

## All-weather heat pump promises energy-saving alternative

Homebuyers visiting Enchantment Ridge, a new subdivision in Loveland, Colo., will find curb appeal, scenic location, custom design and many unexpected features—such as a heating guarantee—that are of interest to area utilities, as well.

### Energy-efficient housing

Enchantment Ridge is the latest project by Aspen Homes, a Colorado-based builder that prides itself on building to, and often exceeding, Energy Star and Built Green Colorado standards. The company has been an Energy Star Partner since 2003 and earned the 2006 Partner of the Year award for building energy-efficient homes.

Built Green gave its 2006 Built Green Home of the Year award to the builder's net-zero-energy house in Fort Collins. The custom home combined a ground-source heat pump system and solar panels with a net-metering agreement with Xcel Energy to eliminate the owner's utility bill. "We take the 'systems approach' to build-

ing our houses," said Jammie Sabin, vice president of Aspen Homes. "All the components have to act together to positively impact the house's energy and water use."

A highly insulated building envelope, low-e windows, mechanical ventilation and sealed-combustion water heaters are standard features on all Aspen Homes. At Enchantment Ridge, an innovative all-weather, air-source heat pump provides heating. The efficiency of the heat pump, combined with the design of the homes, is so effective in lowering the amount of fuel needed to heat the home that Aspen Homes offers buyers a space heating consumption guarantee.

### Tri-State conducts tests

Manufactured by Hallowell International, the heat pump is the next generation of the cold-weather heat pump that has been around for the last eight years, said Sabin. "This all-electric unit works to -30 degrees F, so it eliminates the need for dual-fuel back-up systems," he observed. That makes it both economical and environmentally friendly, he added, because, "The price of electricity is much more stable than heating oil or natural gas, and it can be produced from renewable resources."

Tri-State Generation and Transmission Association is watching Enchantment Ridge closely because



Jammie Sabin (left) of Aspen Homes discusses the advantages of the all-weather, air-source heat pump with Energy Services Representative Linda Swails and Mike McCoy of Tri-State G&T.

the power wholesaler is currently involved in its own multi-year demonstration of the air-source heat pump. Although Tri-State's demonstration is not associated with the subdivision, Tri-State Senior Engineer Mike McCoy has teamed up with Sabin to give tours of the system in Enchantment Ridge show homes. "It's good to have a large-scale project on the Front Range, to compare with data from other parts of the state," said McCoy.

Poudre Valley Rural Electric Association is the only Tri-State member in the area to install a heat pump so far, and that was in June of

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## Heat pump

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this year. Starting with Delta Montrose Energy Association in 2006, Tri-State member co-ops have installed 10 systems since the heat pump hit the market. Tri-State and the National Rural Electric Cooperative Association are funding a study by the Cooperative Research Network, NRECA's research arm, to collect data on the heat pumps' operation through phone line hook-ups. "It is a promising technology, but we want to verify manufacturer claims before we promote it to consumers," McCoy said, "See how it performs in the real world."

Two co-ops are testing the heat pump's performance in the harsher climate of the Rocky Mountain's Western Slope. In Telluride, San Miguel Power Association installed a system at a commercial property. DMEA retrofitted a home that had a conventional air-source heat pump and the back-up gas furnace those systems require. The homeowner will be able to compare heating bills from his old dual-fuel system with the new model.

Highline Electric Association and Y-W Electric Association are testing

units on the eastern plains. More members have expressed interest in joining the demonstration, which Tri-State would welcome. "Our goal is to get the heat pumps spread around the region to test them in all sorts of conditions," said McCoy.

### Affordable alternative

Coming from a utility that has shown such strong support for the geothermal, or ground-source, version of the heat pump, Tri-State's enthusiasm for the all-climate, air-source system might seem surprising. Not at all, McCoy insists. "If there is an option that will give some consumers a bigger bang for the buck, we want our members to have the data on it," he pointed out.

Sabin agreed that while ground-source heat pumps are still more efficient, its air-source counterpart offers other advantages. "Any contractor who knows how to install a forced-air furnace can put in an air-source heat pump," Sabin said. "It's just new engineering of off-the-shelf components. For instance, the air handler is a York—a standard application."

Although the heat pump's cost is similar to a ground-source unit, installation is much less expensive because the air-source equipment is all above ground. The compressor sits on a slab outside the house, the air handler is inside and some piping connects the two units to each other and to the indoor ducts. "There is no loop field," said Sabin. "That makes it perfect for retrofits and production settings."

And the all-climate heat pump outperforms conventional heating systems—it is 300-percent efficient, compared to the 95-percent efficiency

rate of the best natural gas furnaces. The manufacturer claims the heat pump can heat a house for \$2.40 for 24 hours, based on \$0.10/kWh.

### Reaching wider audience

If Sabin seems unusually well-versed in the advantages of the air-source heat pump, it is because he is more than just a customer. He is also head of Lorax Energy Conservation, LLC, a distributor for the Hallowell all-climate heat pump and other energy-efficient systems. "We couldn't find support for the technologies we wanted to use in our houses, so we started our own company," he explained.

Backers are ready for the all-climate heat pump to become commercially available, said Sabin, and Lorax's plan to train local contractors to install the unit would increase its marketability. Utilities offering incentives would help, too, but Tri-State leaves that up to its members, McCoy stated. "We provide a menu of incentives, and our members decide which ones suit their customers' needs," he said. "This is one a lot of them are already considering seriously."

Homebuyers—utility customers—are looking for ways to reduce their dependence of fossil fuels, said Sabin. Combining highly efficient electrical systems, like the air-source heat pump, with on-site generation, like solar panels, reduces the homeowner's carbon footprint, and it makes renewable energy more economical.

For his part, Sabin would like to make the all-climate heat pump standard in Aspen Homes' next subdivision. "We are always looking for ways to do more and better on each project," he said. ⚡

### Energy Services Bulletin

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# Big-box stores show sustainability is good business

In the competitive world of “big-box” department stores, a new kind of competition is emerging, as industry giants strive to reduce their environmental footprint through the use of renewable energy and more efficient buildings and practices.

Wal-Mart Stores, Inc., which pioneered sustainable operations two years ago with experimental Supercenters in Aurora, Colo., and McKinney, Texas, recently announced that it would be adding solar arrays to 22 locations in California and Hawaii. About the same time, Kohl’s Corporation unveiled its plans to convert 75 percent of its California stores to solar power.

## Projects support business, state goals

Wal-Mart’s project represents a major step toward the company’s goal of powering its operations with 100-percent renewable energy. Total generation from the 22 facilities is estimated to be 20 million kilowatt-hours per year.

Kohl’s is working closely with the state to help meet the California Solar Initiative goal to generate 3,000 MW of solar power by 2017. The first two California Kohl’s will go solar this month, with the rest of the designated solar locations to be finalized by the end of 2008. When complete, the retailer’s solar deployment alone will represent approximately 1 percent of California’s 10-year objective.

Economics, as well as environmental concerns, motivated Wal-Mart’s purchase. A press release about the project noted that the pilot stores would realize savings on their utility rates in addition to reducing green-



**Day-lighting and polished concrete floors in Wal-Mart’s experimental Aurora, Colo., Superstore show that sustainable building is also attractive building. (Photo courtesy of National Renewable Energy Laboratory)**

house gas emissions by 6,500-10,000 metric tons per year.

Ron Judkoff, director of NREL’s Buildings and Thermal Systems Center at the National Renewable Energy Laboratory, observed that renewable energy, like energy efficiency, is a good investment. “Wal-Mart’s decision to take advantage of the economic and environmental benefits of solar power and energy efficiency technologies is a great step in the right direction,” he said.

## Early success

NREL is collecting data on Wal-Mart’s Aurora store over a three-year period to evaluate the facility’s 50 different sustainability measures and technologies. Although the project is only at the half-way mark, the data and anecdotal evidence so far are suggesting some lessons. “At this point, my main advice to other companies is that energy and water

efficiency measures are economically attractive and should be pursued,” said NREL Senior Engineer Michael Deru, who also works in the Buildings and Thermal Systems Center.

Lighting has emerged as one area in particular where a few changes can yield significant benefits for retailers. “We found that Wal-Mart’s standard lighting design was already very good,” noted Deru.

Wal-Mart has been employing light harvesting techniques in its stores for about the last 10 years, acknowledged Spokesperson Bill Wertz. Skylights linked to automatic dimming systems light up the stores’ main shopping areas.

Installing LED lights in refrigerator cases really paid off, said Wertz. “The lamps are less expensive to operate than fluorescent lights and they display merchandise better,” he

*See BIG-BOX STORES, page 5*

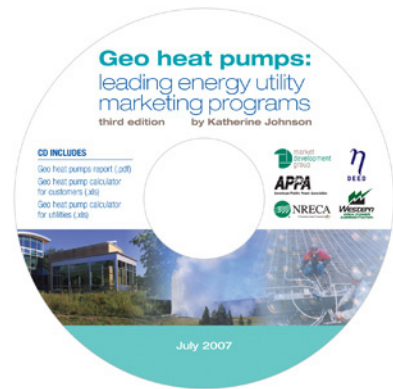
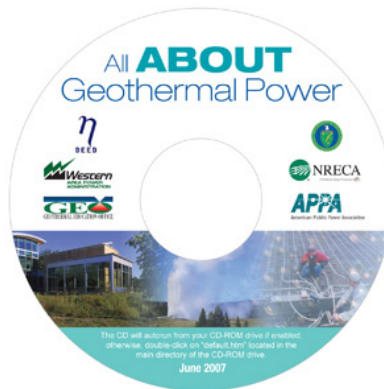
# Western and partners produce new guides on geothermal power

Clean, reliable, homegrown and largely neglected, geothermal energy was the third largest source of renewable energy in the United States in 2003. Yet, if you asked someone, even in the utility industry, to name different types of renewable energy, chances are that geothermal would be further down the list. Western hopes to raise awareness about this base-load renewable resource with two new guides, developed in cooperation with American Public Power Association and several other organizations.

*All About Geothermal Power*, a CD modeled on Western's popular Wind Workshop in a Box, provides a comprehensive overview of geothermal power, while the *Geothermal Heat Pump Report* focuses on a non-electric application. "The scope of these tools shows the versatility of the resource," said Randy Manion, Western Renewable Resources Program manager. "Almost any utility can incorporate some form of geothermal power into its portfolio."

## CD for wide audience

Western cooperated with APPA's Demonstration of Energy Efficient Developments Program, National Rural Electric Cooperative Association and U.S. DOE's GeoPowering the West program to produce *All About Geothermal Power*. "This is a well-done CD with lots of information on geothermal powerplants," said Michael Pehosh, NRECA principal engineer. "I think it will be a good resource for people to learn more about this energy source."



**"All About Geothermal Power" and "Geothermal Heat Pump Report" CDs offer two different perspectives on an often-overlooked base-load power resource.**

The CD collects some of the best resources available to help state and municipal government agencies, community groups, utilities and consumers understand and evaluate geothermal energy. In addition to interactive materials, the CD includes Web links, reports, case studies and calculation tools. Along with general information about geothermal energy, users will learn about power generation technology, financing, permitting, tax policies and much more. There is also a section on non-electric applications, including geothermal heat pumps and direct use of heat.

The resources on the CD were compiled by the Geothermal Education Office, which works to promote public understanding about geothermal resources and their place in a sustainable power portfolio. "Our goal was to offer something for all levels of experience with geothermal energy," said GEO Executive Director Marilyn Nemzer. "Some utilities have experience with generation, some with direct use for heating and others

don't have any type of geothermal experience. Everyone can learn something from *All About Geothermal Power*."

## Non-electric application

APPA and GeoPowering the West were also partners in bringing the *Geothermal Heat Pump Report* to Western customers and other utilities. Authored by Utility Programs Specialist Katherine Johnson of Market Development Group, the report was first released in 2001. "The industry needed a collection of best practices, vendors and strategies for marketing the benefits to customers," explained Johnson.

She subsequently updated the report for a manufacturer who wanted to get more insight into the market. Changes in the third, current edition reflect the continuing evolution of the market and the technology.

The report, available on CD, covers basic information about the equipment and costs and examines successful utility heat pump market-

*See NEW GUIDES, page 5*

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## New guides

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ing programs. Profiles of system manufacturers, architects, engineers and non-profit associations dedicated to promoting the technology describe history, products, markets served and competitive strengths and weakness of each organization.

In addition to the *Geothermal Heat Pump Report*, the CD also includes two Excel-based spreadsheet calculators. One helps utilities calculate the effects of residential geothermal heat pump installations in their territory. The other helps residential customers compare geothermal heat pumps to a variety of alternative heating and cooling systems. “The spreadsheets will help utilities explain and quantify

the benefits of geothermal heat pumps to customers,” explained Johnson. “They will be an indispensable marketing tool for utilities and a great educational tool for consumers. The spreadsheets are a valuable addition to the report.” To obtain a copy *All About Geothermal Power* or *Geothermal Heat Pump Report*, contact your Energy Services Representative. ⚡

## Big-box stores

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stated. “Wal-Mart is already putting LEDs in new stores and retrofitting existing facilities.”

### Measures show promise

Closed refrigerator cases are another measure that Wal-Mart is rolling out to some of its other stores. Open cases for refrigerated and frozen foods pour cold air into store aisles, requiring more energy to cool the case—and to warm the store in cold weather. While placing more products behind glass doors promises energy savings, store managers initially worried that customers might be put off. That was not the case, however, said Wertz. “The acceptance has been great. The products are just as visible and customers don’t perceive the doors as a barrier.”

Of the store’s many “green” building features, two standouts are being adopted in the design of new Wal-Mart stores. The white roof reduces the building’s cooling load, and the handsome, polished-concrete floors cut down on maintenance and the use of some cleaning products. Both

features illustrate Deru’s advice to keep design simple, showing that even low-tech, non-mechanical measures can save time, money and energy.

Generating your own energy is not the easiest way to go green as Wal-Mart’s experience with wind turbines at the Aurora store proves. The turbine has broken down frequently, however, and the verdict is still out. “At this point we aren’t ready to pursue installing our own individual turbines,” Wertz said.

The solar pilot project will help the retailer determine if photovoltaics are a cost-effective way to reach its renewable energy goals. One lesson Wal-Mart has learned quickly is that there are many ways to increase a business’s sustainability.

### Store generates interest

In a collaborative, rather than competitive, spirit, Wal-Mart is reaching out to other retailers to share lessons learned that could improve sustainability across the industry. The Aurora and McKinney experimental stores, and Wal-Mart’s High Efficiency stores in Kansas City, Mo. and Rockton, Ill. offer

tours to interested professionals.

Retailers who would like to learn more about Wal-Mart’s other sustainability efforts—to reduce waste and to sell environmentally-friendly products—can contact Tara Raddohl or David Tovar.

It isn’t only employees from other companies and industries that are interested in Wal-Mart’s experiment, Wertz said. “Our own associates are very enthusiastic about sustainability, and they are proud to be working at the experimental store.”

Customer feedback has been very positive, too, Wertz added. It seems that goodwill increases as a company’s environmental footprint gets smaller. “Businesses should not underestimate the potential image benefits in evaluating efficiency and renewable energy projects,” Deru asserted.

That is another lesson that doesn’t have to wait for the final report. As Wal-Mart CEO Lee Scott told USA Today, “We set out to do (sustainability) as an obligation, a good-works effort, but we discovered the truth: The real reason to do this is for the business itself.” ⚡

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## Technology Spotlight:

# The next generation of solar photovoltaic cells

*This column features helpful information, innovative equipment, systems and applications utilities around the nation can use to save energy and improve service.*

While the “third generation” of solar photovoltaic cells is being developed, the vast majority of solar cells sold today are still “first-generation”—single- and poly-crystalline, wafer-based silicon cells. First generation cells are stable and efficient, but expensive to manufacture. In second-generation solar cells, materials are deposited in thin films of materials such as amorphous silicon, micro-crystalline silicon, cadmium telluride (“CadTel”) and copper indium selenide/sulfide. While thin-film cell efficiencies are lower than first-generation cells, their lower material and manufacturing costs generally result in lower costs-per-watt of electrical output.

Third-generation solar cells show promise of significantly reducing cost by increasing efficiencies, using less expensive materials and/or simplifying fabrication. This new generation of solar cells functions very differently than its predecessors. First- and second-generation cells both rely on a p-n junction to generate electrical current, while a defining characteristic of third-generation cells is that they do not have p-n junctions. The emerging solar cells discussed here fall into three general categories: dye-sensitized cells (also known as Gratzel cells), nanocrystal cells (quantum dots) and organic cells.

## Dye-sensitized solar cells

Dye-sensitized cells for small applications are currently in pilot-scale production by two companies, G24 Innovations Ltd. and Konarka Technologies, Inc., G24 Innovations plans to begin commercial-scale production in 2008. Their first product will be a cell phone charger.

Dye-sensitized solar cells use a transparent, semi-conducting anode on the top surface, metal on the back surface and an electrolyte containing organic dyes sandwiched between them. Because they use low-cost materials and are easy to manufacture, dye-sensitized cells are expected to be significantly less expensive than cells currently on the market. In fact, they are so easy to make that do-it-yourself instructions are available on the Internet. Another big advantage is that they are sensitive to indirect light and so generate electricity in cloudy conditions or even in indoor light. Efficiency is good, with G24's product near 10 percent efficiency. Research is underway to increase efficiency by, for example, combining dye-sensitized solar cells with quantum dots (described below).

Research over the last decade has addressed the cells' longevity under high-light conditions, which has now improved enough that they are considered ready for market for small applications. The major challenge at this point is to develop large-area dye-sensitized panels with power outputs comparable to typical first- and second-generation solar panels.

## Nanocrystal solar cells

Nanocrystal solar cells consist of a silicon substrate coated with nanocrystals or “quantum dots.” Quantum dots may be composed of many of the same materials used in current panels—silicon and cadmium telluride, as two examples. But due to the tiny size and shape of the nanocrystal, one photon of light striking a quantum dot frees two or more electrons. With conventional solar cells, only one electron is freed per photon. This has the potential to dramatically increase efficiency. Researchers hope to achieve efficiencies as high as 42 percent, compared to 10 to 15 percent for solar cells available today. Other advantages include low material costs and the capability of manufacturing flexible panels.

Quantum dots are fragile, however, so longevity is still a problem. It has also proved difficult to harness the electrons that are generated within the nanocrystal to create an electrical current. Recently, researchers have found that combining quantum dots with “carbon nanotubes”—long cylindrical carbon molecules—assists in gathering up the electrons and routing them to the electrode. Other research has focused on developing cost-effective fabrication methods that can be scaled up to commercial levels.

## Organic solar cells

Organic solar cells—such as conducting polymer cells and molecular organic cells—are lightweight, very

*See TECHNOLOGY SPOTLIGHT, page 8*

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## Web site of the month:

# Energy Information Administration

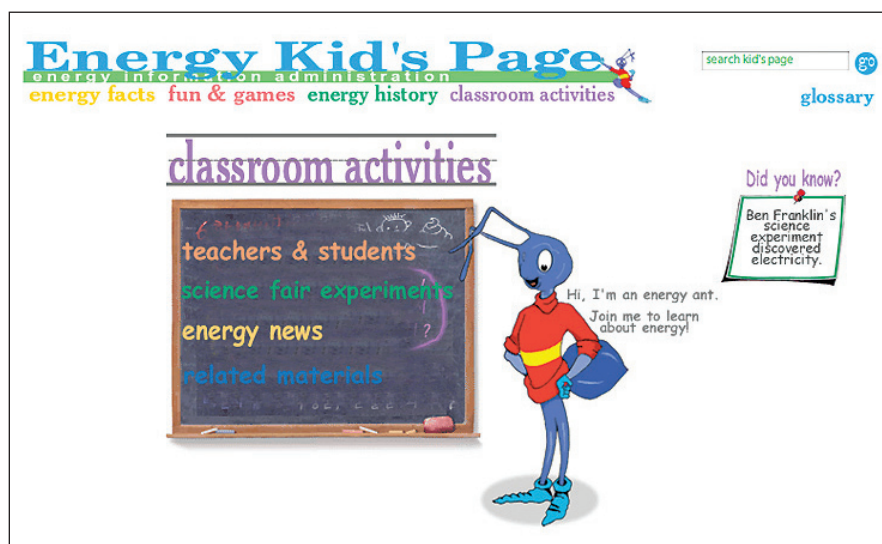
**E**nergy—buying it, selling it, delivering it—is a utility's business. And there's more: figuring out how to use energy more efficiently, putting together the right mix of resources at the right cost, forecasting how much customers will need next month, next year or five years from now.

Clearly, power suppliers need lots of information about energy to do their jobs, and that is what Energy Information Administration provides. EIA, the statistical agency of the U.S. Department of Energy, compiles energy data, analysis and forecasts to promote sound policy making, efficient energy markets and public understanding about energy. By law, EIA's products are prepared independently of administration policy, so it does not form or advocate policy conclusions.

## Fuel, use, market data

The EIA site groups its wealth of data into 12 categories:

- Petroleum
- Natural gas
- Electricity
- Coal
- Nuclear
- Uranium fuel, nuclear reactors, generation, spent fuel
- Renewable & alternative fuels
- International
- Forecasts & analyses
- State & U.S. historical data overview
- Households, buildings & industry
- Environment
- Energy Kids' page



**The Energy Information Administration Energy Kids Page teaches kids about energy sources, uses, science and efficiency in easy-to-understand terms with lots of pictures and graphics.**

Users will also find news, publications and reference materials. The news section features upcoming conferences, training courses and reports.

The Annual Energy Review, EIA's primary report on historical energy data, is located under publications. The data include overviews for each category along with statistics on total energy production, consumption and trade.

Energy Basics 101 and Frequently Asked Questions are some of the reference materials available.

## Resources for utilities

Utility professionals will most likely be drawn first to the Electricity section, for data on markets, generation, fuel, the environment and more. Demand-side management statistics show costs and effects of programs from 1994 to 2005. The Electricity Infocard gives a snapshot of the industry in graphs and charts.

The Wholesale Market Report, Electric Power Monthly and Electric Power Annual monitor electricity sales throughout the year. The Short Term Energy Outlook and the Annual Energy Outlook forecast and analyze future U.S. energy supply, demand and prices. Most data tables are available in html, pdf and Excel format.

The Environment section includes data on electric powerplant emissions and breakdowns of state emissions by fuel and energy sectors. Environmental reports on U.S. power sector emissions from past years and emission forecasts are also available here.

Households, Buildings, Industry & Vehicles contains end-use energy consumption data that can help utilities keep an eye on consumer trends. This section offers extensive information on energy consumption in the residential, commercial and manufacturing sectors. Detailed household microdata is a statistical

*See WEB SITE OF THE MONTH, page 8*

## Technology Spotlight

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inexpensive to manufacture (even “disposable” according to some), flexible and can be manufactured with little potential for environmental impact. Fabrication costs are low because they can be dissolved in solvents and sprayed like paint onto surfaces or printed onto plastic or metal substrates. For example, they can be applied on rolls of plastic in roll-to-roll coating machines, much like printing newspapers.

Some predict “plastic solar cells” will be commercially available within five years, but there are still hurdles to overcome. Organic and polymer solar cells suffer from low efficiencies, currently 3 to 5 percent at most. This is expected to double in the near term and efficiencies of 15 to 20 percent are expected within 15 to 20 years. Perhaps more seriously, the efficiency of current polymer solar cells significantly decreases over time when exposed to the environment. Good protective coatings are not yet available.

## Enhanced energy storage

Hydrogen generation using solar energy may become more cost effective with improvements in photovoltaic materials. By generating

hydrogen, solar energy may be stored for use when the sun isn't shining, transported to regions with poor solar resources and used in fuels cells as a transportation fuel. ⚡

## Web site of the month

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survey on energy consumption and expenditures in housing units, along with data on energy-related characteristics of the houses and occupants. Building microdata compiles similar statistics on mall buildings in the United States.

Looking for a way to engage and educate your next generation of customers? EIA's Energy Kids' Page has some great ideas. “Energy Ant” teaches kids about energy sources, uses, science and efficiency in easy-to-understand terms with lots of pictures and graphics. Puzzles, word games,

quizzes and a downloadable activity book are entertaining as well as educational. Introducing teachers and school districts to the classroom activities and field trip suggestions can turn them into valuable partners in your utility's public outreach program.

These highlights are only a fraction of the data available from the Energy Information Administration. Energy services managers, analysts and board members will think of dozens of uses for the information to be found on this Web site of the month.

*Note: If there is an energy- or utility-related Web site that you find especially useful, let us know. Contact the editor with your suggestion for Web site of the Month. ⚡*

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