL STUDY* page 4

### Energy Services Bulletin

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### Lessons learned

The zoo project was also successful in providing OPPD with enough experience to form some useful conclusions about fuel cell operation and applications.

A fuel cell system performs best and is most economical when it runs at full capacity and as much of the waste heat as possible gets used. The zoo captures

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## Azusa incentive program caters to C&I customer needs

**D**esigning an energy-efficiency program for a large commercial and industrial (C&I) customer base takes a lot of creativity, and by that standard, Azusa Light & Water's Business Energy Partnership Program is a work of art.

Heating and cooling, appliances and electronics and lighting—most of the typical residential load—are only the beginning for a large C&I account. Depending on the business, a customer may have large refrigeration units, motors, compressors or high-temperature processing equipment to name only a few big energy-users. And then there are the buildings: warehouses, garages, cold-storage units, glassed-in showrooms, data-processing centers. All pose unique challenges to business owners trying to control operating costs, and to the utilities that want to help them.

Located in eastern Los Angeles County, Azusa Light and Water has plenty of experience meeting those challenges. About 13 percent of the municipal utility's load is C&I, said Public Benefits Manager Paul Reid. "We've learned that an incentive program has to be flexible to get C&I customers to participate," he noted. "There is no 'one size fits all' approach for business accounts."

### Customized program

In the spirit of choice, Azusa offers C&I customers a number of ways to improve the efficiency of their operations. Free commercial energy audits are available to established businesses. The New Business Retrofit Program provides rebates to new businesses installing energy-efficient equipment.



**Heppner Hardwoods, Inc. took advantage of Azusa Light & Water's Business Energy Partnership Program to install a more efficient dust recovery system. (Photo by Steve Castro, Eagle Photography)**

The Business Energy Partnership Program is the most popular, however. It is not new, but the program's current form is Azusa's response to California's energy crisis. New state requirements to meet specific renewable energy standards and soaring energy costs have only increased customer interest. "I have business customers who call me every year to find out what kind of budget I have for energy efficiency rebates," said Reid.

The secret of success, Reid explained, is that Azusa pays rebates for any cost-effective energy-efficiency improvement. Most of the projects have targeted lighting and HVAC, but a few customers replaced industrial-type equipment such as single-speed reciprocating compressors.

The program's emphasis is on cost-effective upgrades—the net

lifecycle savings from the project must be greater than the dollar amount invested in the improvement. "Otherwise, it's not an improvement," said Reid. "State regulations are getting more focused on results."

### Replacement pays off

And the results from upgrading manufacturing and processing equipment can be impressive, Reid noted, pointing to a retrofit performed by large key account Heppner Hardwood, Inc.

As the first step in the application process, Azusa conducted an energy audit at the milling facility. The audit identified the dust collection system on multiple milling machines as a primary energy user. The system used three constant-speed, 100-horsepower suction blower units. The auditor recommended replacing the constant-

*See INCENTIVE PROGRAM page 4*

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## Incentive program

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speed blowers with variable-frequency drives and adding a state-of-the-art computerized blast gate control system.

Heppner secured two bids for similar, but not identical dust recovery systems, and submitted its application to Azusa. After the utility reviewed the proposal, Heppner selected the Ecogate Advanced Computerized Dust Collection System. By optimizing air velocity, the system lowers energy costs, reduces stress on the motors and eliminates amperage peaks during motor starts. It is also quieter than the system it replaced, allows for future plant expansion and more than satisfies OSHA standards and air quality regulations.

A different, but related efficiency improvement involved moving the air compressor closer to the dust recovery system. This simple change decreased the distance compressed air had to travel from the compressor to the equipment and reduced the chance for leakage. “Compressed air is a major source of waste within a typical industrial facility,” said Reid. “Even a

relatively small leak can cost hundreds of dollars per year in wasted energy costs.”

Adjusted for production, the new dust collection system should save Heppner an estimated 44 percent on its annual electricity bill. After the incentive payment—which varies from project to project—the company’s payback period is slightly less than 50 months. The average savings for customer projects is 20 percent, with a payback period of about three years.

## Good for community

The goal of the Business Energy Partnership is to encourage industrial energy efficiency, but the program is also about building relationships in the community.

During a site visit at Heppner Hardwoods, Reid noted that a large amount of scrap hardwood wound up in the recycling dumpster. At his suggestion, the milling company began donating the waste wood to the local high school’s shop class. “We keep our eyes opened for opportunities like the wood donation,” said Reid. “It’s really rewarding to make connections that strengthen community spirit.”

The program has an economic

development aspect to it, as well. Increasing energy efficiency helps local businesses control costs and continue to provide affordable services to their customers. A municipal utility that actively engages its C&I customers in managing energy consumption helps to keep businesses in Azusa, and makes the city attractive to new businesses. The utility partnership was instrumental in helping Azusa to earn second place as “Most Economical City to do Business in Los Angeles County.”

Of course, the community-minded utility helps its residential customers improve efficiency, too. Azusa provides homeowners with free online home energy audits and home-in-home audits that look at energy use within a residence. Rebates are also available for weatherization and for Energy Star refrigerators and air conditioners.

The municipal utility will continue to keep its sights set on increasing industrial efficiency, however, Reid acknowledged. “Replacing a 100-hp motor with an efficient variable-speed motor saves a lot of energy,” he pointed out. “It takes a lot of compact fluorescent lights to match that.” ⚡

## Fuel cell study

from page 2

The Bronx Zoo’s award-winning, sustainable redesign of its Lion House in 2005 included a fuel cell. As part of its Fuel Cell Demonstration Program, the Los Angeles Department of Water and Power unveiled its 200-kW Zoo Fuel Cell Power Plant in 2006.

Fuel cells can be even more practical for temporary installation. The Smithsonian National Zoo in Washington, D.C., used a Microcell 1-kW fuel cell to help power last year’s annual holiday ZooLights exhibit. Located at one of ZooLights entrances, the unit generated not only power, but also a lot of public interest and excitement for the technology.

It looks like installing a clean, quiet generator to power zoo facilities and educate the public about renewable energy has become an industry trend. Omaha’s Henry Doorly Zoo, a world-renowned leader in animal conservation and research, has become a leader in sustainability as well. Thanks to a leader in customer service—Omaha Public Power District. ⚡

# Geothermal workshops to focus on technologies

**V**olatile energy costs are driving utilities and consumers alike underground, creating lots of questions about geothermal heat pumps (GHP) and geothermal power generation, and how those resources compare to other resource options. To help answer those questions, Western, the Colorado Governor's Energy Office (GEO) and DOE's GeoPowering the West initiative are teaming up to present two geothermal technology workshops.

## Adding geothermal to mix

The workshops are patterned after three very successful events Western co-sponsored earlier this year in Bismarck, N.D.; Redwood Falls, Minn.; and Sioux Falls, S.D. Those events focused on geothermal heat pumps, while the new workshops will also cover geothermal power and other options. "Comparing the different types of geothermal technologies with other renewable resources and conventional power supplies is a small part of the program, but a critical one," said Guy Nelson, Utility Geothermal Working Group (UGWG) team lead. "UGWG's goal is to encourage utilities to add geothermal resources to their power portfolios, but we want to do it in the context of a broader discussion about energy resources."

Sponsors of the event include American Public Power Association and National Rural Electric Cooperative Association. Tri-State Generation and Transmission Association and Snohomish Public Utility District (SNOPUD) will host the workshops.

"We want to attract utilities that are interested in examining both supply- and demand-side options to meet their future needs," said Joani Matranga, GEO Western Regional representative.

The first workshop will take place June 10-11 at Tri-State G&T's office in Westminster, Colo., with the second scheduled for Aug. 11-12 at SNOPUD's offices in Everett, Wash. The two forward-thinking utilities are located in states that have voter-enacted renewable portfolio standards, and are actively developing their renewable resources to meet requirements. Both states also have significant geothermal potential, but no generation. "The need and the resources are there, but that hasn't translated into development so far," said Nelson. "The workshops will provide a forum where UGWG can get power providers' input on how to move geothermal power forward in their territories."

## Comprehensive agenda

The agenda will have something for both program providers and for resource planners, including the opportunity for each to learn more about other's challenges, said Nelson. Ideally, attendees will have some familiarity with GHP technology and geothermal power production. "But it's not required," he added. "A brief tutorial is part of the program."

Through class presentations, case histories and demonstrations, attendees will learn about:

- Cost-effectiveness tests of GHPs from utility and customer perspectives

- Case histories of GHP systems
- Actual GHP energy savings over conventional HVAC systems
- How GHP programs qualify as energy-efficiency programs
- New drilling and installation techniques
- Cost comparisons of geothermal power and other resource options

Speakers from Delta Montrose Energy Association and United Power Inc. will present case studies on successful GHP programs at their utilities. Representatives from Idaho Power and Utah Power have been invited to talk about their utilities' experiences with geothermal generation. In June 2006, Idaho Power issued a request for proposals for geothermal energy, which led to the construction of the state's first geothermal powerplant. In Utah, geothermal facilities have been generating power for more than 20 years. Utah Power, a PacificCorp company, has operated the 26-MW Blundell geothermal power station at the Roosevelt Hot Springs geothermal area since 1984.

## Vendors to exhibit

During breaks between sessions, attendees will be able to talk to vendors of geothermal technology products and services. A display area will feature drillers, installers, turbine suppliers, HVAC contractors, auditors and more. "The presentations will cover issues like economics, technology and program creation, and the exhibitors will be available to answer logistical and practical questions,"

*See GEOTHERMAL WORKSHOPS  
page 7*

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## Synchronous belts—Sometimes a great motion

About one third of the electric motors in the industrial and commercial sectors use belt drives, the majority of which use V-belts. One alternative is the synchronous belt (also called timing, positive-drive or high-torque drive belt), which is toothed and requires installation of a mating toothed-drive sprocket.

Synchronous (sync) belts never slip, and with their shallow depth they have less flexing friction. This gives them about a 5 percent efficiency advantage compared to V-belt drives in a typical service application of load variation and periodic re-tensioning. The V-belt may be only 3 percent less efficient when perfectly tensioned and exactly at its load rating. However, it loses efficiency faster than a sync belt when it departs from this ideal.

A good rule of thumb is that approximately 50 percent of existing V-belt drives would be good potential candidates for conversion to sync belt drives. Consult manufacturer application literature or a reliable vendor to find out if you have a good application, and to choose the best sync belt for your needs from the many product lines.

### Sizing is critical

Be careful on sprocket sizing to ensure that you actually get the energy savings you intend. A sprocket pitch ratio that is the same as the original V-belt sheaves pitch ratio will reduce slip, making the load turn faster. That increase in speed will require a net increase in energy even if the belt

drive power transmission efficiency has increased by 5 percent.

To achieve the same driven speed, the pitch ratio of sprockets (driven over driving) should be targeted for about 5 percent higher than the initial V-belt sheaves pitch ratio. Sprocket catalogs show that incremental size changes vary, but a 4- or 5-percent size increment is typical. Therefore, you will not be able to find the exact pitch ratio. Choose a sprocket pitch ratio at least 3 percent larger than the initial V-belt sheaves ratio to accommodate finite size increments without significantly slowing the driven load, which could be detrimental to the driven load performance.

### When not to convert

Sync belts are always more efficient than V-belt drives, but three considerations preclude them from many applications.

1. They make a whirring sound that can be objectionable in some applications.
2. They transfer more vibration and shock load, and are completely unable to slip when driving loads that are susceptible to jamming.
3. They are more sensitive to misalignment, which can cause them to wear unevenly or fail prematurely. A major belt drive manufacturer states that they should not be used in applications where misalignment is inherent to the drive application such as in any framework (motor mount, structural support, etc.) that flexes under load. When rigidity is not good, the driving and driven shafts

can also be flexed toward each other in high torque situations like starting or jamming, causing the sync belt to jump teeth and be damaged.

### Costs and benefits

Sync belts require less maintenance than V-belt drives because they do not require periodic re-tensioning and sheave realignment. That is partly because the motor and load for which sync belts are suited must be rigid to begin with or modified for greater rigidity when retrofitted with sync belts. Sync belts are not subject to the loss of tension that occurs in V-belt drives where sheave and belt surface wear allow the V-belt to penetrate deeper into the sheave groove. The slight tension decrease from stretching or wear does not cause slippage, so it is not necessary to tighten the sync belt periodically to maintain efficiency.

Sync belts can require more frequent replacement. A good V-belt application has 24,000 operating hours, whereas 12,000 operating hours is more typical of a sync belt application. De-rating to 60 percent of design rating would extend a sync belt's lifetime closer to that of a V-belt. Also, better sync belts with Kevlar fiber cords and polyester rubber, in the right application, can be good for 24,000 hours.

Retrofitting an electric motor with a sync belt should cost between \$11 and \$22/horsepower (HP) according to a 1995 belt drive technology assessment by Almeida and Greenberg

*See SPOTLIGHT page 7*

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## Spotlight *from page 6*

of Lawrence Berkeley Laboratories (adjusted for inflation to 2008 dollars). The investment covers the cost of the sprockets, plus the more expensive belts and installation. Prices vary greatly, depending on the belt drive rating, with the large drives requiring a smaller price premium per

horsepower. Sprockets typically cost 1.5 to two times the cost of belts. One set of sprockets will outlast three belts.

Converting to a sync belt drive can pay back in less than a year in heavy-use applications. Continuous, fully loaded operation of a 100-HP sync belt drive with motor efficiency of 94.5 percent and a \$.05/kWh rate will save \$1,729 per year. A sync

belt retrofit made for less than \$17/HP has a payback of less than a year. Increasing the driven-over-driving sprocket size ratio to reduce driven-load speed at the time of conversion will greatly increasing energy savings. Speed reduction savings are dramatic in variable torque loads like fans. ⚡

## Geothermal workshops

*from page 5*

explained Nelson. “And if any attendee feels inspired to start a GHP program on the spot, the technical resources to do it will be right there,” he joked.

Ron Horstman, of Western’s Energy Services, will be among the exhibitors to introduce a new technical resource. Attendees can pick up a copy of the Geothermal Heat Pump fact sheet, also available online. “At the earlier workshops,

it became clear that utilities needed a fact sheet that summarized GHP technology for residential consumers,” Horstman explained. “Member services managers can offer it to a homeowner who is considering installing a GHP, or Energy Services can brand the fact sheet for a utility to use as part of a program. We hope to be doing more of the latter after the workshops,” he added.

Most of all, however, workshop sponsors hope to encourage utilities to take a closer look at a versatile renewable resource with the

potential to play a large role in the nation’s—and the West’s—energy future.

Registration fees are \$90 for one day and \$130 for two days. Reduced rates are available for members or customers of sponsoring organizations. The fee covers workshop materials, meals and refreshments. Continuing education credits are available. There are also a limited number of display tables available. Questions? Contact Guy Nelson at 541-994-4670. ⚡

# Geothermal Technologies Workshops

**June 10-11**     **Tri-State Generation and Transmission Cooperative, Westminster Colo.**  
**Aug. 11-12**     **Snohomish Public Utility District, Everett, Wash.**

Learn about:

- Cost-effectiveness tests of GHP from utility and customer perspectives
- Case histories of GHP systems
- Actual GHP energy savings over conventional HVAC systems
- How GHP programs qualify as energy-efficiency programs
- New drilling and installation techniques
- Cost comparisons of geothermal power and other resource options

For more information, contact Guy Nelson, [energycguy@utilityforum.com](mailto:energycguy@utilityforum.com) or 541-994-4670.

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## Web site of the month:

# International Ground Source Heat Pump Association

**A** decades-old, energy-efficient heating and cooling technology is getting its moment in the sun, and the International Ground Source Heat Pump Association (IGSHPA) is going to make sure the ground source heat pump (GHP) gets all the credit it deserves.

Headquartered at Oklahoma State University (OSU) in Stillwater, Okla., the 21-year-old association promotes GHP technology, conducts geothermal research and trains and certifies installers. Although the IGSHPA Web site mainly targets the GHP industry, it is an excellent resource for utilities researching options for incentive programs or simply trying to answer customer questions.

## Consumer education

Those who are new to GHP technology can start their education with “What is a ground source heat pump?” This clear, concise explanation of the system includes links to residential and commercial sections that list specific benefits for the respective audiences. An extensive list of frequently asked questions covers just about every issue consumers can think of, and a few they might not.

Contractors have questions, too, and Earth Insights may provide the answers they need. The single-page briefs, written by Certified Geothermal Designer Phil Rawlins, are a resource for detailed information about geothermal design, installation and troubleshooting.

More resources, tailored to a variety of audiences, are available from

IGSHPA’s Publication library. Utilities launching a GHP marketing program can purchase brochures on residential, school and commercial applications to help educate prospective customers. The first four copies of case studies describing specific geothermal installations are free, and can be purchased in bulk. The magazine *Geothermal Outlook* features more case studies, written in a less technical style.

The *Adventures of Iggy*, a coloring book that explains GHP systems to young consumers, makes a great handout at community events. Teachers can download and copy the coloring book to use in the classroom. IGSHPA is also developing a curriculum to give elementary school students an understanding of geothermal technology.

## Ready to install

Now that your customers have read through several IGSHPA publications, they want the benefits of GHP technology for their homes and businesses. It is essential to the success of a utility GHP program—and to customers’ satisfaction—that those systems are correctly installed. Start the search for qualified contractors in IGSHPA’s business directory, a searchable database of accredited installers and certified designers throughout the United States and the world. The vendors in the database have been to IGSHPA-accredited training and have passed the association’s accreditation/certification exam.

The lack of qualified, local GHP contractors often poses a problem for



**The mission of the International Ground Source Heat Pump Association and its members is to promote ground source heat pump technology worldwide through education and communication. (Artwork by International Ground Source Heat Pump Association)**

[www.igshpa.okstate.edu](http://www.igshpa.okstate.edu)

utilities that want to promote GHP systems or launch a GHP marketing program. Conventional HVAC contractors can acquire the specialized skills needed for GHP installation through IGSHPA training courses for installers and designers. Taught by IGSHPA-trained professionals, the courses set the industry standard for installation methods and training. The association also offers continuing education units and “train the trainer” courses to fill the growing need for competent installers familiar with the latest GHP technology.

The workshops, offered on the OSU campus and around the country, have been filling up fast due to increasing interest in the super-efficient GHP systems. Check the IGSHPA training calendar for the nearest event, and urge local HVAC professionals to sign up. ⚡

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