RE
RURAL ELECTRIC MAGAZINE

Electric Cooperatives: Meeting the Challenges of a Carbon-Constrained Future

Politics and policy affecting NRECA members

commentary

GLENN ENGLISH, CEO

According to the U.S. Department of Energy (DOE), demand for electricity nationally will increase by 30 percent by 2030. Yet even with an optimistic projection of a 9 percent reduction in consumption due to increased efficiency, our nation will soon run out of excess generating capacity and must build more power plants and transmission lines to keep the lights on.

This raises a catch-22 situation. Unless significantly more power plants are placed into service soon, there's a good chance consumers could experience brownouts and even rolling blackouts in the not-too-distant future. But this generation will be the most expensive in history, coming at a time when prices for fuels to produce electricity and construction materials like steel, copper, and concrete are skyrocketing. On top of it all, local, state, and federal lawmakers are considering additional costs on utilities to reduce greenhouse gas emissions, notably carbon dioxide, blamed for contributing to climate change.

The nation's 900-plus local electric co-ops, experiencing 2.7 percent consumer growth (twice the national average) and 3 percent average load growth annually, carry a special responsibility to protect our consumer-members against dramatic and potentially crippling increases in electricity costs. When it comes to meeting our nation's energy challenges, including climate change, we believe answers can be found in a diversified mix of clean coal, nuclear, natural gas, and renewable generation, along with advancements in energy efficiency and technology. No magic "silver bullet" exists.

As energy and climate change debates move forward, electric co-ops are encouraging those in power to seek out practical, long-term remedies based on new technology that will allow us to continue providing reliable and affordable power in an environmentally responsible fashion

On the climate change front, we feel recommendations developed by the Electric Power Research Institute (EPRI), a non-profit utility-sponsored consortium based in Palo Alto, Calif., offer a workable framework for starting talks on solutions. The EPRI road map, featured in a seven-part *RE Magazine* series that's reprinted here, spells out how U.S. electric utilities can slash carbon dioxide emissions below 1990 levels by 2030 (roughly 45 percent)—even as they take on 30 percent more load, half of which will be generated by coal—through aggressive steps in seven principal areas.

The blueprint calls for, in the near-term, increases in energy efficiency, improvements in the operating efficiency of coal-fired power plants, expanded development of renewable energy sources, and integration of additional distributed generation. Over the mid-term, EPRI envisions new nuclear power plants coming on-line and successful introduction of plug-in hybrid electric vehicles. The last stage, coming after 2020, sees deployment of carbon capture and storage (CCS) technology on new coal plants. CCS collects, compresses, and permanently sequesters carbon dioxide emissions deep underground in spent oil and natural gas wells, saline reservoirs, or inaccessible coal seams—essentially creating a "zero-emissions" coal-fired generation facility

Of course, implementing many of these ideas on a large scale will require a massive investment of government resources—similar to putting a man on the moon—and mobilization of every sector of the economy. But as the following *RE Maga-*

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PHOTOGRAPH BY MICHAEL MAURER

By **Peter Nye**

As the nation considers ways to deal with global warming, electric co-ops stand out as leaders in offering solutions regarding "the other power supply"—energy efficiency

ENERGIZING EFFICIENCY

For Ray Beavers, CEO of United Cooperative Services in Cleburne, Texas, hubbub about surging wholesale power prices and the ensuing cry for energy efficiency sounds like déjà vu. Since he began working for electric co-ops 30 years ago, he has witnessed a variety of energy-related crises. Now his co-op, in a fast-growing area near Fort Worth, has embarked on an ambitious campaign to conduct free energy audits for all of its approximately 50,000 residential and business members.

"Our directors are totally supportive of our energy efficiency efforts," Beavers explains. "Energy audits will make our members feel that someone from the co-op is there, one-on-one, to help them. The results should demonstrate to everyone the need to use power wisely."

To capitalize on new efficiencies gained from the installation of automated meter reading (AMR) units in 2007, the co-op trained several meter readers to become energy auditors. Beavers now has 10 full-time employees performing energy audits

on a regular basis. These on-site visits include not only walk-through audits but also a complete software analysis of potential savings that can be realized through recommended upgrades and/or retrofits. Each home or facility gets checked for adequate caulking and weather stripping around windows and doors, insulation between walls and in attics, ductworks, condition of pipes, thermostat settings, air conditioning filters, lighting, and whether fireplace flues are closed when air conditioners run.

United Cooperative Services Area Manager Jake Brooks notes that when he talks to residents, civic clubs, and community organizations about energy efficiency, people initially react as if a sales pitch will follow.

"Then I tell them how to save money on their energy bills," he indicates. "Generally, folks are amazed that the co-op would send someone out to tell them how to use less of what we sell."

Auditors enter collected energy audit information into a laptop with special software developed by Oklahoma State University that calculates, based on county-specific conditions, how much energy consumption would be reduced for different recommendations, determines cost savings for each, and shows consumer-members how soon they could recoup their investment. Beavers contends that audits can reduce monthly energy bills by 7 to 10 percent while easing pressure on the grid.

"When our customer service representatives receive high-bill complaints, they can look on a computer and check when the consumer last had an energy audit done," he remarks. "We can ask callers if they followed through on suggestions. Of course, if a member can't afford to pay his or her bill, we will see what we can do to help."

United Cooperative Services' energy audits can serve double duty, too. Using an infrared camera during a recent audit at the Golden Peanut Company shelling plant in Comyn, Engineering Technician II Brian Phipps assisted Brooks by detecting a hot spot in an electrical panel.

"You couldn't see it with the naked eye, but the infrared camera picked up a burned fuse for a 300-hp oscillating fan that pulled hulls off peanuts," Brooks recalls.

A portion of the plant was immediately shut down. "When the electrician pulled out the fuse, it crumbled in his hand," Brooks says. "The fuse was replaced in less than 10 minutes rather than the plant experiencing a lengthy, unplanned outage."

Craig Smith of Golden Peanut Company, which provides peanuts for M&M's, Snickers, and PayDay candy bars, believes that discovering the problem early ensured safety for all 84 staff in the plant and prevented an unscheduled shutdown that would have resulted in lost production, missed customer shipments, a backup in cold storage, and $20,000 in labor costs for each day (24-hour period) the plant sat idle.

United Cooperative Services also promotes energy efficiency at monthly meetings, in print ads, and on billboards—especially one prominently displayed along I-35, a main highway in the Dallas-Fort Worth metroplex. The ad features Customer Service Representative Melinda Montgomery and Lineman Jason Byram, separated by the twisted spiral of a compact fluorescent lightbulb (CFL)—the poster child for energy efficiency. Text informs motorists: "We all have the power to save energy and money!"

Through the EPRI prism

According to a February 2007 study, *Electricity Technology in a Carbon-Constrainted Future*, by the Electric Power Research Institute (EPRI), a Palo Alto, Calif.-based non-profit utility-sponsored consortium whose members include electric co-ops, electric utilities could help the United States reduce emissions of carbon dioxide—a greenhouse gas blamed as the a contributor to global warming—below 1990 levels within 23 years by taking aggressive steps in seven principal areas, including energy efficiency. The report projects the nation will add 30 percent more load to the grid by that date, half of which will be generated by coal. However, EPRI sees potential for a 9 percent reduction in elec-

Previous page: Ray Beavers, CEO of United Cooperative Services in Texas, poses by a billboard the co-op uses to promote energy efficiency in the Dallas-Fort Worth area. The co-op has made a commitment to conduct free energy audits for all of its nearly 50,000 consumers. Below: United Cooperative Services Area Manager Jake Brooks, left, reviews energy audit recommendations with Craig Smith of the Golden Peanut Company, a co-op member.

PHOTOGRAPH BY MICHAEL MAURER

tric consumption—equivalent to the output of 50 large power plants—through efficiency measures.

To help residences, businesses, and industries use electricity more wisely, EPRI recently established The Living Laboratory in Knoxville, Tenn. Researchers at the facility render independent assessments of new gadgets and technologies—like "smart grid" devices that automatically respond to price or emergency demand-reduction signals—to help utilities get the biggest bang out of every kilowatt-hour produced.

"The laboratory provides a controlled environment to evaluate products and processes before we put them in the field for more tests," explains Tom Reddoch, EPRI manager of energy utilization, who directs the lab. "Energy efficiency has two primary aspects—energy consumption and power demand. If you reduce energy consumption, then you reduce your carbon dioxide footprint. If you reduce demand, then you avoid having to create more power."

Leaders of the pack

Energy efficiency efforts are nothing new for electric co-ops. Since the Arab oil embargo of the 1970s, nearly all rural electric systems have conducted ongoing consumer education campaigns to build awareness about saving energy.

"Unlike investor-owned utilities, not-for-profit, consumer-owned electric co-ops aren't structurally motivated to sell more kilowatt-hours," observes John Holt, NRECA senior principal for generation & fuel. "Co-ops, to produce a reliable supply of electricity at a competitive price, strive to maximize use of existing resources and infrastructure. Efficiency has always been a natural extension of our business model."

But power supply and political pressures are forcing co-op boards and management to take a fresh look at existing efficiency programs and consider new ones. During the next decade, the nation's generation and transmission (G&T) co-ops will need to add up to one-third more baseload generation to meet a 2.7 percent average annual increase in consumer growth, plus install pollution-control equipment at existing plants. The price tag attached to "putting iron in the ground," coupled with the likely imposition of climate change and greenhouse gas regulations, increases pressure for action on the efficiency side.

"Efficiency measures can help co-ops head off the need for new generation and curb greenhouse gas emissions," Holt points out. "The biggest payoff will come from consumers switching to more energy-efficient geothermal heat pumps, lighting, and appliances, combined with improved power plant efficiencies and expansion of load management programs that reduce electricity purchases during expensive demand peaks" [see sidebar].

Beavers mentions that the Electric Reliability Council of Texas, operator of the electric grid for much of the Lone Star State, has warned of a power shortage by 2010 and controlled blackouts unless additional generation comes on-line.

"We have a moral obligation to work with our membership to mitigate energy consumption and provide options," he emphasizes. "Since 2004, conservation has been one of our annual board objectives."

'The Cleanest Megawatt'

Believing that efficiency starts at home, electric co-ops have led the nation in reducing power consumption—and keeping the lid on wholesale generation costs—by controlling when electricity gets used. Spearheading this effort are programs known by various names—load management, demand-side response, or peak load shifting/shaving—that interrupt electric service to water heaters, air conditioners, furnaces, and other specialized equipment in the homes of volunteer consumer-members for brief periods, typically just a few hours. This control generally takes place during times of peak demand—the electric utility industry's equivalent of rush-hour traffic—when power costs skyrocket.

"Few realize how well electric co-ops have done with demand management," contends Ed Torrero, executive director of NRECA's Cooperative Research Network. "Roughly 37 percent of all co-op systems can direct-control appliances, chiefly water heaters and air conditioners, while another 40 percent offer contract incentives for large commercial and industrial [C&I] consumers to turn off energy-intensive appliances or equipment."

Torrero comments that load management essentially works like a "power plant in reverse," helping to boost electric system efficiency, cut expensive demand charges co-ops must pay for purchased power, and reduce the need for new power plants. In a typical year, local electric co-ops working with their wholesale power suppliers reduce demand by 2,200 MW (comparable to a commercial nuclear power plant), saving $50 million in fuel costs and offsetting more than 2,000 tons of carbon dioxide emissions.

Vince Kaminski, manager of planning at Allegheny Electric Cooperative, a generation and transmission (G&T) co-op in Harrisburg, Pa., notes that the G&T's Coordinated Load Management System (CLMS) has saved co-op consumers in Pennsylvania and New Jersey about $90 million in power costs since December 1986.

"CLMS remains as beneficial today as when it was launched," Kaminski explains. "It boasts estimated demand-side reduction capabilities of 50 megawatts, about 8 percent of our peak load in winter and about half of it in summer. Close to 97 percent of the 47,000-plus load control receivers on the system are installed on electric water heaters, with the remainder controlling dual-fuel home heating systems, or electric thermal storage units, air


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Good story to tell

NRECA Market Research Services studies find that 49 percent of all electric co-ops provide financial incentives—such as low- or no-interest loans for household improvements, leases on equipment, and ownership or maintenance of standby generators to reduce power use when consumption spikes—to spur investment in energy efficiency. More than 40 percent offer efficiency and weatherization services, including selling and installing high-efficiency lighting systems, electric water heaters, geothermal and air-source heat pumps, insulation, and Energy Star appliances, while roughly half include interactive energy use calculators on their Web sites.

Most co-ops are taking advantage of recent technology advancements, too: 72 percent are upgrading power lines, 56 percent are replacing older transformers, 50 percent use advanced technology to control voltage fluctuations, and 40 percent have deployed advanced meter infrastructure. In fact, the Federal Energy Regulatory Commission (FERC) has reported that "market penetration of advanced meter infrastructure [13 percent] is *highest* among rural electric cooperatives." More than 70 percent of co-ops also employ some type of AMR system.

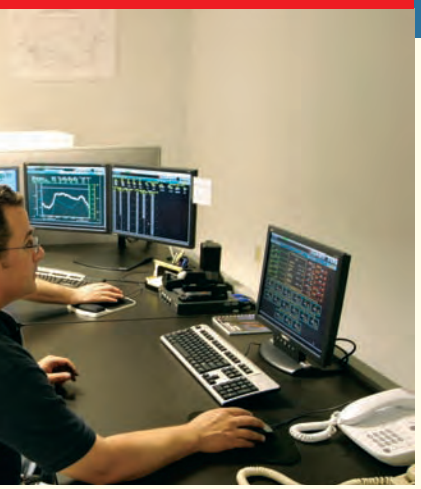
Increasingly, co-ops are pushing energy efficiency by encouraging consumers to change out traditional incandescent lightbulbs with CFLs—which, on average, use less than one-fifth the amount of electricity, last up to 10 times longer, and can save more than $30 in electricity costs throughout their lifetime. Because lighting accounts for about 9 percent of U.S. household power consumption and about 20 percent of the nation's electricity use, replacing just one incandescent bulb with a comparable CFL in every American household would save enough electricity to power more than 2.5 million homes for a year and offset the same amount of greenhouse gas emissions as taking nearly 800,000 cars off the road, according to the U.S. Department of Energy.

Yampa Valley Electric Association, in Steamboat Springs, Colo., has launched a reduction-in-emissions and conservation program that provides free CFLs.

"When a member brings in a coupon [clipped from the co-op's newsletter] to one of our offices, we ask them to identify the top five incandescent bulbs they use, give them one CFL equivalent, and offer to sell them four more at wholesale," relates Jim Chappell, Yampa Valley Electric manager of customer accounts. "We expect 60 percent of our 18,000 residents to participate. That's 10,800 CFLs. We budgeted $26,000 for the giveaways. The rest of the bulbs we sell at cost."

Central Iowa Power Cooperative (CIPCO), a G&T in Cedar Rapids, Iowa, offers its 12 member distribution co-ops and one municipal electric system a variety of incentives and rebates for Energy Star-rated products, including heat pumps, appliances, and CFLs. In 2007, CIPCO introduced a residential lighting incentive that will supply about 7,700 CFLs. The bulbs are expected to save some 2.8 million kWh of electricity and reduce carbon dioxide emissions by more than 3.9 million pounds annually.

In conjunction with adding a 750-MW state-of-the-art coal-fired unit at its 1,300-MW Seminole Generating Station along the St. Johns River in northeastern Florida, Tampa, Fla.-based G&T Seminole Electric Cooperative, as part of a collaborative process with the Sierra Club, agreed to buy about $200,000



Allegheny Electric Coordinated Load Management System technicians Jim Line, Mark Bublinec, and Matt Shaud, left to right, monitor electricity demand and weather conditions 24 hours a day from a master center located at the G&T's headquarters facility in Pennsylvania.

conditioning, and other kinds of miscellaneous loads."

Out of a CLMS master center located at Allegheny Electric headquarters, technicians monitor electricity demand and weather conditions. "Based on weather and daily load forecasts, the coordinating system sends out a control strategy," Kaminski says. "We do the operations and control of CLMS on behalf of our 14 member distribution co-ops, which enroll consumers."

The success of CLMS comes from co-op consumers being made "partners" in efforts to control electric rates. "Retail electricity prices are partially based on how much power each of our member co-ops requires during the five hottest, most humid days each summer," Kaminski adds. "Those hours typically occur in July and August late in the afternoon. To make consumers aware of the need to cut back electricity use during afternoons, when demand peaks may occur, many of our member co-ops conduct advertising and media alert campaigns encouraging folks to take additional steps, such as not running major appliances, during those periods."

Load management has also paid big political dividends for Pennsylvania electric co-ops: they were allowed to comply with the Commonwealth's Alternative Energy Portfolio Standards (AEPS) law through their ongoing CLMS commitments.

"AEPS requires investor-owned utilities to add increasing amounts of green power into their generation mixes, up to 18 percent by 2020," Kaminski relates. "If co-ops had been forced to meet those AEPS mandates, we estimate our consumers would have been saddled with millions of dollars in additional costs per year. Fortunately, the state legislature took into account both the strong renewable energy commitment made by electric co-ops throughout many decades in the form of CLMS and our [21-MW] Raystown Hydroelectric Project. After all, the cleanest megawatt is the one that doesn't have to be produced at all. CLMS helps achieve that goal."

The demand-side management program operated by Central Electric Power Cooperative, a G&T in Columbia, S.C., serving 15 distribu-

worth of CFLs (approximately 120,000 bulbs) for its 10 member distribution co-ops to allocate to 1.6 million residential and businesses consumers in 46 counties. Meanwhile, Tri-State Generation and Transmission Association, a Westminster, Colo., G&T, purchased 44,000 CFLs—1,000 for each of its 44 distribution members—to hand out to consumer-members. Tri-State G&T pledged to rebate $1 per bulb for any additional ones co-ops purchase.

Electric co-ops have also made a dramatic contribution to efficient electric system operation through the MultiSpeak Initiative, a collaboration between NRECA and more than 35 electric utility software companies and consultants that defines what data can be exchanged among commonly used applications and establishes standard messaging formats.

"MultiSpeak allows meters, consumer databases, and utility plant data to 'talk' to one another, helping boost service reliability and reducing waste," declares Gary McNaughton, vice president of Cornice Engineering and MultiSpeak project coordinator.

Saving Fort Knox

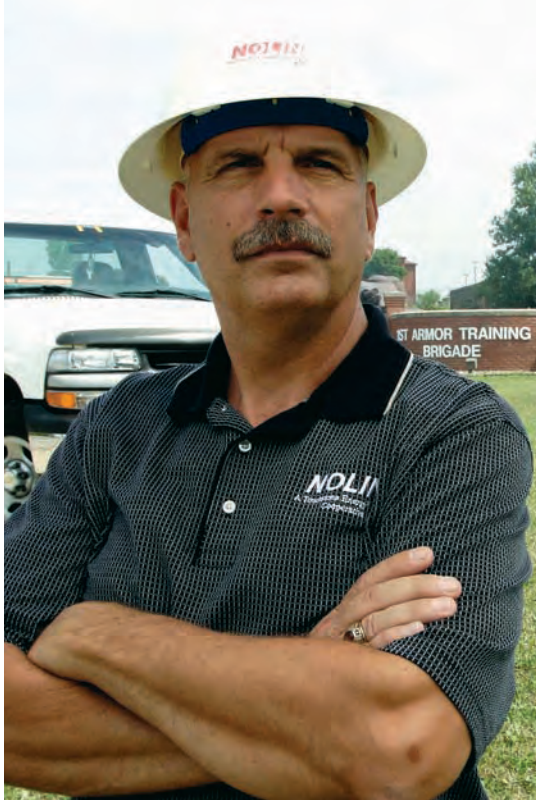
A massive energy-efficiency project performed by Nolin Rural Electric Cooperative Corporation in Elizabethtown, Ky., rescued Fort Knox, the 109,000-acre military complex best known as home of the U.S. bullion depository. Under provisions of the federal Energy Policy Act of 1992, Fort Knox had to shrink energy consumption for powering outdated heating, cooling, and lighting systems 35 percent by 2010 or face decommissioning.

"There are 3,000 buildings on the base, including a hospital, fire stations, a water-treatment plant, barracks, mess halls, and training centers," explains Vince Heuser, Nolin RECC vice president of system operations & engineering. "The base makes up the sixth largest community in Kentucky. About 23,000 active-duty military, civil servants, and contractors live or work there."

Closing the base threatened to wreak economic hardship across the center of the Bluegrass State. Nolin RECC, which had long serviced power lines on the base in addition to maintaining 2,800 miles of lines spanning nine counties, won a bid against an investor-owned utility in 1996 to help Fort Knox reduce energy use.

Patsy Whitehead, Nolin RECC communications coordinator, notes the majority of buildings dated to World War II. "The barracks were experiencing severe indoor air-quality issues, a high rate of respiratory illnesses, and poor comfort conditions," she reflects.

Heuser dubs the project one of the biggest challenges of his career. "We began with a $6,000 lighting project. Everything that followed got bigger, up to $10 million for replacing a central steam-heating system, equivalent to the length of six city blocks, with individual geothermal units. Combined, it makes up the largest geothermal system I know of in the country and, perhaps, the world."



Other energy-saving technologies involve a Trane Tracer Summit Building Automation System, solar panels, smart meters, and peak-shaving generators.

To finance the upgrades, Nolin RECC negotiated a line of credit from the National

'The Cleanest Megawatt' *continued*

tion co-ops, "has more than 100,000 load control switches on water heaters and another 20,000 on air conditioners," remarks David Logeman, Central Electric Power director of power supply.

One Central Electric Power member system, Palmetto Electric Cooperative in Hardeeville, S.C., offers an H2O Select Water Heater Program with 33,000 water heaters—representing about half of the co-op's total consumers—under load control. The program features rebates of $350 for water heaters installed in new construction and $250 for replacing old models, a 10-year contract, and free repair service available around the clock.

"Load control saves us approximately $1 million a year in power costs," stresses Jimmy Baker, Palmetto Electric vice president of marketing & public relations.

Seminole Electric Cooperative, a G&T in Tampa, Fla., has trimmed peak demand through a variety of strategies. Under its load management program, member distribution co-ops turn off electric water heaters, air conditioners, space heaters, and swimming-pool pumps for short periods at the homes of consumer volunteers. And under the G&T's distributed generation program, distribution co-ops work with commercial consumers to install on-site generators for reliability purposes that are also available to meet system peaking requirements. These efforts have helped Seminole Electric avoid building about 240 MW of generating capacity, estimates Lane Mahaffey, director of strategic planning & legislative affairs.

In the Upper Midwest, Great River Energy in Elk River, Minn., a G&T serving 28 distribution co-ops and more than 600,000 consumers in two states, sees demand jump from an annual average of about 1,400 MW most of the year to 2,600 MW in July and August, points out Gary Connett, director of environmental stewardship & member services.

"Load management is an incredible asset," he says. "While spot energy prices typically make up a very small percentage of our total energy-purchasing

PHOTOGRAPH BY ED THOMPSON

Vince Heuser, vice president of system operations & engineering for Nolin RECC in Kentucky, considers the massive energy-efficiency project the co-op undertook at Fort Knox as one of the biggest challenges he's ever faced.

Rural Utilities Cooperative Finance Corporation in Herndon, Va. Energy savings that have so far trimmed consumption by 43 percent—and counting—are used to retire debt.

"We are approaching $130 million in contracts for different kinds of energy efficiencies," Heuser claims. "They range from high-efficiency lighting in offices, window replacements, insulated roofing, and high-ceiling bays for servicing armored tanks."

With some 80 percent of the upgrades finished, "base officials estimate they are saving $9.1 million a year," Heuser asserts.

Banking on it

Maquoketa Valley Electric Cooperative in Anamosa, Iowa, has introduced a series of efficiency programs that help members lower electric bills, including partnering with local banks on home improvement loans used for energy efficiency improvements. The co-op defers a significant part of the interest.

"We started in 2006 with a pilot program involving two banks," says Patty Manuel, Maquoketa Valley REC director of member support. "We told our consumer-members they needed to follow Energy Star standards, such as installing high-efficiency replacement windows, improving ceiling or wall insulation to meet Energy Star levels, and replacing appliances older than 10 years with new Energy Star models."

Participants filled out cooperative applications that included bids for projects up to $10,000, then submitted loan applications to the banks. "We don't get involved in loan applications," insists Manuel. "When the bank gets ready to close on the loan, they tell us what our cost is and we write them a check."

Maquoketa Valley REC has now opened up the loan program to more than 10 banks. "We wanted to allow members to work with their own bank to encourage more program participation," Manuel adds.

Power of human connections

To help electric co-op consumers figure out how much they can save by switching from traditional incandescent lightbulbs to CFLs, Touchstone Energy® Cooperatives—the brand alliance of the nation's electric co-ops—has introduced an online savings calculator powered by Flash Media. The calculator lets folks insert the number of incandescent bulbs they would replace with CFLs. With a click on "calculate," they quickly see how much money can be saved. For example, changing out 15 incandescent bulbs with CFLs saves $66 a year and $598 throughout the bulbs' lifetime. Each co-op can now add their own rate for a more accurate savings calculation.

The program, based on a bulb being used three hours a day and consuming 0.088 kWh, assumes that a 60-W incandescent bulb with 750 hours of life will be replaced with a 14-W CFL equivalent boasting 10,000 hours of life.

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expenses, they far and away eclipse any other cost on a per kilowatt-hour basis. Load management helps trim our winter peak by 12 percent and our summer peak by 13 percent."

During the summer of 2006, as Minnesotans sweltered through a heat wave, wholesale energy prices skyrocketed tenfold, Connett mentions. "We survived because, back in the 1980s, we set a goal to reduce demand and signed up members for our cycled air conditioning program. Today we have more than 270,000 devices directly under control, including 140,000 central air conditioners out of 340,000."

Great River Energy provides member co-ops a $100 rebate for every consumer who joins its cycled air conditioning program and up to a $350 rebate per high-efficiency air conditioner installed. In 2006, the G&T distributed a total of $4.2 million in energy-efficiency rebates and incentives.

Dairyland Power Cooperative, a G&T headquartered in La Crosse, Wis., that serves 25 distribution co-ops in Wisconsin, Iowa, Minnesota, and Illinois, reduces load up to 160 MW in winter and 70 MW in summer (and saved a total of $10.5 million in power costs in 2006) through demand-side management, reports Ed West, Dairyland Power director of telecommunications & control systems. The 160-MW total, comparable to a small power plant, stems from controls on roughly 75,000 residential electric water heaters, 15,000 air conditioners, 8,000 residential heat-storage systems, 275 C&I generators, 180 agricultural grain dyers, and 100 C&I accounts on interruptible rates.

"We 'operate' our load-management system hundreds of times per year to avoid purchasing market energy or providing operating reserves," West explains. "And we're constantly upgrading our equipment. The ability to develop an extremely accurate load estimate is important. Our Web site provides updates on all load management developments, allowing our co-ops to know what is happening without picking up the telephone."

Freelancer Samuel Western contributed to this report.

SQUEEZING MORE OUT OF COAL

Electric co-ops are equipping coal-fired power plants with the latest pollution-control devices to clean the air, taking steps to make facilities run more efficiently, and looking at ways to reduce carbon dioxide emissions

By **Peter Nye**

According to the U.S. Energy Information Administration, "King Coal" still reigns as the least expensive and most abundant fuel used to create electricity—some 1 billion tons are burned annually. The black rock, in fact, accounts for 50 percent of the nation's and roughly 62 percent of electric co-op power supply needs.

Factored into this market, most of the approximately 65 coal-fired power plants owned by generation and transmission (G&T) co-ops—comprising 8 percent of U.S. coal-based electricity production—are relatively new compared to the industry as a whole.

"G&Ts have a very successful track record of owning and operating coal-fired power plants," argues John Holt, NRECA senior principal for generation & fuel. "In general, co-op facilities tend to run more efficiently, and burn coal cleaner, than aging

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generating stations operated by other utilities."

Over the next decade, G&Ts also plan to spend more than $5 billion installing state-of-the-art pollution-control devices on coal plants to cut emissions of regulated pollutants—acid rain-contributing sulfur dioxide, smog-causing nitrogen oxides, fine particulates blamed for respiratory problems, and toxic mercury that works its way into the human food chain through eating fish and seafood—by more than 150,000 tons a year. The high-tech equipment being used includes electrostatic precipitators and bag houses that remove fly ash and particulates, selective catalytic reduction (SCR) systems that slash nitrogen oxides by roughly 90 percent, and flue gas desulfurization devices, commonly called "scrubbers," that absorb up to 99 percent of sulfur dioxide and, as a "co-benefit," reduce mercury anywhere from 25 percent to 85 percent.

"You can do a lot of upgrading for less than what it takes to build a new power plant," contends Pat O'Loughlin, chief operating officer at Buckeye Power, a G&T in Columbus, Ohio, that supplies wholesale power to 25 electric distribution co-ops across the Buckeye State and one in Michigan.

Currently, Buckeye Power is in the middle of a program to invest $800 million through 2010 to add scrubbers and SCRs on its two generating units at the coal-fired Cardinal Station along the Ohio River. The 600-MW Cardinal Unit 2 went on-line in 1967; the 630-MW Cardinal Unit 3 in 1977. Until 2004 they served as the G&T's sole generation resources.

Driving the upgrades were changes in federal clean air rules, notably the first-ever curbs on mercury emissions and additional sulfur dioxide and nitrogen oxides caps imposed on nearly all states east of the Mississippi River. To partially offset scrubber costs, Buckeye Power entered into a contract to purchase less expensive, high-sulfur coal from a mine under development adjacent to Cardinal Station.

"Buying coal right from the mouth of a nearby mine will decrease our transportation costs and increase plant reliability," O'Loughlin emphasizes. "We won't have to worry about railroads upping rates to deliver low-sulfur

coal from out West or the Ohio River freezing and blocking coal shipments by barge."

O'Loughlin expects the scrubbers to remove about 95 percent of sulfur dioxide (200,000 tons total, a net improvement of 35,000 tons) and 85 percent of mercury (a decline of about 765 pounds) emissions from the two units per year. SCRs will remove more than 90 percent of nitrogen oxides (approximately 18,000 tons) from boiler flue gas when they begin operating year round in 2009.

Carbon crunch

But pollution control could soon become even costlier. Legislation being debated by Congress would, for the first time, regulate emissions of carbon dioxide, a greenhouse gas blamed as a contributor to global climate change. Nationwide, coal-fired power plants make up approximately 39 percent of U.S. man-made carbon dioxide output—the largest single source—and about 33 percent of all greenhouse gas emissions from human activity.

At Minnkota Power Cooperative, a G&T in Grand Forks, N.D., Vice President for Generation Luther Kvernen sees the process of heating coal and mixing it with air to create electricity as comparable to releasing a genie.

"Burning carbon is how we get our energy," he stresses. "But reducing carbon dioxide emissions . . . that becomes a little like trying to put the genie back in the bottle."

"Burning carbon is how we get our energy. But reducing carbon dioxide emissions . . . that becomes a little like trying to put the genie back in the bottle."

Minnkota Power, serving 11 electric distribution co-ops and more than 115,000 consumers across 34,500 square miles in the eastern part of the Peace Garden State and northwestern Minnesota, plans to spend about $130 million to upgrade two lignite coal-fired units at its Milton R. Young Station near Center, N.D. The 250-MW Young 1, which went into commercial service in 1970, will have a new scrubber installed and be fitted with an existing chimney from its sister unit, Young 2. The 455-MW Young 2, which has been kicking out the kilowatts since 1977, will have its existing scrubber modified and receive a new chimney.

The G&T began seeking bids for the environmental improvements in 2007, reports John Graves, Minnkota Power environmental manager. "Work on Young 1 should be completed by the end of 2011; we will have all of the Young 2 upgrades operational in late 2010." Annual sulfur dioxide reductions of about 19,000 tons from Young 1 and 7,000 tons from Young 2 are expected.

To reduce nitrogen oxides by 37 percent a year (3,100 tons) on Young 1 and about 40 percent (5,800 tons) on Young 2, over-fired air (OFA) cyclone systems will be put in, starting with Young 2 this fall.

"Our cyclone units are somewhat unique," Graves marvels. "There are about 100 cyclone boilers that use bituminous or subbituminous coal around the country, but we're burning low-sulfur lignite coal. Temperatures in the center of the cyclone can reach 2,800 degrees to 3,000 degrees Fahrenheit, which better utilizes the coal but results in higher nitrogen oxides emissions. We will spend about $5 million for the Young 2 OFA system and about $10 million on Young 1."

Kvernen emphasizes that while present technology crimps the worst pollution emissions, it has no effect on carbon dioxide. "Immediate carbon dioxide cuts will come from increases in plant efficiencies, such as

Mining coal info

To help generation and transmission (G&T) chief executives, managers, and engineers get the most out of existing coal-fired power plants, NRECA's Cooperative Research Network (CRN) has released three guides.

The first, *Multipollutant Strategies and Technologies*, which looks at removing sulfur dioxide, sulfur trioxide, nitrogen oxides, mercury, and particulate matter from combustion gas, includes brief technical descriptions of various emissions-control technologies, cites potential removal efficiencies for each based on coal type, and provides a screening tool that calculates costs and outputs for individual G&Ts.

"The study will help G&Ts comply with clean air regulations, identify which technologies are relevant, and develop strategies to reduce emissions with incremental improvements to existing equipment," explains Tom Lovas, CRN senior project manager.

The second guide, *Mercury Monitoring Simplified*, offers intelligence on the potential value of a new, cost-effective mercury measurement technique called Quick SEM (also known as Method 324) that places small glass tubes the size of ballpoint pens in a plant's smokestack for a fixed period of time. The report provides a snapshot of mercury-emissions levels from diverse units burning different types of coal—as well as a brief account on conditions affecting mercury emissions and removal.

"For example, coal with low levels of chlorine can make mercury more difficult to get rid of," Lovas comments.

The third publication, *Integrated Gasification Combined Cycle* (IGCC), evaluates if IGCC can help G&Ts achieve their goal of providing a reliable supply of electricity at a competitive price. With electric co-op power requirements increasing nationwide due to strong 3 percent average annual load growth, G&Ts considering whether to add new baseload generation will soon have to make tough power supply choices, such as developing IGCC plants instead of facilities that burn pulverized coal, repowering existing plants with IGCC technology, or joining IGCC projects proposed by other utilities and merchant operators.

turbine improvements and some component replacements."

One of the country's fastest-growing G&Ts, Seminole Electric Cooperative, headquartered in Tampa, Fla., needs to add roughly 200 MW a year in either new plant capacity or purchased power just to keep pace with consumer growth. The wholesale power supplier's 10 member distribution co-ops serve some 1.6 million consumers across 46 counties.

Seminole Electric has begun spending $300 million to upgrade existing scrubbers to achieve 95 percent removal and install new burners, SCRs, and an acid gas removal system on its two-unit, 1,300-MW coal-fired Seminole Generating Station, located along the St. Johns River 50 miles south of Jacksonville. The pollution controls are expected to eliminate 16,490 tons of sulfur dioxide and nearly 20,000 tons of nitrogen oxides per year.

The environmental upgrades started in February 2007 and are scheduled to finish in May 2009. In addition to scrubbers and SCRs, a lime injection system will be used to control sulfur trioxide, another agent affecting acid rain.

"We chose the upgrade-and-additional-controls route instead of purchasing clean air allowances in a fluctuating trading market," explains Seminole Electric Manager of Environmental Affairs Mike Roddy. "Also, upgrading our scrubbers will increase our synthetic gypsum sales [currently 550,000 tons per year] by approximately 75,000 tons." The gypsum—derived from scrubber waste—gets delivered by conveyor to a wallboard manufacturing plant located right next door.

"Synthetic gypsum production is just one of many environmental initiatives we have pursued since voluntarily joining the U.S. Department of Energy Climate Challenge Participation Accord in 1995," Ross adds. "In addition, we've agreed to distribute more than 100,000 compact fluorescent lightbulbs to our member co-ops. To date, these efforts have reduced our carbon dioxide emissions by more than 3.3 million tons."

The G&T plans to construct a third unit at Seminole Generating Station (estimated cost: about $2 billion). The new 750-MW generator, scheduled to go on-line in May 2012 with the most advanced pollution-control equipment, will employ "supercritical" boiler technology that produces more megawatts from less coal. When completed, the entire three-unit plant will emit less sulfur dioxide, nitrogen oxides, mercury, and sulfuric acid than the two existing units do now.

"Seminole Electric is also planning to proceed with a new zero-liquid discharge system that eliminates the liquid waste stream from the plant and recycles high-purity water for reuse," Roddy declares. "In the end, the only wastewater discharged into the St. Johns River will be blowdown from the closed cooling water system."

While the zero-liquid discharge setup will require about 6 MW to operate, Roddy says the loss could be mitigated by a planned carbon burnout system that reburns fly ash, removing any remaining carbon so the ash can be sold for use in road construction.

"The resulting waste heat from the carbon burnout system can be placed in the units' feedwater system to reduce fuel consumption," he remarks.

Hefty price tag

A 2007 study, *Electricity Technology in a Carbon-Constrained Future*, by the Electric Power Research Institute (EPRI), a Palo Alto, Calif.-based nonprofit consortium whose members include electric co-ops, shows how electric utilities could help the United States reduce carbon dioxide emissions below 1990 levels within 23 years—even after adding 30 percent more load, half generated by coal—by taking aggressive steps in seven principal areas, including improving the efficiency of coal-fired power plants.

At present, the nation's 600-plus coal-burning generating units average 33 percent efficiency. Even so, O'Loughlin at Buckeye Power holds that "a kilowatt-hour of electricity is still more useful than a lump of coal."

"Heat is lost from boiling water to make steam and then condensing it back to water," he observes. "There are also mechanical losses from boiler circulating pumps, valves, and the spinning turbine. Finally, energy is consumed by pollution control systems. Despite these losses, power plants generate electricity—the most useful energy by any measure."

Recently, EPRI has collaborated with the Coal Utilization Research Council (CURC)—composed of the U.S. Department of Energy, as well as state, university, and business interests—to boost efficiency of coal-burning generators.

"Part of the CURC-EPRI roadmap calls for improving coal plant efficiency for new facilities to between 39 percent and 46 percent by 2020 and to 49 percent by 2030," reports John Novak, EPRI executive director of federal & industry activities.

Tony Facchiano, EPRI senior program manager for generation combustion performance, suggests several ways electric utilities can improve plant efficiency. For starters, retiring older plants and replacing them with new ones boasting the latest technology will hike efficiency levels.

"But we also need to look at improving the hardware already in place," he says. "There is a lot of potential there, such as operators of older plants measuring the fuel-to-air mixture in boilers and matching things better."

Phase one of the EPRI plan would establish basic information baselines. "We don't have a big database," Facchiano admits. "People across the electric industry are more enthusiastic now about defining the baselines to save fuel and improve plant efficiencies, which will reduce carbon dioxide emissions."

With baselines compiled, the industry could move to the next step—major improvements.

"These will involve more capital-intensive projects," Facchiano observes.

And probably sticker shock as well. EPRI estimates that returning utility carbon dioxide emissions to 1990 levels by 2030 will cost $17 billion. However, competition from China and India for copper, steel, nickel, concrete, and other raw materials has pushed that price tag 30 percent higher in just 18 months, so the total could rise even more.

Among promising innovations EPRI sees

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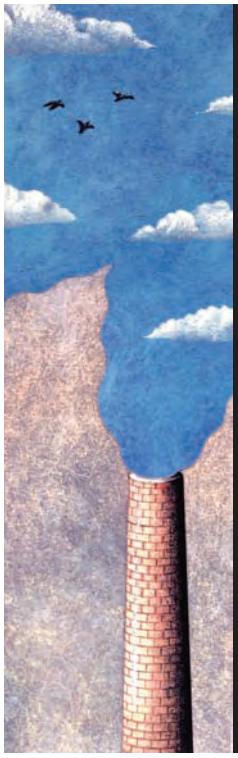
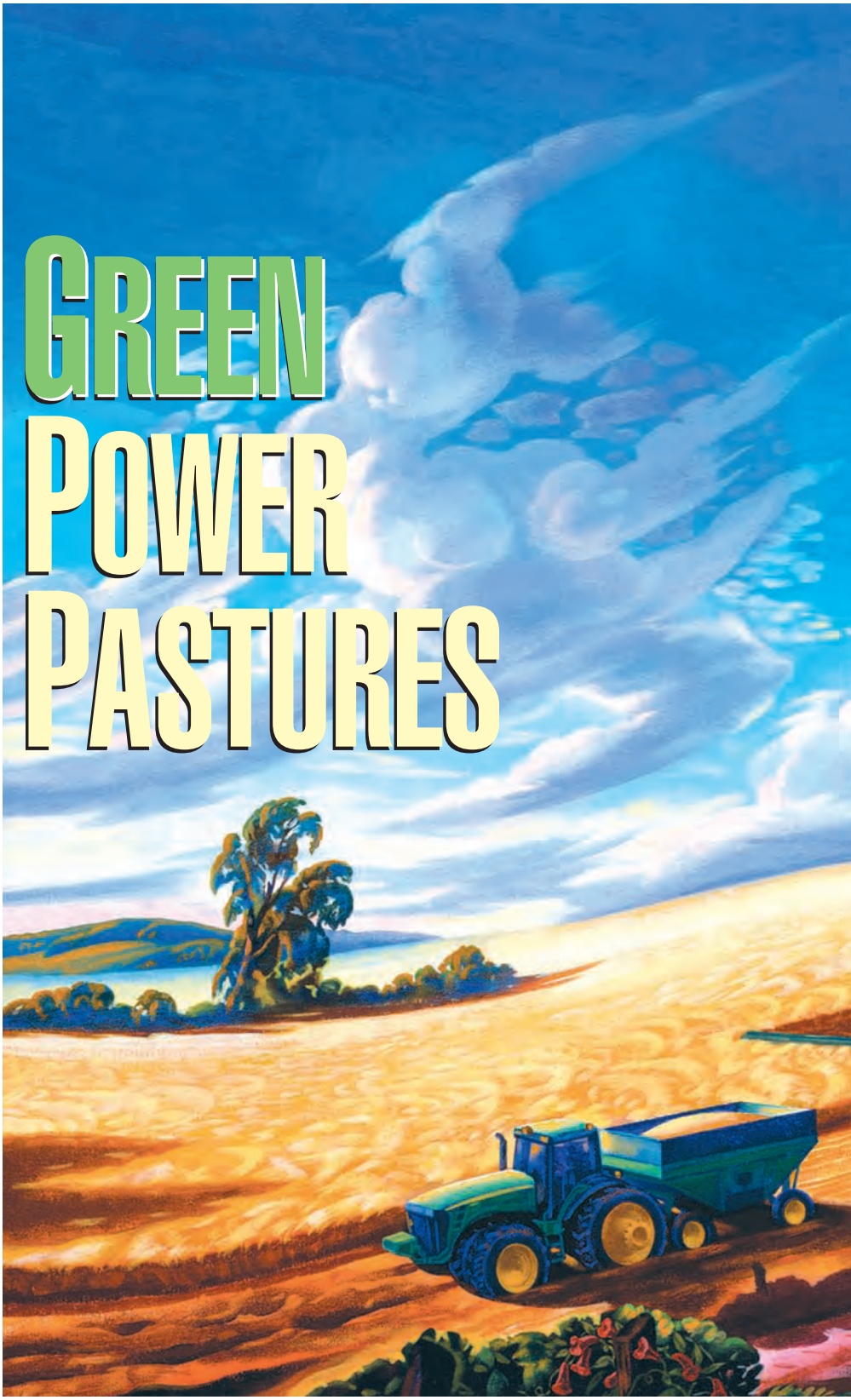


"Part of the CURC-EPRI roadmap calls for improving coal plant efficiency for new facilities to between 39 percent and 46 percent by 2020 and to 49 percent by 2030."

Sowing Green Power Pastures

Being closely connected to the communities they serve and committed to securing our nation's energy future, electric co-ops continue adding renewable resources as a way to slash carbon dioxide emissions and meet growing consumer needs



By **Peter Nye**

For decades, consumer-owned electric co-ops have blazed trails when it comes to developing renewable energy. Today, more than 80 percent of the nation's 900-plus electric co-ops supply some of their electricity from wind, solar, hydro, biomass (including landfill gas, livestock waste, timber byproducts, and crop residue), and other "earth-friendly" sources.

"Renewable energy makes up about

NRECA Director Don R. McQuitty, CEO of NW Electric Power Cooperative in Cameron, Mo., commissioned this painting, Harvesting the Wind, *by artist Bryan Haynes. Painted in the fluid style of Missouri native son Thomas Hart Benton, famous for his bucolic images, the work was presented to Springfield, Mo.-based Associated Electric Cooperative for display in the generation and transmission co-op's headquarters lobby.*

11 percent of all co-op kilowatt-hour sales—more than the amount marketed by the nation's investor-owned utilities," points out Kirk Johnson, NRECA vice president of environmental policy.

This pioneering co-op investment—made for economic, environmental, and community development reasons as well as to meet strong, 3 percent average annual load growth—now has begun to pay dividends on other fronts. Nationwide, legislators—scrambling to find ways to curb emissions of carbon dioxide, a greenhouse gas blamed as a contributor to global climate change—have focused attention on coal-fired power plants. Coal facilities, which generate roughly 50 percent of the nation's electricity, account for approximately 39 per-

cent of U.S. man-made carbon dioxide output (the largest single source) and about 33 percent of all greenhouse gas emissions from human activity.

To reduce reliance on coal, 29 states and the District of Columbia have enacted renewable portfolio standards (RPS) that encourage or require investor-owned utilities, competitive electric generation suppliers, and, in some cases, electric co-ops to add increasing amounts of green power—totaling 15 percent to 25 percent of their generation mix—between 2018 and 2025. Congress may also impose a sweeping RPS on the rest—an energy bill passed by the U.S. House in August 2007 included a 15 percent RPS mandate, although the measure exempted electric co-ops. (The RPS provision was later stripped.)

"Curbing carbon dioxide and other greenhouse gas emissions must include a blend of clean coal, nuclear, natural gas, and renewable generation sources," declares NRECA CEO Glenn English. "There is no single magic bullet. But electric co-ops, serving areas linked to resources like wind and biomass, are naturally positioned to take maximum advantage of clean power options."

Embarking on a new "green wave," more than 100 co-ops have received a total of $450 million in Clean Renewable Energy Bonds (CREBs) from the U.S. Treasury to develop renewable energy projects involving wind, geothermal, closed-loop biomass (trees grown expressly for electricity production), open-loop biomass (sawdust, tree trimmings, farm byproducts, animal waste, landfill gas), small hydropower (less than 25 MW), and solar systems. CREBs, created in the federal Energy Policy Act of 2005, provide not-for-profit electric co-ops with a way to level the "green power financing playing field" with investor-owned utilities, which can qualify for investment tax credits to support solar energy and a 1.9 cents per kilowatt-hour production tax credit to "sprout" other renewable sources.

"These bonds act as interest-free loans, and demand for the program is strong," stresses Susan Pettit, NRECA senior principal for legislative affairs. "Electric co-ops have submitted nearly $700 million in applications since CREBs were first authorized."

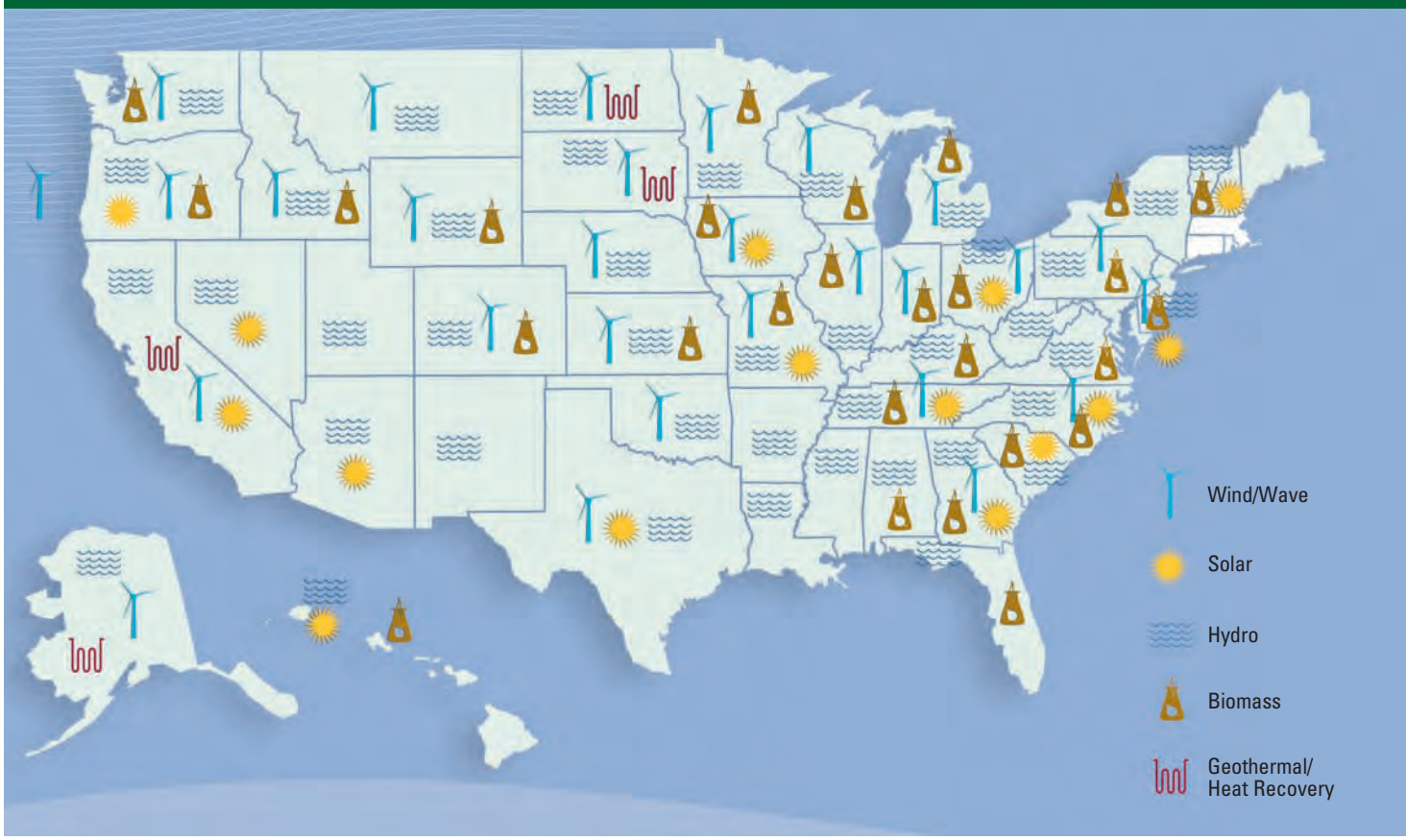
Renewables will receive an additional boost if Congress passes legislation imposing a carbon tax or creating a cap-and-trade program to lower carbon dioxide emissions, suggests Tom Key, manager of renewables with the Electric Power Research Institute (EPRI), a Palo Alto, Calif.-based non-profit consortium whose members include electric co-ops.

"Either of those actions will narrow the price difference between using renewables and coal to generate electricity," he imparts. "For example, a carbon tax of around $35 to $40 per ton would make some renewables cost-competitive with coal."

In fact, a recent U.S. Energy Information Administration (EIA) analysis of an economy-wide greenhouse gas cap-and-trade bill, S. 280, introduced by U.S. Sens. Joseph Lieberman (I-Conn.) and John McCain (R-Ariz.), found that it would push up the price of coal 129 percent by 2020 and 245 percent by 2030. In addition, it would drain about $533 billion out of the nation's economy from 2009 to 2030 while growing

Green Giants

(Electric co-op renewable power production, by state)



renewable generation to between 22 percent and 29 percent of the power sector. The legislation calls for gradually shrinking U.S. greenhouse gas emissions to 2004 levels by 2012, 1990 levels by 2020, 22 percent below 1990 levels by 2030, and 60 percent below 1990 levels by 2050.

In 2007, EPRI released a study, *Electricity Technology in a Carbon-Constrained Future*, showing how electric utilities could help the United States reduce carbon dioxide emissions below 1990 levels within 23 years—even after adding 30 percent more load, half generated by coal—by taking aggressive steps in seven principal areas, including vastly expanding renewable energy supplies. Leaving hydropower out of the equation, EPRI sees renewables, led by wind energy, leaping from 24,000 MW produced nationally in 2006 to more than 120,000 MW by 2030.

"While renewables by themselves are not the end-all answer to controlling carbon dioxide emissions from coal-fired power plants, they are one part of the solution," Key insists.

Blowin' in the wind

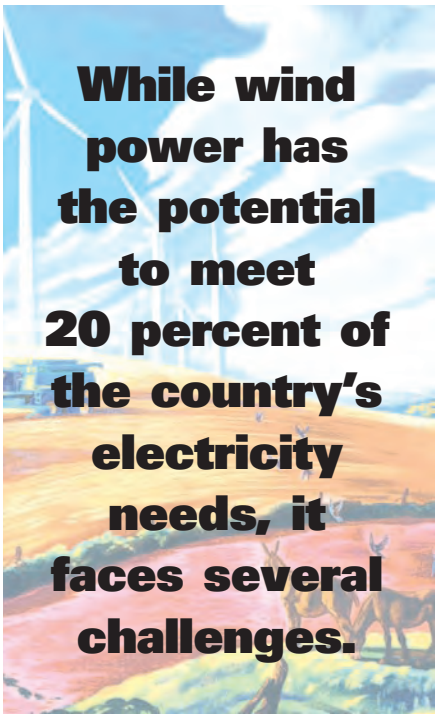
As projected by EPRI, wind power will lead the renewable parade. Currently, 150 electric co-ops either own wind turbines or buy output from wind farms, amounting to more than 820 MW, or about 5 percent, of U.S. wind generating capacity. Co-ops also have plans to build an additional 961 MW of wind over the next few years.

Not surprising, co-ops in states spanning the Upper Midwest and Great Plains—the "great American wind tunnel"—consume the most wind power. Throughout the United States, wind will kick out an estimated 48 billion kWh in 2008—enough to serve nearly 5 million average homes.

During the 2007 annual meeting of Kearney, Mo.-based Platte-Clay Electric Cooperative held in August, a dozen members snagged T-shirts emblazoned with vibrant-color reproductions of a new painting, *Harvesting the Wind*, depicting wind turbines lining a ridge behind a wheat field during harvest.

"The purpose of the painting is to raise awareness that we have wind energy going on the grid," explains Platte-Clay Electric CEO Mike Torres. "We hope that people seeing the T-shirts will ask about our wind power program."

Associated Electric Cooperative, a generation and transmission (G&T) co-op in Springfield, Mo., and the wholesale power supplier to Platte-Clay Electric, agreed in 2006 to buy all of the energy (156 MW) from three wind farms under development in the northwest part of the Show Me State. The wind power will help Associated Electric's 57 member electric co-ops in Missouri, northeast Oklahoma, and southeast Iowa meet demand growth of about 2.3 percent a year, or 100 MW, equivalent to about 45,000 new homes. As a result, the U.S. Department of Energy (DOE) awarded the G&T its 2006 Wind Cooperative of the Year Award for initiative and leadership.



Alaska Village Electric Cooperative, headquartered in Anchorage, Alaska—long reliant on diesel fuel to generate electric power at its remote service locations—has installed 10 wind turbines in the villages of Selawik, 500 miles northwest of Anchorage and north of the Arctic Circle, Toksook Bay, 500 miles to the west, and Kasigluk/Nunapitchuk, 400 miles west, over the past three years. The co-op also plans to install wind turbines in Chevak and Hooper Bay, both some 500 miles west of Anchorage on the Bering Sea.

"With average diesel prices doubling since 1990 and expected to soar higher, our members consider wind turbines as one way to reduce their monthly bills," explains Amy Murphy, Alaska Village Electric public relations officer. "At the end of 2006, our average rate was 51 cents per kilowatt-hour, which is pretty high." EIA, for its part, pegs the co-op as having the highest retail electric rates in the country.

In late 2007, Minnkota Power Cooperative, a G&T based in Grand Forks, N.D., purchased 99 MW of a 159 MW wind farm near Langdon—the biggest operation of its kind in the Peace Garden State. The wind project, owned by FPL Energy, will produce and sell more than 350 million kWh annually to the G&T.

"We've added wind resources—now more than 10 percent of our energy requirements—in response to consumer interest and with an attractive price from FPL Energy," contends Minnkota Power President/CEO David Loer.

Corn Belt Power Cooperative, the Humboldt, Iowa-based wholesale power supplier to 11 electric co-op distribution systems in northern sections of the Hawkeye State, has purchased more than 50 MW of additional wind power on top of the 32 MW it already controls. Coupled with hydroelectric resources, Corn Belt Power's renewable energy resources will make up nearly 15 percent of its power supply portfolio.

While some analysts contend that wind power—a tested and cost-effective technology—has the potential to meet 20 percent of the country's electricity needs, it faces several challenges: transporting generation from wind farms, usually located in remote rural areas, to population centers (the three Missouri wind farms proved viable, for example, only because Cameron, Mo.-headquartered NW Electric Power Cooperative, a G&T, operated transmission lines in the area); "intermittency"—the fact that even with good resources wind only reaches about 30 percent to 40 percent of its generation capacity, and generally does not blow during periods of peak demand on hot, humid summer weekday afternoons or cold days below minus 22 degrees Fahrenheit; and the need for advancements in storage technology so electricity from wind farms can become a reliable form of baseload generation.

"Wind is often not there when you need it most," cautions Floyd Robb, vice president of communications & marketing support for Basin Electric Power Cooperative, a G&T based in Bismarck, N.D. "When a heat wave hit our system in July 2006, our wind turbines were producing about 6 megawatts, even though our peak demand was 1,947 megawatts."

Basin Electric Power, serving 126 member electric co-ops and about 2.5 million consumers in nine states, draws 137 MW of wind energy from purchase power agreements with

three commercial wind farms in North and South Dakota; two small projects jointly owned with sister G&Ts Central Power Electric Cooperative in Minot, N.D., and East River Electric Power Cooperative in Madison, S.D., and several "backyard" turbines owned by consumers. It has also set a goal of voluntarily meeting at least 10 percent of its peak demand requirements from clean and renewable energy sources by 2010.

"We're near that number now, but as we add new generating resources, the 10 percent goal keeps moving," remarks Robb. "Our board has authorized us to build up to 300 megawatts of additional wind capacity."

Bob Gibson, senior project manager for NRECA's Cooperative Research Network (CRN), notes that the Great Plains typically see winds blow in winter during off-peak, early-morning hours. "And if the wind blows too hard, turbines have to shut down for safety."

However, electronics and software can aid grid operators handling sudden drop-offs when turbine blades slow or stop. CRN recently tested very fast transmission optimization software at East Kentucky Power Cooperative, a G&T headquartered in Winchester, Ky.

Dale Bradshaw, a CRN expert on power generation and transmission, holds that the software can evaluate the entire Eastern Interconnection of the United States in a half-second for potential transmission contingencies. Within 40 seconds, a transmission operator can collect all of the data needed to optimize performance—a major advantage in a job where critical decisions often must be made within five to 10 minutes of discovering a problem.

"The software monitors lines and equipment for thermal constraints, voltage constraints, and voltage instabilities that create transmission congestion and bottlenecks or lead to outages," Bradshaw mentions.

Underground power

According to the Massachusetts Institute of Technology, the United States possesses 100,000 MW of "enhanced geothermal capacity" that could be developed by 2050.

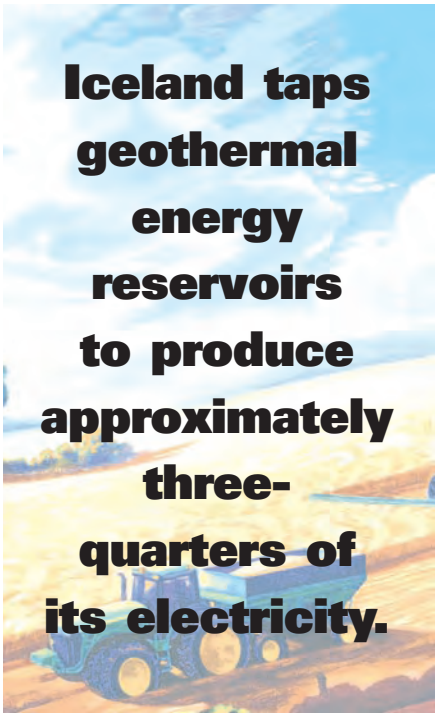
One Last Frontier State electric co-op moving toward a geothermal option, Naknek Electric Association in Naknek, located along Bristol Bay in southwest Alaska, has seen electric rates for its headquarters town of 1,000 climb toward 34.5 cents per kilowatt-hour. But that's a bargain. Twenty-five miles to the south, the 350 residents of Egegik served by the co-op pay close to 70 cents per kilowatt-hour.

Prices are sky high because both communities—like those served by Alaska Village Electric—burn diesel fuel to generate power. It's an unsustainable situation, according to Donna Vukich, Naknek Electric general manager, who feels electricity costs are crippling the Bristol Bay salmon fishery, the area's economic engine.

"Bristol Bay hosts the world's largest run of sockeye salmon—40 million to 50 million annually," she says. "But since 1997, when a summer heat wave left rivers shallow and warmed the water, millions of salmon have sought refuge deep in the Pacific Ocean. As a result, the whole region has gone into an economic spiral. People have moved away. Our school population declined from 350 kids in 1997 to 165 today."

Vukich, whose husband works as a fisherman, and the Naknek Electric board have outlined an ambitious plan to reduce retail electricity prices "by at least 70 percent" in Naknek, South Naknek, King Salmon, Egegik, 21 other villages, as well as Dillingham, the other "big town" on the bay. They are replacing dozens of isolated diesel generators with central station geothermal power.

"We considered other renewables such as wind and hydropower," she recounts.



"Wind's drawback, of course, is that it's not steady enough for baseload, and we ruled out hydro because we weren't going to mess with the tidal flow for the fish."

Before embarking on the project, Vukich toured geothermal generation plants in Nevada and California—including the world's largest complex, the 850-MW The Geysers in the Mayacamas Mountains, about 70 miles north of San Francisco—while two staffers visited Iceland to research how that island nation incorporates geothermal energy to produce approximately three-quarters of its electricity. The co-op then drilled three shallow geothermal test holes near Naknek.

Seismic studies on two that "showed fairly good numbers" were completed in October 2007. The next step, Vukich emphasizes, was choosing a site with good road access and drilling deeper holes, 8,000 to 12,000 feet, to tap the geothermal reservoir. To stay on schedule, drilling rigs had to be brought up the Naknek River by the end of September, when the ice season started.

Construction of a 25-MW geothermal power plant, 425 miles of transmission line, and 17 or 18 substations will be completed by 2010. The first phase will serve Naknek, Dillingham, and four or five villages.

How to cover the project's estimated price tag of $200 million? "We're looking at various avenues of financing, including Alaska state funding and federal Rural Utilities Service loans," Vukich remarks.

All of the utility planning took place with the fishery in mind. Cheaper electricity will allow canneries in Naknek to expand and add at least two more species—herring and halibut—while extending the canning season from two months to four.

Plumas-Sierra Rural Electric Cooperative in Portola, Calif., taps into geothermal power as an associate member of the Northern California Power Agency (NCPA) in Roseville. NCPA operates a pair of 110-MW-capacity power plants at The Geysers.

"In 2006, approximately 5 percent of our power mix came from geothermal energy," states Jessica Nelson, Plumas-Sierra REC manager of energy services. "We also have received approval for $31 million in CREBs to build our own wind farm."

Light bright

Every hour, enough sunlight reaches the planet to meet global energy needs for a year, according to DOE. EPRI's Key believes that over the

coming century, solar will probably become the world's main renewable energy source.

"The trick to date has been capturing tiny packets of solar energy, called photons, to create electricity," he explains. "They have to be captured at a lower cost. Solar generation now costs about 30 cents per kilowatt-hour—four times more than wind and 15 times more than nuclear or coal."

Solar photovoltaic (PV) technology—designed for home or single-building use and familiar as distributed power sources for remote sites like irrigation pumps, telecommunications towers, and highway warning signs—has been around for decades. However, high equipment costs (a basic 4-kW PV system can cost more than $50,000) and several-decades payback have hindered deployment in the United States.

"PV passed the 1,000-megawatts-installed-capacity milestone worldwide only in 1999, but the U.S. now has 750 megawatts on-line alone," says NRECA's Johnson. "Surging sales—led by California and New Jersey, the largest solar markets—have slashed PV prices about 40 percent over that time. Many G&Ts and local distribution co-ops purchase excess power generated by household PV systems owned by consumers of member co-ops."

For baseload power purposes, concentrating solar power (CSP) facilities hold promise. Shiny long parabolic troughs concentrate the sun's rays on receiver tubes; synthetic oil in the system gets pumped through heat exchangers to create steam that turns a turbine-generator. A 64-MW CSP plant with 760 parabolic concentrators spread over 350 acres went into operation in June 2007 near Boulder City, Nev.

Two G&Ts, Benson, Ariz.-based Arizona Electric Power Cooperative and Westminster, Colo.-based Tri-State Generation and Transmission Association—in conjunction with EPRI, national energy labs, and other utilities—have begun looking into the feasibility of constructing separate CSP plants that will produce anywhere from 50 MW to 500 MW.

"This technology holds potential," asserts Tri-State G&T Communications Manager Jim Van Someren. "Dozens of utility-sized CSP plants are currently in operation or being built, all in the Southwest."

Tri-State G&T also sells more than 7,500 MWh of green power a year from wind, biomass (methane digesters), and small hydro projects to its 44 distribution systems in Colorado, New Mexico, Nebraska, and Wyoming.

Tri-State Generation and Transmission Association, in conjunction with EPRI, has begun looking into constructing a concentrating solar power plant in New Mexico.

"In 2007, we put out a request for proposals for 50 megawatts of renewable power," Van Someren continues. "Part of this is in response to RPS legislation passed in both Colorado and New Mexico."

In another potential role for solar, CRN has released a report, *Solar Options to Enhance Combustion Turbines*, that evaluates the viability of cooling natural gas-fired peaking facilities using solar troughs.

"More than 140 co-ops around the country provide summertime peaking power using simple-cycle gas-turbine plants and could take advantage of renewable resources to cool them," cites CRN Executive Director Ed Torrero. "As temperatures go up, combustion turbines lose efficiency, causing reduced output and challenging the utility. A solar cooling system that combines parabolic troughs with absorption chilling could improve turbine capability and count toward a co-op's RPS share."

Meanwhile, three electric co-ops—Sulphur Springs Valley Electric Cooperative in Willcox, Ariz., Kaua'i Island Utility Cooperative in Lihue, Hawaii, and Kit Carson Electric Cooperative in Taos, N.M.—have received CREB funding for various-sized solar ventures.

Back to nature

Tapping into organic sources of electricity like crops, trees, animal waste, and garbage, G&Ts and distribution co-ops across the nation buy power from thousands of small-scale "biomass" systems operated by co-op (and occasionally non-co-op) consumers. Among the top biomass producers in co-op service territories are timber-products firms that burn sawdust, wood chips, and other waste in boilers, or large livestock operations that employ anaerobic digesters to harness methane gas from decomposing manure to spin turbine-generators.

"G&Ts and local co-ops often work with owners of these projects on issues related to system safety and interconnection and even design," says Johnson.

Some alternative energy projects using animal waste even reach baseload generation levels. Green Power Electric Membership Corporation, a partnership of 37 Georgia electric co-ops, has entered into a 15-year agreement to purchase 20 MW—enough to meet the needs of more than 15,000 homes—from the Peach State's first poultry litter-burning power plant, constructed by Earth Resources, Inc., near Carnesville, Ga., about 70 miles northeast of Atlanta.

"This adds another environmentally friendly source of energy to our stable that includes 5 megawatts of landfill gas from two facilities, 2.3 megawatts of low-impact hydro, and small PV projects at more than a dozen middle and high schools," points out Michael Whiteside, Green Power EMC president/CEO. "Since we were launched in October 2003, we've generated more than 100 million kilowatt-hours of renewable power."

In scattered cases, G&Ts even use farm byproducts as supplemental fuel for coal-fired power plants. Generally, such items are much more expensive than coal because of their low energy output and the additional labor required to collect, load, and transport the feedstock.

Central Electric Power Cooperative in Jefferson City, Mo., one of six G&Ts that owns Associated Electric and which supplies wholesale power to eight distribution co-ops over 22,000 square miles, has tried burning corncobs at its 72-MW Chamois Power Plant in Chamois, Mo. A mixture of 98 percent coal and 2 percent cobs was tested.

The actual test, however, proved disappointing because the cobs were mixed with husks, stalks, and leaves (30 percent to 40 percent of the total mass). The fodder lowered the Btu value of the cobs and didn't combust well in the plant's boilers.

"The cobs should have been around 16 percent to 20 percent moisture," indicates Tim Backes, Central Electric Power Chamois plant superintendent. "The stalks and leaves added moisture, so we couldn't prep the fuel right. We planned to burn 100 tons, but had to stop at 11 tons."

In the past, Backes has also experimented with burning sawdust, railroad ties, and even 3,400 tons of walnut shells acquired after a tornado tore the roof off a shed where they were being stored.

"Walnut shells work real well," Backes relates. "They burn at 7,800 Btu per pound, which compares favorably with 8,800 Btu from the Powder River Basin coal we purchase. But the shells are too expensive to use on a regular basis. We pay around $25 a ton for coal, while walnut shells normally cost $300 per ton."

Household refuse also plays a power supply role for many co-ops. East Kentucky Power offers 15 MW of landfill-gas electricity to 14 member distribution systems packaged under the brand "EnviroWatts: Earth-Friendly Alternatives."

"Trash from five landfills provides the methane gas necessary to produce electricity for about 9,000 homes," reports Meredith Boyd, EnviroWatts marketing representative. "Considering that landfill gas usually escapes into the air, the process of using it to make electricity eliminates 29,881 tons of methane a year and reduces carbon dioxide emissions by 88,235 tons, the equivalent of planting 178,934 acres of trees, offsetting the use of 3,210 railcars of coal, or averting the electricity use from 1,173,335 incandescent lightbulbs."

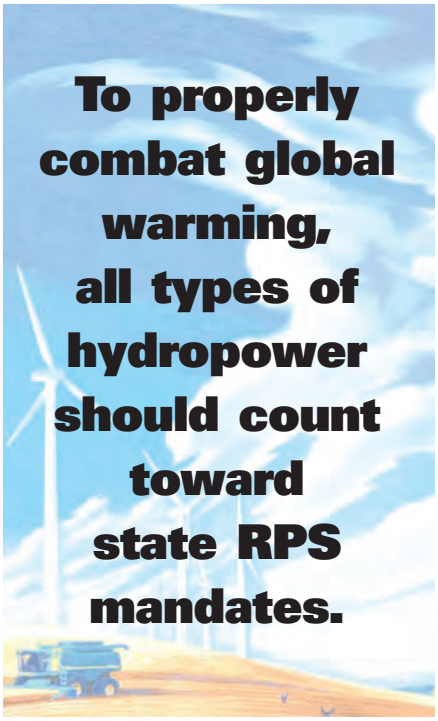
EnviroWatts sells 100-kWh blocks through participating distribution co-ops, which sign up residential consumers and commercial and industrial accounts. Each block costs $2.75 a month for a one-year commitment.

In similar fashion, consumer-members in Alabama and the Florida panhandle can purchase 100-kWh blocks of landfill-methane power for $2 each through their local electric co-op. The offering comes courtesy of a partnership between Andalusia, Ala.-based G&T PowerSouth Energy Cooperative and Waste Management, Inc., which operates a regional landfill near Campbelton on the Florida-Alabama border. The 4.8-MW generating plant at the landfill can power about 4,000 homes.

In Indiana—where renewable sources will provide 10 percent of the electricity used in government buildings by 2010—power will be supplied by Indianapolis-based Wabash Valley Power Association landfill-gas plants. Since 1999, Wabash Valley Power, a G&T, has steadily increased its renewable capacity through a deal with Waste Management. The wholesale power supplier to 28 electric distribution co-ops in Indiana, Illinois, Michigan, Missouri, and Ohio now owns eight landfill gas plants capable of generating 3.2 MW each, with two more under construction.

Washington Electric Cooperative in East Montpelier, Vt., produces power from the Green Mountain State's largest landfill, in Coventry, a village about 80 miles north and near the Canadian border.

"Vermont presently does not have an RPS, but mandatory renewable percentages for utilities may kick in after 2012," says Washington Electric General Manager Avram Patt. "The Coventry plant would more than meet our RPS requirement if and when we have one. We are presently selling renewable energy certificates to a company in Massachusetts that can utilize them to meet that state's RPS requirement."



Patt adds that Washington Electric built the landfill facility "because studies showed it would be better than buying energy on the open market, just based on production costs alone." CREB financing allowed the 10,000-member co-op to boost capacity at the landfill plant to 6.4 MW, more than half of the amount needed to meet non-peak demand.

Water world

Among renewable energy sources, hydropower boasts the lowest cost and greatest reliability. About 8 percent of all electric co-op power requirements are met through hydro generation—mostly from large state- and federally operated facilities. The country's four federal power marketing administrations, for example, ship hydropower to rural electric systems in 33 states, with rates paid by co-ops and public power entities covering all costs.

"Hydro is a mature technology that produces no greenhouse gas or carbon emissions," observes Ted Case, NRECA senior director of legislative affairs. "However, most RPS laws do not count electricity generated by large hydropower plants as a renewable resource. To properly combat global warming, electric co-ops believe all types of hydropower should be factored in."

Small hydro (under 25 MW), though, usually fits the RPS bill. One such co-op facility—the 21-MW, two-unit, run-of-river Raystown Hydroelectric Project, William F. Matson Generating Station (Raystown), operated by Harrisburg, Pa.-based G&T Allegheny Electric Cooperative—recently became the first in the Keystone State, and 23rd nationwide, to earn low-impact certification. The designation followed an exhaustive and rigorous review by the Low Impact Hydropower Institute (LIHI), a non-profit group that supports market incentives for reducing the effects of hydroelectric dams on the nation's rivers and streams.

To achieve the honor, Raystown—located at Raystown Lake & Dam in central Pennsylvania—had to meet eight LIHI criteria, including river flow, water quality, fish passage and protection, watershed health, endangered species protection, cultural resources, recreation use and access, and whether or not the dam had been recommended for removal. The LIHI certification will remain valid for eight years.

"The low-impact certification validates that we are doing what is in the best interests of the environment and our 14 member cooperatives in Pennsylvania and New Jersey," comments Dick Osborne, Allegheny Electric vice president-power supply & engineering. "It ensures that our generation portfolio contains bona fide renewable resources."

Electric co-ops are also looking to the world's oceans to create electricity. Kaua'i Island Utility in Hawaii has been working with EPRI to study the feasibility of wave motion as a power source.

"You use a buoy, or floating device, and the ocean wave action causes the object to go up and down like a piston," Key describes. "The kinetic energy can then be converted to electric energy. You can put several buoys a half-mile out so they don't affect the shoreline and then run cables from these devices to the grid."

Another G&T, PNGC Power in Portland, Ore., will provide $500,000 for a 2-MW wave-power plant that Ocean Power Technologies plans to install 2.5 miles offshore from Reedsport, Ore. A phase-in plan already approved by the Federal Energy Regulatory Commission could eventually increase output of the project to 50 MW. PNGC Power, which supplies wholesale power to 15 electric co-op distribution systems serving consumers in Oregon, Washington, Idaho, Montana, Utah, Nevada, and Wyoming, will purchase all 2 MW and has an option to obtain more output down the road.

"Electric co-ops remain committed to an overall goal of fostering domestic energy independence while benefiting the environment and assisting rural economic growth," concludes NRECA's English. "While no single approach or policy is appropriate for every co-op, we see renewable generation as an important part of our future." ■

This article represents the third in a series on how electric co-ops are looking out for their consumers and working to control power costs in an environmentally responsible fashion. Aimed at "closing the reality gap" on public understanding about climate change, the series examines ways electric co-ops are addressing seven Electric Power Research Institute recommendations that will allow the electric utility industry to slow, halt, and eventually decrease carbon dioxide emissions to 1990 levels by 2030 while still meeting demand for affordable, reliable electricity. The seven recommendations (some of which are still on the drawing table) are: boosting energy efficiency, improving the operating efficiency of coal-fired power plants, investing in renewable energy, expanding nuclear power capacity, capturing and storing carbon produced by coal-fired power plants, adding distributed generation resources, and putting plug-in hybrid electric vehicles on the road.

Energy efficiency

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"Touchstone Energy member co-ops can link directly to the lightbulb energy saver calculator from touchstoneenergy.coop," mentions Ann Maggard, Touchstone Energy director of communications & brand education. "We've also introduced additional animated applications that will calculate potential savings through electric water heaters and HVAC systems, as well programs designed for kids as part of our residential energy management portfolio."

Maggard adds that Touchstone Energy Cooperatives offers educational guides to help homeowners and small businesses root out energy waste and has established recommended efficiency standards for both new and existing homes. In addition, other energy efficiency programs available from Touchstone Energy include a Small Commercial Energy Auditing Workshop, a Residential Energy Auditing Workshop, an online home energy audit, and new Customer Service Representative Energy Efficiency Workshops designed to educate and improve member satisfaction.

Efficiency works

Since the early 1970s, U.S. energy consumption has climbed by 33 percent, but thanks to efficiency measures taken and technological advancements made during that period, the nation now uses half as much energy per dollar of economic activity.

"To run today's economy without the energy efficiency improvements that have taken place since 1973, we would need 43 percent more energy supplies than we currently use—more energy than we currently generate from any single fuel source like nuclear, gas, coal, or renewables," Jim Kerr, president of the National Association of Regulatory Utility Commissioners and member of the North Carolina Utilities Commission, testified in April 2007 before the U.S. Senate Energy and Natural Resources Committee.

Beavers stresses that when TXU Energy, the giant Dallas-based investor-owned utility, announced plans in early 2007 to build 11 new coal-burning plants to generate about 7,000 MW to meet expected growth, environmentalists expressed outrage. Due to pressure from "green groups" on Wall Street, a $45 billion buyout of the utility by private equity interests came with a huge caveat: TXU Energy had to scuttle eight of the proposed power plants and make up the generation difference through demand-response programs.

"If consumers around Texas shifted 10 percent of their electricity use to off-peak hours, that would save 7,000 MW," he suggests. "That's enough power to make up for the 11 new plants—without spending one penny in capital investment, building any transmission lines, or emitting any greenhouse gases."

"Energy efficiency remains key to how electric co-ops will keep electricity affordable in the face of rising energy prices," concludes NRECA CEO Glenn English. "Whether it's fostering the construction of more energy-efficient buildings, promoting the development and use of more energy-efficiency appliances, accelerating the development and use of advanced electric meters, or helping to commercialize fuel-efficient, plug-in hybrid electric vehicles, co-ops will put their energy and business expertise to work in developing innovative member programs that help get the most out of every kilowatt." ■

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REACTOR RENAISSANCE

Concern over how the United States can generate large amounts of baseload power without increasing carbon dioxide emissions has positioned nuclear power for a roaring comeback. And electric co-ops are interested.

Currently, 10 generation and transmission co-ops hold minority shares in 13 different nuclear units owned and operated by investor-owned utilities.

PHOTOGRAPH BY AP PHOTOS

By **Peter Nye**

Despite being largely ignored—and some would argue better forgotten—for nearly three decades, nuclear power has re-emerged as a darling on the national stage. In June 2007, the Tennessee Valley Authority (TVA) restarted its 1,200-MW Browns Ferry Unit 1 reactor in northern Alabama after a five-year, $1.8 billion refurbishing project—making it the first "new" U.S. nuclear reactor to come on-line in 11 years. TVA has also announced plans to complete work on the mothballed 1,180-MW Watts Bar Unit 2 plant at a cost of $2.49 billion. Its sister reactor, Unit 1, had been the last U.S. commercial nuclear power facility to begin operation.

For its part, the federal Nuclear Regulatory Commission (NRC) expects to receive up to 29 applications from utilities to build new nuclear power plants in 20 states, chiefly in the South. Applications for the streamlined, combined construction and operating licenses—the first in nearly 30 years—are already rolling in.

To ensure proper oversight, NRC has also created an Office of New Reactors staffed with 400 inspectors, nearly as many as oversee the nation's existing 104 commercial nuclear power units. The agency believes the next wave of nuclear power plants could begin feeding the grid between 2015 and 2020.

This unlikely revival comes courtesy of perhaps the central issue swirling about legislative circles today: climate change.

"Electric utilities are scrambling for ways to generate more electricity while curbing emissions of greenhouse gases, primarily carbon dioxide, blamed for contributing to global warming," explains John Holt, NRECA senior principal for generation & fuel. "As a result, lots of attention has been focused on nuclear power. It's the only source other than coal that can generate adequate amounts of reliable baseload power to meet growing demand, and it only emits steam—clean water vapor."

Coal-fired power plants, in contrast, which generate roughly 50 percent of the nation's electricity, account for approximately 39 percent of U.S. man-made carbon dioxide output—the largest single source—and about 33 percent of all greenhouse gas emissions from human activity. That puts them squarely in the crosshairs of lawmakers.

"Clearly, from a public policy perspective, climate change is a pressing crisis, and nuclear is a proven off-the-shelf technology that emits essentially no carbon dioxide," says Tom TerBush, manager of nuclear market strategy for the Electric Power Research Institute (EPRI), a non-profit utility-sponsored consortium based in Palo Alto, Calif., whose members include electric co-ops. "That makes nuclear power an attractive option to have as part of a utility's generation mix."

Overall, nuclear power plants provide 20 percent of the nation's power supply, second behind coal. For electric co-ops, 13 percent of the power produced by generation and transmission (G&T) co-ops, and 15 percent of all power requirements, are supplied by nuclear units, trailing only coal at 80 percent and 62 percent, respectively.

In 2007, EPRI released a study, *Electricity Technology in a Carbon-Constrained Future*, showing how electric utilities could help the United States reduce carbon dioxide emissions below 1990 levels within 23 years—even after adding 30 percent more load, half generated by coal—by taking aggressive steps in seven principal areas, including nudging nuclear power up to 25 percent of market share by 2030.

"The country already has 100,000 megawatts of nuclear power capacity," TerBush remarks. "We project adding 24,000 megawatts of new nuclear by 2020 [roughly 12 two-unit plants] and then 4,000 megawatts a year after that to reach a total of 64,000 megawatts by 2030. That amount would prevent about 260 million metric tons of carbon dioxide being emitted by the electricity sector."

Sleeping beauty

Most of the nation's nuclear fleet was ordered in the late 1960s through the late 1970s and operational by the mid-1980s. But after

the infamous March 1979 accident at the Three Mile Island nuclear plant in Pennsylvania, many planned reactors were shelved. Those under construction, meanwhile, experienced crippling delays and skyrocketing cost overruns due to additional safety features and design changes mandated by the NRC. Holt notes one G&T that had bought into a nuclear plant at the time saw costs to finish the facility escalate from $400 per kWh to $5,000 per kWh.

"Before Three Mile Island, nuclear power was sometimes advertised as being 'too cheap to meter,'" he recalls. "However, in the aftermath, the exploding debt burden heaped on utilities that had made nuclear investments, coupled with public fear about catastrophic nuclear plant meltdowns, essentially put the industry into a deep sleep. Ironically, cost factors and new public fears [global warming] have awakened it."

With utilities having paid down nuclear debt considerably over the past two decades, the nation's reactors in 2006 produced electricity for an average of 1.72 cents per kWh according to the Washington, D.C.-based Nuclear Energy Institute. That compares with 2.37 cents per kWh for coal and 6.75 cents per kWh for natural gas-fired plants.

"Unlike fossil fuels, a rise in uranium prices to power nuclear reactors has only a minimal effect on the price of electricity," Holt comments. "And uranium is a natural resource in plentiful supply. Actually, about half of the nuclear power generated in the U.S. today comes from dismantled and reprocessed nuclear weapons, a sizeable chunk being old Soviet Union warheads."

Holt believes construction costs in the anticipated "nuclear build cycle" should be easier to calculate than they were the previous go-around, as applicants are planning to use standardized advanced reactor designs. The NRC has already certified two of the five most likely designs, all of which boast a smaller plant footprint.

"The new plants will include significant safety improvements over the boiling water and pressurized water reactors used today," he mentions. "For starters, they won't rely on active components like coolant pumps,

Yucca Mountain or Bust?

Ever since atomic research commenced in earnest with the U.S. entry into World War II, federal officials and Congress have focused on finding the perfect solution for disposing of high-level radioactive waste—such as spent uranium fuel bundles and other "hot" items—produced by nuclear reactors and weapons factories. To date, their efforts have borne little fruit.

Currently, nearly 60,000 tons of nuclear waste sits at 126 "temporary" sites—commercial nuclear power plants, defense installations, and national laboratories—in 39 states, all of it in aboveground cooling pools or dry casks. Roughly 161 million Americans—including 85 percent of those on the East Coast—live within 75 miles of an interim nuclear waste storage location.

"These on-site facilities were designed to handle nuclear material only for a short time," argues NRECA CEO Glenn English. "For nuclear power to stay viable, electric co-ops believe that permanent storage is necessary."

To achieve that goal, Congress in 1982 passed the federal Nuclear Waste Policy Act, which called on the U.S. Department of Energy (DOE) to develop a central, deep-mined, geologic, and essentially long-term nuclear waste storage repository. The law was amended five years later to focus all repository studies on Yucca Mountain, Nev., a remote spot located about 90 miles northwest of Las Vegas near former nuclear warhead testing grounds.

"The legislation effectively required DOE to begin accepting high-level nuclear waste at Yucca Mountain by January 31, 1998, with 77,000 tons eventually planned for entombment in underground tunnels," explains Dena Stoner, NRECA vice president of governmental relations. "Needless to say, the deadline was missed."

Myriad problems, such as ongoing lawsuits and political resistance by Nevada officials as well as inadequate congressional appropriations, helped sidetrack the project. To kick-start efforts, DOE in February 2002 formally designated Yucca Mountain as the nation's permanent nuclear waste repository. Following Nevada's formal "veto" of the action (permitted under the Nuclear Waste Policy Act), President Bush in July of that year signed a congressional resolution overriding the protest.

But the political and legal maneuvering did not end there. Today, Yucca Mountain remains in a state of limbo—even as DOE contractors continue to drill tunnels and conduct scientific tests.

Ongoing Silver State opposition efforts, including a protracted dispute over water rights at Yucca Mountain, received a boost in 2004 when a federal appeals court rejected a proposed U.S. Environmental Protection Agency radiation safety standard for the site. (The agency has since proposed a new standard that stretches the safety compliance period to 1 mil-

Since 1983, consumers served by electric co-ops that own stakes in nuclear power plants have paid roughly $700 million, including interest, to help construct a nuclear waste storage repository at Yucca Mountain in Nevada, shown here.

PHOTOGRAPHS BY AP PHOTOS

fans, chillers, or diesel generators to shut things down in an emergency. To reduce human error, the plants will feature more passive systems that can open and close valves automatically using gravity or water flow to cool reactor cores, multiple backup power supplies, and digital control rooms. And they will incorporate enhanced post-9/11 security measures, including hardened concrete exteriors that can better withstand the shock of events such as an airplane strike."

To keep work on the fast track, most new nuclear plants will rely on modular construction with large parts, such as the reactor vessel, made in other countries like Japan. By using standardized design and modular construction, nuclear plant contractors like General Electric claim they can construct an entire facility from the ground up in approximately 36 months.

A 30 percent solution

At present, 10 G&Ts hold minority shares in 13 different nuclear units owned and operated by investor-owned utilities, representing more than 3,150 MW. The largest G&T owner, Oglethorpe Power Corporation, headquartered in Tucker, Ga.—which supplies wholesale power to 38 electric distribution co-ops around the Peach State—maintains a 30 percent stake in the two-unit, 2,320-MW Vogtle Nuclear Plant near Waynesboro, as well as a similar share in the two-unit, 2,565-MW Hatch Nuclear Plant near Baxley. Both facilities are operated by the Southern Nuclear Operating Company, a subsidiary of Atlanta, Ga.-headquartered Southern Company.

"We get about 1,200 megawatts of capacity from the four nuclear units," points out Mike Price, Oglethorpe Power chief operating officer. "That's about 20 percent of our total capacity. But since those plants are designed to run 24 hours a day, seven days a week, and at full output, they produce about 40 percent of our energy needs on an annual basis. We are very pleased with the reliability and availability of nuclear power. It's a key part of our diversified generation portfolio."

Oglethorpe Power has owned its portion of the Hatch Nuclear Plant since the mid-1970s, shortly after the state's distribu-

lion years—a length some industry groups deem inconsistent with the 10,000-year standard required for other high-level nuclear waste and hazardous facilities.) In 2005, internal e-mails surfaced that suggested Yucca Mountain researchers had falsified data.

But the National Academy of Scientists' National Research Council in 2006 put to rest some fears about hauling spent nuclear fuel to Yucca Mountain, finding "no fundamental technical barriers to safe transport in the United States." In addition, a three-judge panel of the U.S. Court of Appeals for the District of Columbia has upheld DOE's plan for shipping high-level radioactive material to the site—estimated to take more than 4,300 trips over 24 years, about three-fourths by rail and the rest over highways.

With so many repository studies having been made throughout the years, the U.S. Senate Committee on Environment and Public Works in March 2006 issued a white paper, *Yucca Mountain: The Most Studied Real Estate on the Planet,* which not only found the location sound for nuclear waste storage but held that such disposal capability advanced national security and environmental imperatives.

High price to pay

Yucca Mountain slowdowns directly impact the 10 generation and transmission (G&T) co-ops that own minority shares in 13 different nuclear reactors, representing more than 3,150 MW. But the pinch doesn't end there.

Dairyland Power Cooperative, a G&T based in La Crosse, Wis., has been forced to spend $5.5 million annually on security, maintenance, and monitoring to store nuclear waste at the site of a 50-MW reactor in Genoa it shut down more than 20 years ago.

"We had bought the reactor in 1973 from the Atomic Energy Commission [predecessor to the Nuclear Regulatory Commission, or NRC], and everyone assumed that used nuclear fuel would be reprocessed before it became a long-term storage problem," says Deb Mirasola, Dairyland Power manager of corporate communications. "Now, we can't decommission the plant until spent fuel rods are removed from the cooling pool."

In June 2007, the wholesale power supplier to 25 electric distribution co-ops and 19 municipal electric systems in four Upper Midwest states, contracted with Energy Solutions, a national nuclear waste service contractor, to transport a 310-ton reactor pressure vessel and other low-level, non-fuel waste from the site to a Palmetto State-owned repository in Barnwell, S.C. The next step involves placing spent fuel into a passive, dry-cask storage system.

Due to troubles at Yucca Mountain, Dairyland Power has also been working with Private Fuel Storage (PFS), a consortium of eight large investor-owned utilities, to develop a private, interim nuclear waste storage facility on the Skull Valley

tion co-ops formed the G&T. It has maintained part ownership of the Vogtle Nuclear Plant since the first reactor went into operation in 1987, followed by the second unit in 1989.

Southern Nuclear Operating Company recently submitted an application with the NRC to add two more reactors to the Vogtle site, both of which will employ NRC-approved standardized Westinghouse AP1000 (advanced passive) technology.

"Southern Nuclear has now submitted an application for a combined operating license," Price indicates. "In Georgia, our members continue to experience substantial load growth. We are excited about the prospects of participating in these two new units. It's a great opportunity."

If the application gets approved by the NRC and the Georgia Public Service Commission, construction at Vogtle could begin in early 2011. "If that happens, the first new unit would go on-line in January 2016 and the second unit 12 months later," Price says.

Another G&T in a similar position, Allegheny Electric Cooperative in Harrisburg, Pa., owns 10 percent of the Susquehanna Steam Electric Station (SSES), a two-unit, 2,360-MW nuclear power plant located along the Susquehanna River near Berwick in the north-central part of the Keystone State. Allegheny Electric supplies wholesale power to 13 electric distribution co-ops across the Commonwealth and one in New Jersey, serving more than 220,000 homes, businesses, farms, and industries.

"SSES provides roughly 60 percent of our power requirements," notes Dick Osborne, Allegheny Electric vice president-power supply & engineering. "We became a part owner in 1977 when we needed more generation and when a lot of G&Ts were being encouraged by the federal government to get involved in nuclear power. It's a very stable, reliable source of power and remains very competitive with coal- and natural gas-fired generation."

The plant's principal owner and operator, Allentown, Pa.-based PPL Corporation, notified the NRC in June 2007 that it might apply for a combined construction and oper-

Yucca Mountain or Bust? *continued*

Goshute Indian Reservation in western Utah. As planned, 40,000 tons of commercial high-level radioactive waste would be stored aboveground on 820 acres of desert.

"While the Skull Valley facility received an operating license from the NRC in September 2005, obstacles to construction remain," Mirasola recounts. The U.S. Interior Department in September 2006 rejected the Goshute tribe's lease to build the facility, but PFS continues to evaluate options.

"Without Yucca Mountain or a substitute, all of our spent nuclear fuel will need to be stored on site," asserts Mike Price, chief operating officer of Oglethorpe Power Corporation, a G&T based in Tucker, Ga., which owns 30 percent of two nuclear power plants in the Peach State operated by Southern Nuclear Operating Company. "Even though both our Plant Vogtle and Plant Hatch have adequate storage space, we are counting on DOE taking responsibility for the spent fuel at a permanent repository."

Because of delays at Yucca Mountain, a federal court in 2004 awarded private power company Exelon Corporation $80 million to cover costs already incurred for storing spent uranium fuel at its nuclear power plants and ordered DOE to reimburse the utility for additional storage costs until the federal government meets its "contractual obligations" to haul away the material. In all, 60 similar lawsuits have been filed by electric utilities against DOE for breach of contract, with nearly $350 million in settlements already received. Total damages from the litigation will top at least $7 billion over the next few years and could exceed $35 billion.

Liability of that magnitude has many in Congress looking at alternative storage options, such as building federally owned interim disposal facilities on non-sensitive public lands or private property purchased from willing sellers. These temporary sites would hold used nuclear fuel for up to 25 years (or until Yucca Mountain becomes a reality), and DOE would take title to the waste.

In addition, lawmakers are also considering lifting a ban on reprocessing nuclear waste imposed in the late 1970s by President Carter.

"Technology exists that can break down nuclear waste into different components and recycle the usable material into new fuel," relates Tom TerBush, nuclear market strategy manager at the Palo Alto, Calif.-based Electric Power Research Institute (EPRI), a non-profit utility-sponsored consortium that includes electric co-ops. "Other countries are already doing reprocessing, including France, Britain, and Russia. But while reprocessing can reduce the volume and heat output of nuclear waste [the controlling factor in repository capacity], it does not eliminate the need for permanent storage."

More than a decade away, still

The U.S. Office of Civilian Radioactive Waste Management expects to file a license application in 2008 with the NRC to begin full-fledged design and construction on Yucca Mountain. That, effectively, pushes the repository opening back until at least 2021.

Even if a 2021 ribbon-cutting actually takes place, nuclear waste keeps growing by 2,000 tons annually, meaning Yucca Mountain will quickly fill up unless expanded. However, a 2006 EPRI study places potential Yucca Mountain disposal capacity at between 286,000 and 628,000 tons, due to additional space available in adjacent rock formations.

"There is no crisis on central storage, but having it eventually is necessary," contends TerBush. "For the foreseeable future, delays at Yucca Mountain do not pose a barrier to new nuclear power plant construction."

But they do keep pushing up the project's price tag, now pegged at $58 billion and counting. Stoner notes that electric co-ops are deeply concerned about how Congress continues to use money flowing into the federal Nuclear Waste Fund—created in the Nuclear Waste Policy Act to pay for construction at Yucca Mountain—to mask the size of the federal budget deficit.

"Since 1983, Americans who consume electricity produced by nuclear power plants have paid roughly $30 billion, including interest, to the Nuclear Waste Fund through a one-tenth of 1 cent per kilowatt-hour fee," she remarks, "although only $9.5 billion has been spent on repository work. More than $700 million of the total has come from electric cooperative consumers."

—Perry Stambaugh with Peter Nye

ating license on a third unit at SSES. Osborne asserts, "Allegheny Electric is very interested in working with PPL on continuing our joint-ownership relationship."

Is the price right?

Even with climate change pressures, nuclear power still faces heavy political and philosophical opposition in many circles. In February 2007, Standard & Poor's Rating Services noted that nuclear "is realistically only available to those G&Ts that are participants in an existing plant considering unit expansion."

Holt reports that eight G&Ts have talked with investor-owned utilities about possible participation in new nuclear power plants. But he cautions that if proposed plants manage to overcome nearly three decades of "application drought" and the prospect of community hostility, and if Congress maintains federal Price-Anderson Act limits on utility liability in case of a nuclear accident plus delivers loan guarantees sufficient to satisfy financial institutions, and, finally, if owners are able to line up necessary financing themselves, nuclear reactors will still take longer to build and cost at least three times more than similarly sized coal- or natural gas-fired generating stations.

"If plans for a nuclear plant of 1,000 megawatts to 1,500 megawatts capacity were permitted in 2008, the earliest one could go on-line would be 2015," Holt estimates. "The cost would be at least $5 billion, and maybe higher, per unit of that size." ■

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Coal-fired plants

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for new coal-fired power plants are circulating fluidized bed (CFB) technology, developed by the U.S. Department of Energy Clean Coal Technology Program, and Integrated Gasification Combined Cycle (IGCC). Unlike conventional generating stations that burn powdered coal at temperatures ranging from 2,200 degrees to 2,400 degrees Fahrenheit, CFB units consume crushed coal—less than three-eighths of an inch thick—at between 1,500 degrees and 1,650 degrees Fahrenheit and mix in limestone; air blown into the boiler suspends the mixture as it burns (referred to as fluidizing).

Integrated Gasification Combined Cycle (IGCC) turns coal into a syngas, stripped of sulfur compounds, which gets burned to generate electricity. In addition, the process recovers waste heat to produce even more electricity.

"IGCC results in lower emissions of sulfur dioxide, particulates, and mercury, and because it is more efficient than a normal coal-fired power plant, produces less carbon dioxide," notes NRECA's Holt. "However, IGCC plants don't have a strong track record on reliability unless they add an additional gasifier chain at a cost of at least 20 percent more. Only two are currently operating in the U.S., although several others are being evaluated."

EPRI sees the largest carbon dioxide cuts coming from coal-burning plants equipped for carbon capture and storage (CCS), a method that collects, compresses, and sequesters the gas thousands of feet underground in geologic formations. CCS, still largely restricted to the laboratory, likely won't be tested commercially until 2012 or later when the $1.8 billion FutureGen project—the world's first zero-emissions coal-fired power plant—goes on-line. The prototype 275-MW FutureGen facility will couple CCS with IGCC, since IGCC—by creating a more pure stream of carbon dioxide through gasification—makes capture easier. (The U.S. Department of Energy in January 2008 pulled its support for FutureGen, which was to be built by an alliance of power and coal companies in central Illinois. Instead, the department will focus on funding the addition of CCS technology to multiple IGCC plants.)

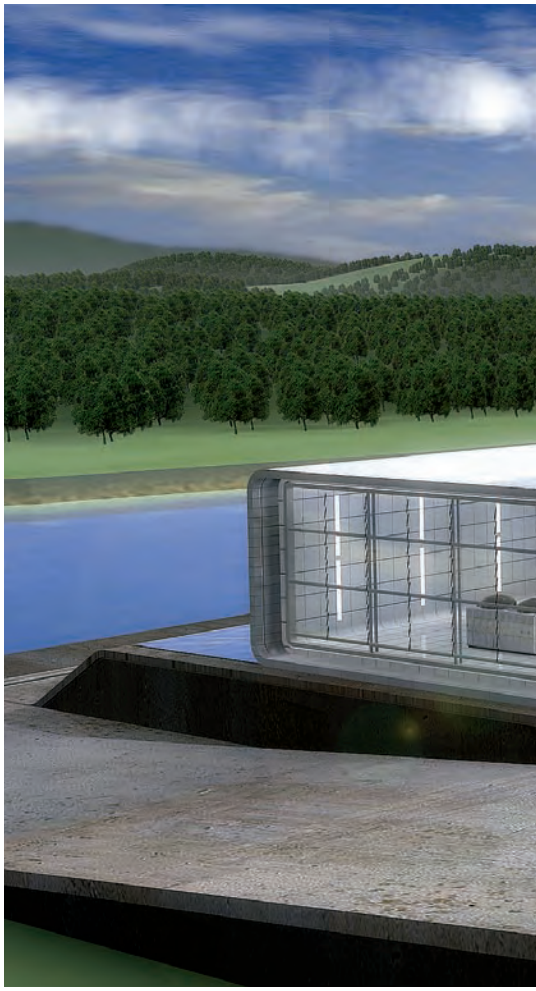
"Current carbon capture and storage methods drain an estimated 20 percent to 30 percent of plant energy," cautions Facchiano, "and increase production costs 60 percent to 80 percent."

Fortunately, electric co-ops do have experience with carbon capture and storage, although not from coal generation—yet. The only commercial-scale operation in the United States for turning coal into synthetic natural gas, the Great Plains Synfuels Plant—owned and operated by Basin Electric Power Cooperative, a G&T based in Bismarck, N.D.—ships 8,700 tons of compressed carbon dioxide daily via a 205-mile-long pipeline to Weyburn, Saskatchewan, for permanent entombment in old oil wells. However, Basin Electric Power recently contracted with a developer to retrofit its existing 900-MW coal-fired Antelope Valley Station with a carbon capture and storage process.

"Given that electric co-ops over the next decade must build half again as many new power plants [roughly 20,000 MW]—a large portion of which will use coal as fuel—to keep the lights on, we feel technology remains the best way to mitigate greenhouse gas emissions and enhance energy efficiency," concludes NRECA CEO Glenn English. "As a result, the electric co-op program continues to push for increased federal investment into research and development aimed at providing workable, market-driven solutions in the areas of advanced clean coal and carbon capture and storage." ■

This article represents the second in a series on how electric co-ops are looking out for their consumers and working to control power costs in an environmentally responsible fashion. Aimed at "closing the reality gap" on public understanding about climate change, the series examines ways electric co-ops are addressing seven Electric Power Research Institute recommendations that will allow the electric utility industry to slow, halt, and eventually decrease carbon dioxide emissions to 1990 levels by 2030 while still meeting demand for affordable, reliable electricity. The seven recommendations (some of which are still on the drawing table) are: boosting energy efficiency, improving the operating efficiency of coal-fired power plants, investing in renewable energy, expanding nuclear power capacity, capturing and storing carbon produced by coal-fired power plants, adding distributed generation resources, and putting plug-in hybrid electric vehicles on the road.

COMING FULL CIRCLE ON CARBON



PHOTOGRAPH BY AP PHOTOS

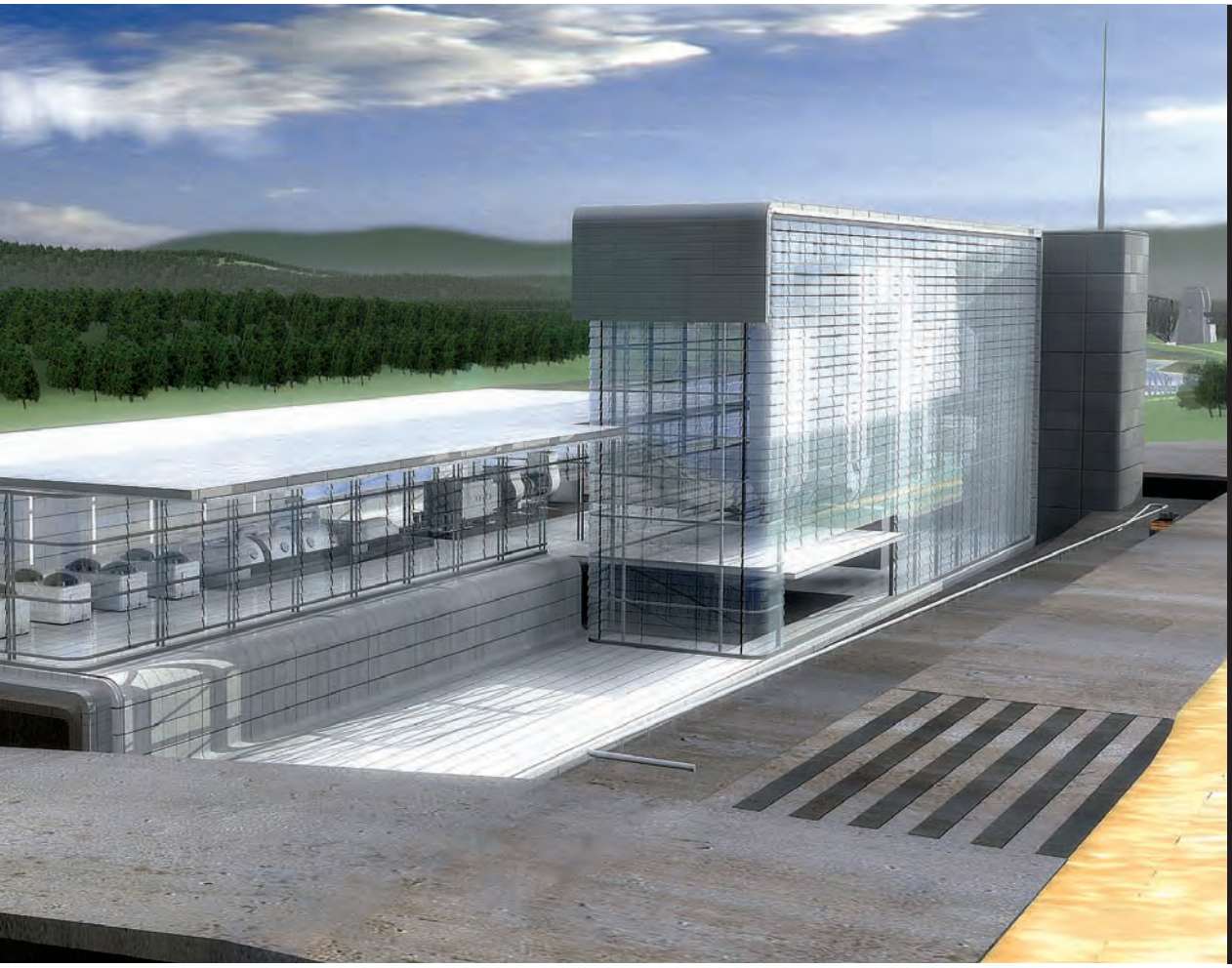
By **Peter Nye**

Electric co-ops are already showing the world how to capture carbon dioxide emissions produced by burning fossil fuels and then returning the gas to where it came from—deep underground. Success in applying this technology to coal-fired power plants could very well determine if electric utilities can "keep the lights on" in coming years.

Every day, the Great Plains Synfuels Plant near Beulah, N.D., ships 8,700 tons of compressed carbon dioxide via a 205-mile-long pipeline buried four feet underground to oil fields in Weyburn, Saskatchewan. There, two oil companies inject the gas several thousand feet down into depleted wells to bring more crude to the surface. In turn, the carbon dioxide gets entombed permanently.

"Technicians say that carbon dioxide improves viscosity—it acts sort of like a solvent so that more crude oil can be recovered," explains Daryl Hill, media relations supervisor for the synfuels plant's owner, Basin Electric Power Cooperative, a Bismarck, N.D.-based generation and transmission (G&T) co-op that supplies wholesale power to 126 member co-ops in nine states. "We're told that the carbon dioxide injections boost oil production 60 percent and will increase life of those oil fields by 25 to 30 years."

Over the years, more than 10 million tons of carbon dioxide from the co-op-



This sketch shows how the planned 275-MW FutureGen project—billed as the world's first zero-emissions coal-fired power plant—may look. The project was scrapped by the U.S. Department of Energy in early 2008.

owned facility, which turns coal into synthetic natural gas, have been captured and removed.

"As the only coal-based commercial-scale plant in the world that sends carbon dioxide through pipelines for storage underground, our synfuels plant has drawn global media," Hill adds. "We have been visited by reporters from the BBC in London, FOX News, Tokyo Broadcasting, Canada's edition of *National Geographic*, National Public Radio, The History Channel's *Modern Marvels* program, and even the Natural Resources Defense Council. It appears we are operating the largest carbon dioxide sequestration project in the world."

Keeping coal viable

Coal-fired power plants, which generate roughly 50 percent of the nation's electricity, produce approximately 39 percent of all U.S. man-made carbon dioxide output (more than 2.4 billion tons, the largest single source) and about 33 percent of all greenhouse gas emissions from human activity. Overall, coal accounts for 80 percent of the power generated by G&Ts and 62 percent of all electric co-op power requirements.

As electric utilities with coal-burning power stations scramble for ways to meet electricity demand while curbing emissions of greenhouse gases, primarily carbon dioxide, blamed for contributing to global climate change, one solution has come to the forefront: separating carbon dioxide that normally goes up a smokestack, compressing it, pumping it down into spent oil and natural gas wells, saline reservoirs, or inaccessible coal seams, and keeping it there forever—a process called carbon capture and storage (CCS). In a 2007 study, *Electricity Technology in a Carbon-Constrained Future*, the Electric Power Research Institute (EPRI), a non-profit utility-sponsored consortium based in Palo Alto, Calif., whose members include electric co-ops, spelled out how electric utilities could help the United States slash carbon dioxide emissions below 1990 levels within 23 years—even after adding 30 percent more load, half generated by coal—by taking aggressive steps in seven principal areas. The biggest cuts, EPRI noted, would come from adding CCS technologies to new coal-fired power plants (72,000 MW) coming on-line after 2020.

"Much study still needs to be done on CCS," concedes George Offen, EPRI senior technical executive. He confirms that only three plants currently remove carbon dioxide from gas production and store it underground—Sleipner West Field in Norway's North Sea, InSalah Gas Carbon Dioxide Storage Project in central Algeria, and the Great Plains Synfuels Plant. But the Great Plains facility remains the only one where the process begins with coal.

Although technology to take carbon dioxide from flue gas in coal-burning power plants exists, "it's just not ready for prime time," asserts Ed Torrero, executive director of NRECA's Cooperative Research Network (CRN). "The big worry for utilities is that if advancements in this field are slow to take root, the price of electricity from a generating station employing CCS as we know it today could easily double."

A recent Massachusetts Institute of Technology study, *The Future of Coal: Options for a Carbon-Constrained World*, echoes Torrero's thoughts, noting that "carbon dioxide capture and sequestration is the critical enabling technology to reduce carbon dioxide emissions significantly while also allowing coal to meet the world's pressing energy needs."

"The MIT authors found that worldwide coal use will increase under any foreseeable scenario because it remains cheap and abundant, particularly in countries with growing economies like China and India," mentions Kirk Johnson, NRECA vice president of environmental policy. "The study emphasizes that coal can provide energy at a cost of $1 to $2 per million Btu versus $6 to $12 per million Btu for oil and natural gas. It also assumes a global carbon price, or tax, of at least $25 per ton because that's where CCS becomes economic."

Independent of whatever government policies are adopted to control carbon dioxide emissions, the MIT researchers advocate as a "priority objective" five large-scale projects that demonstrate the technical, economic, and environmental performance of technologies for capturing, transporting, and storing carbon dioxide. "The MIT report clearly shows that we need a crash program to make CCS economically and technically feasible to address climate change," Johnson stresses.

In late October 2007, the InterAcademy Council, an international panel of 15 researchers representing 13 national academies of science, cautioned that governments and the private sector are spending too little on CCS development. Worldwide investment in all types of energy research and development, estimated at $9 billion, should be at least doubled, the group suggested.

On the vanguard

As they have with energy efficiency programs and renewable energy growth, electric co-ops are taking the lead in testing and deploying CCS technology. Basin Electric Power recently selected a developer to retrofit its 900-MW coal-fired Antelope Valley Station, which sits next door to the Great Plains Synfuels Plant, with a CCS process.

The War on Coal Hits Home

Across the nation, environmental and allied groups are waging an aggressive public relations and legal campaign to essentially "rid the world of coal-fired plants." And no segment of the utility industry has been impacted more by these efforts than electric co-ops.

In July 2007, a federal lawsuit was filed to stop the Rural Utilities Service from financing at least seven co-op power plants that will consume coal, charging the agency with fostering "large-scale federal investment in new coal-fired power plants that will substantially increase emissions of greenhouse gases responsible for global warming." One of the loans, for $650 million, would fund 80 percent of the 250-MW Highwood Generating Station planned by Southern Montana Electric Generation & Transmission Cooperative, a generation and transmission (G&T) co-op based in Billings, Mont. Applications for the other six disputed generating facilities top $5.1 billion total.

Florida, meanwhile, has seen five planned power plants—which would have generated 4,642 MW of electricity, enough power for nearly 3 million homes—scrapped in the wake of Republican Gov. Charlie Crist's crusade against coal. Two were rejected at the final step by state regulators—one of them being a 750-MW third unit planned by Seminole Electric Cooperative, a Tampa-headquartered G&T, for its 1,300-MW Seminole Generating Station, located along the St. Johns River, 50 miles south of Jacksonville. The $2 billion new generator, scheduled to go on-line in May 2012, would employ supercritical boiler technology that produces more megawatts from less coal, reducing carbon dioxide output.

"We are appealing the decision," says Seminole Electric Director of Projects Jim Frauen. "We met every aspect of the approval process and believe this new unit balances the critical need for additional reliable, affordable capacity with the need to safeguard the environment."

To smooth the way for project approval, Frauen relates that the G&T entered into a settlement with the Sierra Club.

"In return for them not opposing our state certification, we agreed to further lower annual emissions from all three units [the expanded facility in total would emit less sulfur dioxide, nitrogen oxides, mercury, and sulfuric acid than the two existing units do now], continue to pursue renewable energy and carbon dioxide-reducing efforts, and purchase approximately $200,000 worth of high-efficiency compact fluorescent lightbulbs that our member co-ops can allocate to their consumers," he points out. "The denial of the state license was particularly disappointing because in addition to resolving all issues of concern with the Sierra Club, we also had entered into stipulations with the Florida Department of Environmental Protection and other state environmental and wildlife agencies, which concurred that all applicable standards and regulations had been satisfied."

PHOTOGRAPH BY AP PHOTOS

To the west, environmental officials in Kansas—pressured by attorneys general in eight states, including California and New York, and bolstered by Democratic Gov. Kathleen Sebelius and Lt. Gov. Mark Parkinson—in October 2007 denied an air-quality permit to Sunflower Electric Power Corporation, a Hays, Kan.-based G&T, to begin construction on two 700-MW coal-burning generating units at its 360-MW Holcomb Station, located four miles south of the town of Holcomb. Tri-State Generation & Transmission Association, a G&T based in Westminster, Colo., had joined as a partner on the $3.6 billion Holcomb Station expansion.

"I believe it would be irresponsible to ignore emerging information about the contribution of carbon dioxide and

Arizona Electric Power Cooperative (AEPCO), a G&T based in Benson, Ariz., that supplies wholesale power to six distribution co-ops in the Southwest, is participating with three other Grand Canyon State utilities in the $4 million Arizona Utilities Carbon Dioxide Storage Pilot Project sponsored by the West Coast Regional Carbon Sequestration Partnership—one of seven U.S. Department of Energy (DOE) large-scale carbon storage initiatives. The program tests carbon dioxide storage in geologic formations, with DOE picking up 80 percent of the costs.

"This project will look only at sequestration," remarks AEPCO Manager of Regulatory Affairs Jim Andrew. "Plans call for drilling a well 4,500 feet down into a saline reservoir in northeastern Arizona's Colorado Plateau Province, injecting 2,000 tons of commercial-grade liquid carbon dioxide that's being trucked in, and monitoring it for re-emission or leaks. It will also gauge public acceptance."

According to the U.S. Environmental Protection Agency (EPA), Arizona power plants emitted 54 million tons of carbon dioxide in 2003. A state geological survey indicates that abandoned oil and gas fields and deep saline reservoirs could store more than 3 billion tons of carbon dioxide.

"If successful, the work may expand to evaluate the feasibility of carbon capture at the nearby Cholla Power Plant," Andrew notes. Investor-owned utilities APS and PacifiCorp own the 995-MW, four-unit coal-fired facility.

CRN has joined a DOE sequestration endeavor near Gaylord, Mich., where 10,000 tons of carbon dioxide derived from a natural gas processing plant will be injected into deep saline formations. The carbon dioxide will be captured by an amine scrubber; a derivative of amine scrubbing technology holds promise for post-combustion carbon capture at power plants. The Michigan site features most elements of a complete sequestration system—a compression plant, an 8-mile-long supercritical pipeline, and injection and monitoring wells.

"Carbon sequestration is very expensive," says Tom Lovas, CRN senior project manager. "With DOE partnership, CRN gains a unique opportunity that we might otherwise not have."

CRN also continues to follow progress being made on the $1.8 billion public-private

Nationwide, 31 coal-fired power plants totaling at least 23,500 MW have been scrapped in recent months, and more than three dozen have been delayed due to global warming jitters and rising construction costs.

other greenhouse gases to climate change and the potential harm to our environment and health if we do nothing," said Kansas Department of Health & Environment Secretary Roderick Bremby. The move marked the first time a government body had denied an air-quality permit specifically because of concerns about carbon dioxide.

The Sunflower Electric Power project also involves plans to create a roughly $400 million self-sustaining, carbon-neutral, integrated bioenergy center. The center—slated to include ethanol and biodiesel plants, a dairy farm, and a cow manure-fueled anaerobic digester designed to produce methane gas to operate the ethanol plant—would feature a reactor that grows algae in coal flue gas. The "crop," which absorbs carbon dioxide, would then be refined into biofuel, dried for cattle feed and fertilizer, and harvested as feedstock for the ethanol plant.

"The bioenergy center would eventually employ 161," reports Clare Gustin, the G&T's vice president for member services & external affairs. "While power sale revenues from the plant were expected to finance our investment, we intend to continue vigorous development." Sunflower Electric Power supplies wholesale generation to six electric co-ops and 400,000 consumers in western Kansas. A bill to overturn Bremby's decision cleared the Kansas legislature in March 2008, but was vetoed. Legislative wrangling over the plant continues.

On another front, New York Attorney General Andrew Cuomo (D)—in addition to helping derail Holcomb Station—has begun investigating five major energy companies to determine if their proposals to develop coal-fired power plants present an undisclosed financial risk to investors. Cuomo has used the Martin Act—a state securities law created to investigate corruption on Wall Street—in sending subpoenas to AES Corporation, Dominion Resources, Dynegy, Peabody Energy Corporation, and Xcel Energy. In accompanying letters, Cuomo suggests that the firms could take a financial hit if federal lawmakers tighten controls on coal plants.

Overall, 31 coal-fired power plants nationwide totaling 23,500 MW have been scrapped since January 2007, and more than 50 have been delayed due to global warming jitters and rising construction costs. Of 151 new coal plants announced since 2002, only 15, generating 3,700 MW, have been built. However, 28 others, comprising 15,000 MW, are currently underway. G&Ts have full or partial ownership in six of them, for 1,074 MW.

Misguided legal schemes against coal don't make economic sense, insists NRECA CEO Glenn English. "Coal is the one indigenous form of energy we have in abundance, and we just have to find ways to burn it cleaner—but not outlaw it."

He concludes, "Electric co-ops support new generation capacity with technology that's available, and improving existing equipment and facilities as cost-effective options present themselves. We have an obligation to serve. If we don't continue to build coal-fired and nuclear baseload generation, where will the electrons needed to meet a projected 30 percent increase in electricity demand by 2030 come from? Clearly, renewables and energy efficiency can't do it all. The only other generation option is natural gas, and we've seen prices for that commodity triple over the past five years while pipeline capacity remains inadequate to handle greater use. The unfortunate end result from all of this could be increasing our dependency on foreign sources of energy, such as liquefied natural gas, and enormous increases in electric bills."

—Perry Stambaugh

FutureGen project—the world's first zero-emissions coal-fired power plant. The prototype 275-MW FutureGen facility (which was to be built by a coalition of power and coal companies in central Illinois before DOE withdrew its support in January 2008) will couple CCS with Integrated Gasification Combined Cycle (IGCC) operation. IGCC, by turning coal into a syngas stripped of sulfur compounds, creates a more pure stream of carbon dioxide that makes carbon capture easier.

"While IGCC is interesting, it's not ready for widespread utility operations, either," cautions Torrero. "IGCC plants don't have a strong track record on reliability unless they add an additional gasifier chain at a cost of at least 20 percent more."

Only two IGCC generating plants are currently generating electricity in the United States, one of them owned by Indianapolis, Ind.-based Wabash Valley Power Association—the wholesale power supplier for 28 electric distribution co-ops in Indiana, Illinois, Michigan, Missouri, and Ohio. The G&T purchased the synthetic gasification unit in 2005 and has since completed acquisition of the 290-MW combined cycle power island. According to Wabash Valley Power CEO Rick Coons, the facility was one of the first in the country to demonstrate the use of gasified coal to generate electricity.

However, IGCC received a kick-start when DOE in October 2007 issued final regulations for a program, authorized in the federal Energy Policy Act of 2005, that provides 100 percent loan guarantees to build up to 16 IGCC facilities. Meanwhile, DOE and EPA are evaluating how storing carbon dioxide may affect groundwater tables.

Federal funding essential

EPRI and the Washington, D.C.-based Coal Utilization Research Council—composed of DOE as well as state, university, mining, and other business interests—argue that for electric utilities to begin adopting CCS by 2020, major demonstration projects with coal-fired plants need to begin soon, each able to sequester more than 1 million tons of carbon dioxide 10,000 feet down per year. Legal and regulatory guidelines for CCS also need to be established.

"To conduct research and answer all of the questions the public has about carbon capture and storage will require spending $800 million annually over the next 10 years—a total of $8 billion," Offen points out. "But without this expenditure, the cost of doing CCS with today's technology to meet growing electric demand would cost at least $1 trillion more than with advancements."

In September 2007, NRECA CEO Glenn English testified before the U.S. House Select Committee on Energy Independence and Global Warming and encouraged Congress to invest in the emerging technologies required for reducing greenhouse gases from coal plants.

"Cooperatives are at the cutting edge in demonstrating the viability of integrated CCS technology," English stated. "Funding for federal research and development incentives is essential to full availability of CCS technology."

Rae Cronmiller, NRECA environmental counsel, contends that the electric industry will also have to overcome regulatory hurdles to get CCS off the drawing board on a commercial scale. "There are issues involving groundwater protection, mineral rights, waste disposal, pipeline transmission eminent domain, liability in case of accidents, and federal/state jurisdiction that remain to be worked out," he declares. "Without a comprehensive permitting system in place ahead of time, it will be difficult for CCS to achieve significant reductions in carbon dioxide emissions."

A states' rights clash over sequestration may materialize, too. EPA has announced plans to issue rules for underground carbon storage under the federal Safe Drinking Water Act. That may not sit well with states like North Dakota, where Gov. John Hoeven (R) recently released a carbon dioxide management plan—based on one cobbled together by the Interstate Oil & Gas Compact Commission, of which he serves as chairman—that recommends states, not the federal government, oversee vast, buried carbon dioxide storage "warehouses." To

Each day, 8,700 tons of compressed carbon dioxide gas produced at the Great Plains Synfuels Plant in North Dakota are shipped through a 205-mile-long pipeline for permanent burial in Canadian oil fields. Basin Electric Power Cooperative, a generation and transmission co-op based in Bismarck, N.D., owns the synfuels facility.

PHOTOGRAPH BY BASIN ELECTRIC

finance state monitoring activities and provide liability protection, a fee would be levied for each ton of carbon dioxide sequestered.

Consumer costs

In a July 6, 2007, editorial, "Global Warming and Your Wallet," the *New York Times* highlighted that "leading politicians have yet to educate their constituents [and fellow colleagues] about an unpleasant and inescapable truth: any serious effort to fight warming will require everyone to pay more for energy."

Offen concurs. "Just building new coal-fired generators with CCS technology will boost capital costs by around 40 percent, while the tab for retrofitting plants, if possible, could run 60 percent to 80 percent of what it would take to replace a facility. In addition, CCS drains an estimated 20 percent to 30 percent of the energy from a coal plant."

According to the EPRI carbon constraints study, all new domestic electric supplies built after 2020 would need to implement CCS for the energy sector to lower carbon dioxide emissions to 1990 levels by 2030. "By then, new generation—presumably equipped with CCS—will provide about 15 percent of all coal-derived electricity in the U.S.," Offen estimates.

English sees the debate on climate change growing hotter. "Electric co-op consumers want something done, but they also are conscious that there is a price to pay for reducing greenhouse gas emissions like carbon dioxide," he concludes. "But as co-ops, we have a responsibility to protect our consumer-members and an obligation to serve. We need to encourage our elected officials to 'get climate change right,' and to work for creating sustainable, long-term solutions based on new technology. If we can get the issue of what it will cost the consumer into public policy discussions, then we will succeed." ■

This article represents the fifth in a series on how electric co-ops are looking out for their consumers and working to control power costs in an environmentally responsible fashion. Aimed at "closing the reality gap" on public understanding about climate change, the series examines ways electric co-ops are addressing seven Electric Power Research Institute recommendations that will allow the electric utility industry to slow, halt, and eventually decrease carbon dioxide emissions to 1990 levels by 2030 while still meeting demand for affordable, reliable electricity. The seven recommendations (some of which are still on the drawing table) are: boosting energy efficiency, improving the operating efficiency of coal-fired power plants, investing in renewable energy, expanding nuclear power capacity, capturing and storing carbon produced by coal-fired power plants, adding distributed generation resources, and putting plug-in hybrid electric vehicles on the road.

Commentary *from page 3*

zine series demonstrates, electric co-ops have a great story to tell in how we're tackling each of these ambitious goals. We are industry leaders and know what works. Tapping our network, we are providing elected officials with expertise on what's feasible technologically and what programs can be sustained economically—and politically.

In the end, not-for-profit, consumer-owned and -governed electric co-ops recognize that average folks ultimately pay the freight for whatever energy policy decisions are made. Because of this, consumers deserve a full accounting on costs. As energy and climate change debates move forward, electric co-ops are encouraging those in power to seek out practical, long-term remedies based on new technology that will allow us to continue providing safe, reliable, and affordable power in an environmentally responsible fashion. ■

Distributed generation *from page 39*

supervisor for the co-op. "Most payments have been for PV systems where consumers want to take advantage of Colorado's 300 days of sunshine annually."

In California, Plumas-Sierra Rural Electric Cooperative in Portola—as part of the Golden State's Million Solar Roofs campaign, which aims to place 3,000 MW of electricity on the grid from solar sources by 2017—has been offering rebates since 2006 to encourage PV for residences, farms, and small commercial accounts.

"Starting in January 2008, we increased our rebate rate from $2,000 per kilowatt, capped at $3,000 per account, to $2,800 per kilowatt, with a much higher cap," indicates Jessica Nelson, Plumas-Sierra REC energy services manager. ■

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By **Peter Nye**

Through a variety of distributed generation resources, consumers—both large and small—are helping electric co-ops offset the need to build new power plants and transmission facilities, reduce load during times of peak demand, and curb greenhouse gas emissions

POWER FROM THE

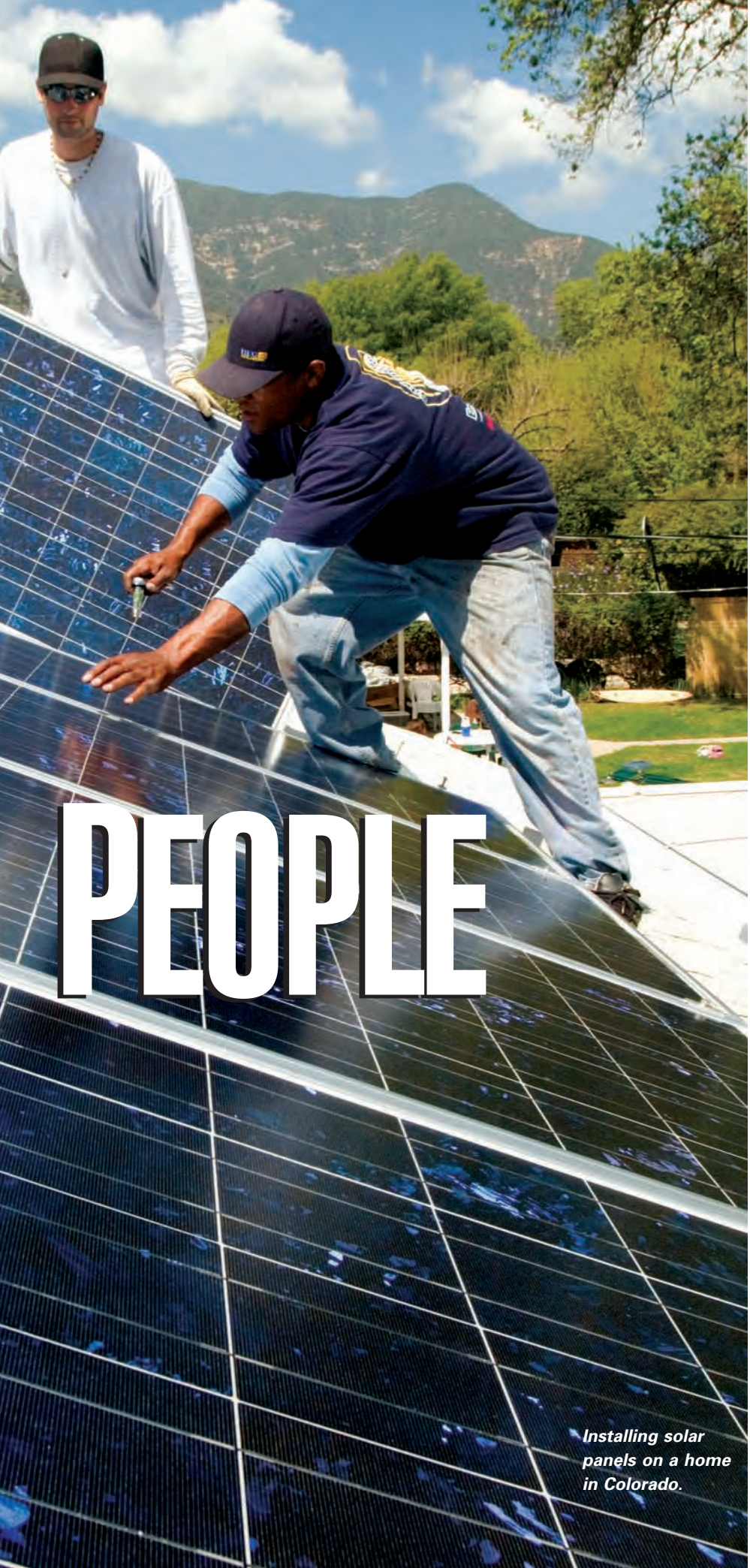
After a tornado swept through central Illinois in spring 2006, Shelby Electric Cooperative line crews quickly restored power to more than 10,000 members. However, 300 accounts—served off a substation fed by an investor-owned utility transmission line—remained in the dark, leaving the co-op virtually helpless to remedy the situation.

"The investor-owned utility had lost several transmission poles in the storm and just didn't respond as fast as we could in getting power flowing," recalls Jim Coleman, president/CEO of Shelby Electric in Shelbyville, about 90 miles southeast of the state capital in Springfield. "We had to wait several days before we could bring those members back on. From that experience, we decided to try something a little different."

Within weeks, Coleman had met with representatives of the co-op's wholesale power supplier, Prairie Power, Inc. (formerly Soyland Power Cooperative), a generation and transmission (G&T) co-op based in Jacksonville, Ill., to discuss a solution that would kill two birds with one stone—provide consumer-members with emergency power and allow Shelby Electric to increase its load-control capabilities. The answer lay in distributed generation—small "power plants" owned by consumers.

"Everything just fell together," Coleman

ALAMY



Installing solar panels on a home in Colorado.

explains. "Our for-profit subsidiary, Shelby Energy Company, would sell 7-kilowatts to 25-kilowatts Generac Power Systems Guardian automatic standby generators to our residential consumers. Fueled by natural gas and liquid propane, they kick on within 30 seconds of an outage; when co-op electric service resumes, they shut off."

In addition to ensuring reliability following a crippling storm or other extended outage, the generators would help Shelby Electric control power costs. Prairie Power currently operates just 22 MW of coal-fired baseload generation capacity but 154 MW of oil- and natural gas-fired peaking units. (Several of the G&T's members recently committed to a roughly 130-MW ownership stake in the 1,582-MW coal-fired Prairie State Energy Campus now under construction in southern Illinois.)

"If enough generators were installed by member distribution co-ops, Prairie Power would not need to turn on the peakers, trimming fuel costs," Coleman insists.

Under Shelby Electric's generator program, participating consumers receive a rate cut of up to 15 percent on the energy portion of their electric bill if they allow the co-op to interrupt service during times of peak demand—the electric utility industry's equivalent of rush-hour traffic—when power costs skyrocket. After the member signs a contract, the co-op installs a disconnect ring to their automated meter reading (AMR) device.

"Generators and interruptible load have been around for a long time, though they are normally associated with large users of electricity, not homeowners and small businesses," Coleman stresses. "But we married them up with AMR into a program that works for us."

He adds, "Of course, most folks don't buy generators for savings. They buy them for peace of mind. A lot of our line techs have bought them, too."

For every 100 residences that buy a generator and agree to interruptible power, Shelby Electric, which averages less than five members per mile of energized line, gains

about 1 MW of demand-side management under its belt—and a potential savings of $50,000 annually in power costs.

"Our goal is to get 10 percent of our accounts signed up for interruptible power," Coleman recounts. "That would save us about $600,000 a year in fuel costs. It's a perfect example of how distributed generation can benefit both co-op and consumer."

EPRI's solution

Prior to arrival of central station electric service in rural areas—an event that came courtesy of electric co-ops or the competition they placed on investor-owned utilities to begin extending lines into the countryside—many farm families relied on primitive forms of on-site distributed generation to provide themselves with power: noisy, expensive, unreliable, and sometimes dangerous steam engines, windmills, ram pumps, and complicated battery arrays.

Now, with electric demand surging and aging transmission infrastructure becoming a serious concern, the popularity of on-site distributed generation has begun to climb, led by several factors: increasing utility focus on shaving peak demand charges, a growing desire by commercial and industrial (C&I) consumers for ever-more reliable power and lower electric bills to stay competitive, concerns over climate change and handling livestock waste, and falling prices for "backyard power plants" like small wind, solar photovoltaic (PV), and microhydro systems.

"Electric utilities with coal-burning power stations are scrambling for ways to churn out more electricity while curbing emissions of greenhouse gases, primarily carbon dioxide, blamed for contributing to global climate change," acknowledges John Holt, NRECA senior principal for generation & fuel. "This places increased focus on using natural gas, which emits half the carbon dioxide of coal, and renewable resources. Both natural gas and renewables can be used as fuels for distributed generation. And distributed generation, even if powered by diesel fuel or gasoline, can boost efficiency and cut costs by reducing the need for building additional power plants and high-voltage transmission lines."

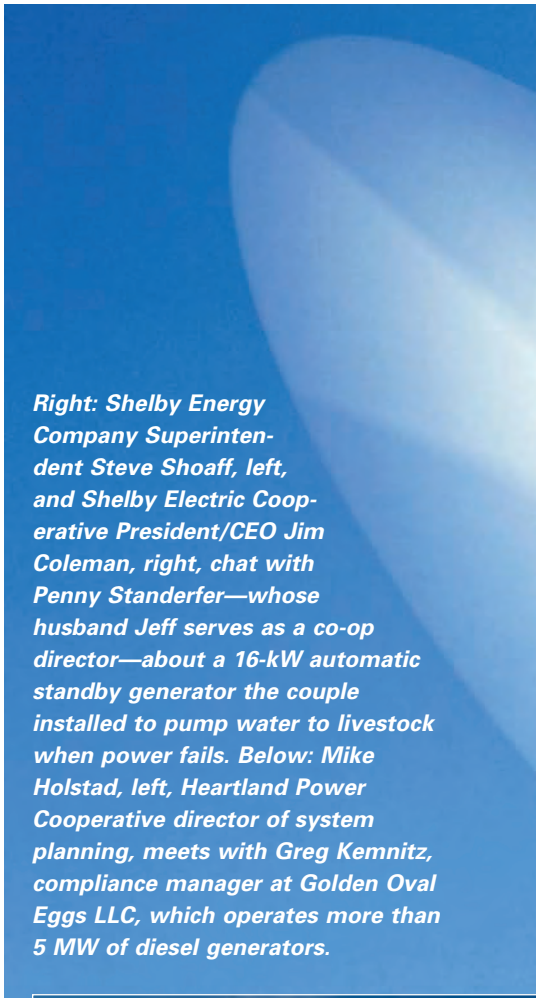
Coal-fired power plants, which generate roughly 50 percent of the nation's electricity, produce approximately 39 percent of all U.S. man-made carbon dioxide output (more than 2.4 billion tons, the largest single source) and about 33 percent of all greenhouse gas emissions from human activity. Overall, coal accounts for 80 percent of the power generated by G&Ts and 62 percent of all electric co-op power requirements.

In the study *Electricity Technology in a Carbon-Constrained Future*, released in 2007, the Electric Power Research Institute (EPRI), a non-profit utility-sponsored consortium based in Palo Alto, Calif., whose members include electric co-ops, spelled out how electric utilities could help the United States slash carbon dioxide emissions below 1990 levels by 2030—even after adding 30 percent more load, half of which will be generated by coal—by taking aggressive steps in seven principal areas. One of the measures involves having 5 percent (or 57,600 MW) of the nation's electricity produced from distributed generation, up from 1 percent today.

"Deriving 5 percent of our electricity needs from distributed energy is difficult, but not impossible," remarks Revis James, EPRI director of energy technology assessment. "You don't have to invent something new to achieve that level of deployment. Our calculations also assumed that with more distributed generation in 2030, the intensity of carbon dioxide emissions would decline because they would be less dominated by coal."

C&I connection

Propelling distributed generation in co-op service areas are the needs of C&I consumers—such as manufacturing firms, data centers, retail out-



PHOTOS BY MARK LUINENBURG

Right: Shelby Energy Company Superintendent Steve Shoaff, left, and Shelby Electric Cooperative President/CEO Jim Coleman, right, chat with Penny Standerfer—whose husband Jeff serves as a co-op director—about a 16-kW automatic standby generator the couple installed to pump water to livestock when power fails. Below: Mike Holstad, left, Heartland Power Cooperative director of system planning, meets with Greg Kemnitz, compliance manager at Golden Oval Eggs LLC, which operates more than 5 MW of diesel generators.

PHOTO BY JIM BATTLES

CORBIS

lets, and large livestock farms—for enhanced service reliability and decreased energy costs. In most cases, these large electricity users—where an unscheduled outage could result in tens of thousands of dollars of lost production and possibly damaged equipment—install diesel generators or natural gas-fired turbines (or versions that can run on a combination of both fuels) as supplemental power supply.

"Since access to distributed generation can help G&Ts better manage load during system peaks, and keep the lid on wholesale power costs, companies that own these valuable assets generally receive a special electric rate or other contract incentives if they allow a co-op to briefly interrupt service under certain conditions," Holt confirms. "So when electricity consumption spikes on a hot, humid weekday afternoon in the middle of summer, the C&I consumer—upon receiving notification from the co-op—switches over to generator power. The bottom line is the distributed generation owner, along with the co-op, saves money."

Energy Alternatives, a subsidiary of Farmington, Minn.-based Dakota Electric Association, has put in 189 MW of utility- and customer-owned distributed generation at 117 commercial sites in Minnesota, North Dakota, South Carolina, and Virginia. Dale Gundberg, Energy Alternatives CEO, notes that most of the generators operate on a biodiesel blend, with the remainder fired by natural gas.

"The most successful distributed genera-

tion programs offer 35 to 45 percent savings from the general service rate to the interruptible rate every month," he claims.

Seminole Electric Cooperative, a G&T headquartered in Tampa, Fla., boasts more than 100 MW of distributed generation capacity spread among C&I consumers served by its 10 member distribution co-ops.

"Generators ranging from 1 to 2 megawatts in size are the most common," suggests Lane Mahaffey, Seminole Electric director of strategic planning & legislative affairs. "They're about the size of a semi. Usually they're enclosed and neatly packaged with internal fuel storage, making them mobile."

Seminole Electric and its member systems initiated a distributed generation program in the early 1990s when the electric utility industry began marching toward retail competition.

"Some of our member co-ops reached out to C&I consumers seeking a hedge against the risk of losing load," Mahaffey relates. "Under the program that resulted, the co-ops offered on-site backup power during extended outages in return for a retail contract for a specified term and an operating agreement so we could run the units to meet our system peaking needs. Local distribution co-ops provide fuel and maintain the generators, which serve a dual role—they provide backup power for the C&I consumer and a reliable peaking resource for us."

When outages do occur, power becomes critical. In 2004, Hurricane Charley's 150-mph winds wiped out the service territory of Seminole Electric member Peace River Electric Cooperative. Fortunately, the co-op had installed a generator at its central office in Wauchula that also powered a local business district, including a Wal-Mart Supercenter.

"During the period when the entire region was blacked out, the Peace River Electric headquarters and the local business district were able to stay open and operating with their lights on to help people get what they needed to recover," Mahaffey recalls. "The co-op gained a lot of positive media attention for giving the local economy a boost and helping people cope after the devastation."

Although diesel generators don't burn as cleanly as natural gas, the higher cost of fuel makes them the last resource to run, Mahaffey mentions. "The emissions from emergency generators are statistically insignificant. They run less than 150 hours a year—just 1 percent to 2 percent of the time on an annual basis. But from a G&T standpoint, the extra generation provides significant benefits in avoiding the need to construct as many new

Fuel Cells Still in the Cards

NRECA's Cooperative Research Network (CRN) has been working with member electric co-ops to field test innovative distributed generation applications, including a project involving the Holy Grail of home power plants—fuel cells that run on hydrogen and oxygen and emit only heat and water vapor.

"Despite lots of promise, nobody so far has successfully cracked the nut to produce an affordable fuel cell for residential use," observes Bob Gibson, CRN senior project manager.

The CRN fuel cell effort involves Raleigh, N.C.-based North Carolina Electric Membership Corporation (NCEMC), a generation and transmission co-op. NCEMC and its 27 member distribution co-ops have invested in Microcell Corporation, considered the world's leader in producing low-priced proton exchange membrane (PEM) fuel cells. Microcell has begun manufacturing the product for both distributed generation and vehicles at its plant in rural Robersonville, N.C.

"The Microcell product would deliver 5-kilowatt output, enough to power a typical house," Gibson adds. "Initially, we see PEM units being used as backup power supply for a co-op substation or to operate remote telecommunications sites."

In 2007, Tarboro, N.C.-based Edgecombe-Martin County Electric Membership Corporation provided a $500,000 zero-interest loan to a local economic development commission, which, in turn, loaned the money to Microcell Corporation as an incentive for the firm to open the plant. The Edgecombe-Martin County EMC financial capital came from an economic development fund operated by NCEMC.

On another front, NRECA recently revised its distributed generation interconnection toolkit. The revamped kit—first developed in 2002—consists of business templates, model procedures and contracts, a technical implementation guide for Institute of Electrical and Electronics Engineers Standard 1547 on interconnection, and best practices developed by the utility industry. In addition, a new version of NRECA's distributed generation white paper—one of the elements of the toolkit—can be found at the following Web sites: NRECA.coop and Cooperative.com.

"As updated, the toolkit is now an even better resource for electric co-ops, other utilities, and regulators looking at interconnection issues," contends Jay Morrison, NRECA senior regulatory counsel.

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Electric co-ops are involved in a project to develop low-priced fuel cells ideal for home generators or cars.

power plants or enter into purchase power contracts. For our member systems, generators are a valuable asset in maintaining relationships with key C&I accounts. And C&I consumers get access to a backup power source which improves reliability."

Dairyland Power Cooperative, a G&T in La Crosse, Wis., serving 25 member distribution co-ops and 19 municipal utilities in four Upper Midwest states, encourages C&I accounts, mostly farms, to install an alternative power supply and take advantage of cost savings. As a result, more than 33 MW of distributed generation remains available to the G&T for load management purposes. One C&I consumer, Golden Oval Eggs LLC, served by Dairyland Power member Heartland Power Cooperative in Thompson, Iowa, operates more than 5 MW of diesel generators.

"If power went out in the summer and the cooling fans were not operating, all of their chickens would die within an hour," comments Ed West, Dairyland Power director of telecommunications & control systems.

The G&T's C&I consumers can achieve cost savings by selecting a load management rate option available through their local distribution co-op that best fits their operation.

"Many of our member distribution cooperatives offer a peak alert rate," says Craig Harmes, Dairyland Power manager of business development. "The co-op calls its C&I participants to notify them about an approaching peak period and asks them to reduce their power use. Reduction may be accomplished through a backup power source or by shifting power use to another time. The decision concerning whether to reduce or shift load is up to the consumer and thus provides flexibility. Depending on their level of participation, consumers receive a reduction in the demand charge on their power bill."

He continues, "We also have an interruptible rate option that provides a C&I consumer with power cost savings but allows us to automatically interrupt power during a peak period."

In addition, Dairyland Power recently introduced a pilot critical peak pricing program that offers a lower day-to-day energy charge. "We call participating C&I consumers when we see a peak demand period approaching," Harmes points out. "If we think we might have to go out on the market to purchase higher-priced energy, we can give the consumer day-ahead notice. They decide whether to operate through the peak period or fire up their generator and avoid paying a higher price for power."

On another distributed generation front, Dairyland Power supports efforts by dairy farms across its service territory to put in anaerobic digesters as a way to better manage odor and waste problems. Currently, there are three such projects within the G&T's system. On average, each of these cow manure-fueled digesters—which create methane gas to spin a generator—produce approximately 800 kW of electricity, sufficient to supply at least 600 homes.

"Digesters enable us to put more renewable energy into the power pool," Harmes asserts.

Taking heat

NRECA's Holt signals that through cogeneration—combining waste heat and power—benefits from distributed generation can multiply as well.

"If a shopping center has an on-site natural gas turbine to create electricity, waste heat from the turbine can be captured to make steam and generate additional power for heating or cooling the stores," he argues. "Considering that a typical coal-fired power plant is about 33 percent efficient after heat, mechanical, and pollution control losses are factored in, converting byproduct heat for heating or cooling effectively doubles distributed generation efficiency to 66 percent."

In 2006, 22 MW of innovative, high-tech distributed generation that essentially acts as baseload power took its place in the energy portfolio of Bismarck, N.D.-headquartered Basin Electric Power Cooperative, a G&T serving 126 member co-ops in nine states. That's when four waste-heat recovery plants appeared, like pearls on a necklace, along the 1,200-mile Northern Border natural gas pipeline that runs from western Canada to Chicago.

Compressor stations spaced every 80 miles down the pipeline house turbine engines that—running on gas pulled from the pipeline—pressurize the facility to keep 2.37 billion cubic feet of natural gas flowing each day. High-pressure exhaust from the turbines reaches 900 degrees Fahrenheit—heat that normally dissipates. To convert some of that energy into electricity, Basin Electric Power contracted with Ormat Technologies, based in Reno, Nev., to install waste-heat recovery at co-op-served pipeline pumping stations near St. Anthony, N.D., and around the South Dakota towns of Wetonka, Clark, and Estelline.

"The units tap the exhaust to power a 5.5-megawatt turbine-generator at each site," explains Ron Rebenitsch, Basin Electric Power manager of member marketing. "In some circles, waste heat may not be called renewable energy, but it has zero emissions and low costs, and it's ready when we need it. We plan to develop another four facilities later this year that will generate an additional 22 megawatts."

The Basin Electric Power endeavor holds major promise for electric co-ops, contends Ed Torrero, executive director of NRECA's Cooperative Research Network. "Electric co-ops serve more miles of natural gas pipelines than any other utility," he says. "Collectively, compressor stations are the largest co-op load nationwide. Overall, using recoverable waste heat from all types of small and medium industrial sites rather than fossil fuels to generate electricity would save co-ops about $200 million a year."

Home hookups

Increasingly, residential co-op consumers are investigating distributed generation alternatives as well. While those interested in emergency power usually turn to diesel- and gasoline-powered generators, folks seeking "sustainable solutions" that will allow them to sell power back to the co-op on occasion, or disconnect from the grid entirely, are turning to renewables, observes NRECA Senior Regulatory Counsel Jay Morrison.

"Small-scale renewable systems like rooftop solar panels, small wind turbines, and microhydro systems have been hindered by high costs [small wind turbines can cost from $35,000 to $50,000; solar PV setups up to twice that amount], ongoing maintenance expenses, and several-decades payback," he states. "Solar energy, for example, can cost three times as much as power from a diesel motor and up to 15 times as much as coal or nuclear power. But costs have begun to fall to some degree as these technologies are deployed in greater numbers and interconnection procedures become standardized."

While many G&Ts and local distribution co-ops purchase green power from household distributed generation systems, Holy Cross Energy in Glenwood Springs, Colo., nestled among the Rocky Mountains, goes a step further with its WE CARE Program. The initiative pays an incentive rebate of up to $2,000 per kilowatt of installed capacity for renewable electricity generation using biomass, geothermal technology, hydro, PV, and wind.

"Since the program's inception in September 2004, we have provided incentives for 56 systems, totaling 225.7 kilowatts of generation, at a cost of approximately $450,000," reports Stephen B. Casey, member services

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In the first and largest project of its kind, electric co-ops are testing whether plug-in hybrid electric vehicles can wean our nation off foreign oil, curb greenhouse gas emissions, and increase off-peak electric sales

By **Peter Nye**

HAVE PLUG, WILL

As prices continue to shoot up at gas pumps, Alan Shedd, commercial-industrial marketing engineer at Jackson Electric Membership Corporation in Jefferson, Ga., draws stares and questions from strangers who spot the eye-catching graphics of the Toyota Prius plug-in hybrid electric vehicle (PHEV) he drives for the co-op.

"People stop me in the parking lot of grocery stores, rest stops, and elsewhere and ask if it really gets 100 miles per gallon as painted right above the gas tank," he remarks. "Often, they want to know how to get one."

Of course, PHEVs won't be commercially available for at least a few years. Jackson EMC's model joins only about 100 now cruising about the country, all retrofitted by a handful of shops in what's essentially become a fledgling cottage industry.

But information Shedd collects while driving the PHEV as part of his duties for the 200,000 member distribution co-op will be evaluated as part of a two-year study being conducted by NRECA's Cooperative Research Network (CRN). Four other electric co-ops are also participating in the project: two generation and transmission (G&T) co-ops, Basin Electric Power Cooperative, headquartered in Bismarck, N.D., and Central Electric Power Cooperative in Columbia, S.C., and two distribution systems, Four County Electric Membership Corporation in Burgaw, N.C., and Salem Electric in Salem, Ore. More may follow.

Dan Allen, vice president of Four County EMC in North Carolina, gets 70 miles per gallon from the Toyota Prius hybrid he converted to a plug-in. A monitor mounted on the dashboard displays in real time the status of various operating components.

PHOTOGRAPHS BY ED THOMPSON

TRAVEL

"This program has a lot of spunk," asserts Ed Torrero, CRN executive director. "It is the first and largest set of PHEV tests now under way nationally, a distinction for electric co-ops. We offer diversity spread over a large geographic area."

CRN goals include assessing how PHEVs might affect electric co-ops, consumers, and the entire electric utility industry; gaining hands-on experience with vehicle performance on a day-to-day basis; finding out if PHEVs can save co-op consumers money by charging overnight for less than the cost of gasoline or diesel fuel; and looking into the feasibility of PHEVs being turned into a source of distributed generation that co-ops and consumers could tap during a power outage.

PHEV primer

Shedd, who has experience designing and building electric cars and has taught high school classes about the technology, started the PHEV effort rolling in February 2007 with a cross-country trek from Monrovia, Calif.—where his 2004 Prius gasoline-electric hybrid with 60,000 miles was turned into a plug-in by the engineering firm EnergyCS—to Jackson EMC headquarters. He has since logged an additional 30,000 miles.

The EnergyCS conversion, which cost roughly $30,000 and took place over four days, included putting in a plug-in charging system accessed above the left rear bumper, disassembling part of the car's interior, mounting extra restraints to hold down the larger battery, and installing software that operates a special data-collection monitor sitting atop the dashboard.

"For a geek like me, the monitor is great—like having a video game in my car," Shedd, a member of the CRN Renewable Energy & Distributed Generation Membership Advisory Group, declares. "I watch in real time what goes on 'under the hood'—miles per gallon and how much electricity and gas get used."

Compared with conventional cars, a factory-built hybrid—such as the Toyota Prius or Ford Escape SUV—achieves better gas mileage around town and when driven at lower speeds because its 1.3-kWh nickel-metal hydride battery/electric motor and gasoline engine both provide power. The battery constantly gets recharged by the engine and regenerative braking system.

In Shedd's PHEV, the nickel-metal hydride battery was replaced with a custom-built 9-kWh lithium-ion model—a much larger version of those used in cell phones and laptops—that delivers more electric power and better fuel economy. When the battery runs down to the point where a one-third charge remains, the PHEV starts acting like a regular hybrid, using the gasoline engine to maintain that level. But the engine and brakes don't recharge the battery much further. Instead, a full charge requires a regular 110-V outlet.

"When plugged in, a PHEV can recharge in four hours," says Torrero. "Doing so consumes around 4 kilowatt-hours, or about 40 cents, of electricity. It's cheaper to fully recharge the battery this way than using the gasoline engine."

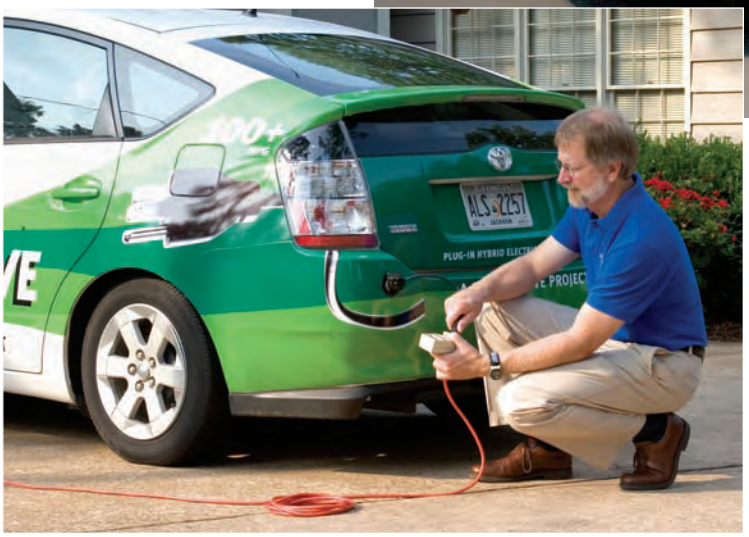
The lithium-ion batteries, which cost more than the car itself, also offer greater range. "On my drive to work, around 30 miles, I can get 100 miles per gallon—I'm using electricity most of the time and little gas," Shedd indicates. "When the batteries run down and the gas engine kicks in, the PHEV averages 50 miles per gallon."

As Shedd prepared to get behind the wheel in California for his cross-country drive to the Peach State, EnergyCS engineers suggested he first stop by a local Home Depot store and buy an extension cord.

"I bought two cords—one 25 feet long, the other 50 feet," he recalls. "Usually I can find an outlet within that length."

Driving 2,800 miles in three days, Shedd discovered that inexpensive motels allowed him to park directly in front of the room so he could stretch the cord from inside.

"I put a little duct tape down on the sidewalk so nobody would trip over it," he recounts. "At one motel, I discovered the only available outside plug was blocked by another guest's car. So I drove around and found a different motel with an outlet where I could park."



Eye-catching graphics allow Alan Shedd, commercial-industrial marketing engineer at Jackson EMC, to quickly communicate the advantages of the Georgia co-op's plug-in hybrid electric vehicle. Information he collects while driving the car will be evaluated as part of a two-year study being conducted by NRECA's Cooperative Research Network.

In October 2007, Shedd cruised to Washington, D.C., to show lawmakers—and the media—how PHEVs work. At an upscale Capitol Hill hotel, he was treated to parking his vehicle at the valet stand.

"The attendants were very interested in how it worked," he marvels. "I stressed that on longer trips, or at speeds faster than 35 miles per hour, the gasoline engine runs more of the time to deliver additional energy. But since it's cheaper to 'burn' electricity, you can run the car overall for the equivalent of buying gasoline at 80 cents per gallon. And battery power doesn't produce any tailpipe emissions."

Enhancing load balance

A joint 18-month study by the Electric Power Research Institute (EPRI), a non-profit utility-sponsored consortium based in Palo Alto, Calif., whose members include electric co-ops, and the Natural Resources Defense Council (NRDC), an environmental advocacy group headquartered in New York City, released in July 2007 finds that greater use of PHEVs promises huge environmental benefits.

"Widespread adoption can reduce greenhouse gas emissions [blamed for contributing to global climate change] from vehicles by more than 450 million metric tons annually by 2050—equivalent to removing 82.5 million passenger cars from the road," points out Mark Duvall, EPRI director of electric transportation. "Combined, the country's electric and transportation sectors account for nearly three-quarters of all U.S. greenhouse gas emissions from human activity. Electricity generation alone represents the biggest chunk, about 40 percent—mostly from carbon dioxide being released when fossil fuels like coal and natural gas are burned."

In the 2007 report *Electricity Technology in a Carbon-Constrained Future*, EPRI spelled out how electric utilities could help the United States slash carbon dioxide emissions below 1990 levels within 23 years—even after adding 30 percent more load, half generated by coal—by taking aggressive steps in seven principal areas, including making PHEVs commercially available. The study assumes that PHEVs will hit the market around 2010 and comprise 10 percent of new vehicle sales by 2017 and 30 percent by 2027—a schedule that would require significant market transformation.

In addition to lowering gasoline consumption—and U.S. dependence on imported oil—by about 3 million to 4 million barrels per day (20 percent of current consumption), PHEVs further cut carbon dioxide emissions when batteries are recharged by electricity generated from renewable resources. EPRI estimates 50,000 MW of addi-

PHOTOGRAPHS BY ROBB MAAG / LSIPHOTO.COM

tional green power will be developed by 2020, with the total then rising by about 2,000 MW a year through 2030.

According to a study by the U.S. Department of Energy Pacific Northwest National Laboratory in Richland, Wash., the nation's existing power grid could fuel as many as 180 million PHEVs. Duvall calculates that PHEV batteries would be charged three-quarters of the time during off-peak periods, raising electric demand between 3 percent and 4 percent and better balancing utility loads. The end result: greater system efficiencies that could help hold down costs.

"Plug-ins have the potential to create the greatest end-use product, and greatest challenge, for electric utilities since air conditioning was introduced in the 1950s," Torrero relates. "Air conditioning load grew much faster than expected and caught a lot of utilities unprepared, including electric co-ops. We need an early understanding to get ahead of any unintended consequences."

Torrero contends that if PHEVs become popular, they will put extra demands on all aspects of electric co-op operations, from residential transformer sizing to distribution system and generation capacity. "But PHEVs also represent an opportunity for new off-peak load growth, increased kilowatt-hour sales, and lower transportation costs for co-ops and their consumers."

Conversion fly-in

Even though the Achilles heel of PHEVs remains energy storage, Torrero feels confident that entrepreneurs in the market will soon achieve the long-awaited "battery physics breakthrough." One of these firms, A123 Systems, founded in 2001 in suburban Boston, Mass., produces a 225-lb. lithium-ion battery pack that features conductive material made from thin layers of nanophosphate, licensed from the Massachusetts Institute of Technology.

"The batteries are made up of more than thousands of individual cells, each the size of a roll of quarters," Torrero explains.

Basin Electric Power, serving 126 member co-ops in nine states, created a media event in late October 2007 when one of its two Ford Escapes was converted to a PHEV during the Great Plains Energy Expo & Trade Show in the Bismarck Civic Center Exhibit Hall. Experts flown in from A123 Systems and its subsidiary, Hymotion out of Toronto, Canada—which makes custom-engineered Battery Range Extender Modules that can be installed in the spare-tire well—modified the SUV in about six hours. Watching the process take place were North Dakota Governor John Hoeven (R), U.S. Sen. Byron Dorgan (D-N.D.), U.S. Energy Secretary Samuel Bodman, Basin Electric Power CEO/General Manager Ron Harper, and students from a local automotive vocational-tech school.

"The retrofit added an 8-kilowatt-hour lithium-ion battery to supplement the Escape's 330-volt nickel-metal hydride battery," comments Chris VandeVenter, Basin Electric Power legislative representative. "Working together, the gasoline engine and electric motor produce a combined 155 horsepower. We initiated the process in response to a 2006 membership resolution that endorsed the national grassroots campaign of Plug-In Partners. [CRN has also joined more than 500 cities, businesses, utilities, auto manufacturers, and battery developers in support of Plug-In Partners, a coalition seeking to build a market for flex-fuel, plug-in hybrid vehicles.] The resolution tied in nicely with discussions we already had under way to improve the efficiency of our vehicle fleet."

In fall 2006, Ron Rebenitsch, Basin Electric Power manager of alternative technologies and chairman of the CRN Renewable Energy & Distributed Generation Membership Advisory Group, asked VandeVenter to take charge of the Basin Electric Power conversion. CRN had just approved the PHEV research project, and VandeVenter then contacted Hymotion, the only company at the time performing conversions on Ford Escapes. However, the G&T needed to get in line behind Internet giant Google, which had previously hired Hymotion to adapt its growing fleet of hybrids into PHEVs.

"Hymotion engineers perfected the conversion process with Google, and we were next," VandeVenter reports. "We've assigned the PHEV to our government relations department and make it available to others as needed to enhance its exposure."

No golf cart

When Dan Allen, vice president of Four County EMC in Burgaw, N.C., started driving his Toyota Prius PHEV in fall 2007, he expected it to handle as sluggish as a golf cart.

"That's not the case," he admits. "It has a lot of pick-up. I'm impressed."

He's also satisfied with fuel savings from commutes around the co-op's service territory, which includes more than 5,400 miles of lines in the southeastern corner of the Tar Heel State.

"Our fleet vehicles [pickups and cars] average about 20 miles per gallon," Allen suggests. "In April 2007, we bought a Prius hybrid which gets 46 to 48 miles per gallon. Now, with the Prius converted to a PHEV [by A123 Systems and Hymotion], I can get 70 miles per gallon. If I used it just for local trips no longer than 30 miles or so, I'd never have to fill up at a gas station."

Four County EMC volunteered for CRN's PHEV endeavor. "We wanted to be part of the solution about global warming," Allen maintains. "This car demonstrates our commitment, and we let our members know of its success. We drive it in parades. It's the subject of two middle school projects. We visit local high schools and talk with the students about green power, plug-ins, and the conversion. That gives us the opportunity to talk about cooperatives, Touchstone Energy® Cooperatives, and to tell our youngsters what we do."

The latest co-op to join the PHEV family, Salem Electric in northwestern Oregon, did so "to find ways to use electricity for transportation, and we wanted to test the new hybrids," notes Roger Kuhlman,

the co-op's manager of engineering & operations and a member of the CRN Renewable Energy & Distributed Generation Membership Advisory Group. Salem Electric's service territory spans 17 square miles and embraces 18,000 consumers.

"A lot of our trips are under 30 miles," Kuhlman discloses. "At the same time, we have hills, so we need a boost from the gas engine. The PHEV will give us the optimum of gas and electric power."

In 2006, the co-op bought a Ford Escape hybrid that more than doubled the miles per gallon as compared to a Ford Explorer SUV. Kuhlman had the vehicle converted in January 2008 by Hybrids Plus of Boulder, Colo., and then drove it to the CRN Renewable Energy & Distributed Generation Membership Advisory Group meeting in Phoenix, Ariz.

Chris VandeVenter, Basin Electric Power Cooperative legislative representative, uses the wholesale power supplier's Ford Escape SUV plug-in as a co-op "innovation ambassador."

PHOTOGRPAPHS BY MARK LUINENBURG

"We're a bit skeptical but plan to put the plug-in through its paces reading meters, meeting with members, and maintaining our electric system," he insists. "If it does work, hopefully car manufacturers will get on board and make them in bigger numbers and lower costs."

Back to the future

From Shedd's years of talks before classrooms, civic clubs, and lawmakers about hybrids and plug-ins, he observes that people often confuse them with electric vehicles (EVs), typically perceived as slow.

"The reality is that electric motors generate a lot of torque at lower speeds, better than gasoline combustion engines that produce maximum torque at high speeds," he says. "An electric vehicle, such as the all-electric $98,000 Tesla Roadster, puts out a huge amount of power right off the line—from zero to 60 in four seconds."

The world land speed record for an EV, incidentally, tops 300 mph, and EV dragsters are allowed on most tracks that hold National Hot Rod Association events. The Portland, Ore., International Raceway provides 240-V outlets that charge 10 EV dragsters at a time. EV dragsters, though, don't usually race heats against gas-combustion rivals because spectators accustomed to the roar of engines find the quiet EV dragsters underwhelming.

Ferdinand Porsche, renowned for designing the Volkswagen (and whose son made the sports car company famous), built an electric car and drove it 38 miles at the Paris Exhibition of 1900. Porsche and Vienna coach builder Jacob Lohner added an internal-combustion gas engine to charge the batteries. The Lohner-Porsche prototype hybrid reached a top speed of 35 mph.

In the United States, electric cars were more popular than their gasoline-powered cousins at the start of the 20th century because gas engines required drivers to turn a dirty hand crank on the front of the vehicle to get the engine started.

"Electric cars appealed to women because they didn't have to get out of the car or risk breaking an arm from a cantankerous crank," Shedd mentions.

By 1920, thanks to the arrival of the starter motor, more roads being paved (allowing for excursions beyond the range of batteries), and relatively cheap gasoline prices, electric cars were pushed aside. Now, with crude oil prices crowding $100 per barrel and anxieties over global warming climbing, EVs, hybrids, and PHEVs are finding new life.

"Going electric" may also be a key to economic survival. Authors Ian Carson and Vijay V. Vaitheeswaran of *Zoom: The Global Race to Fuel the Car of the Future* (Twelve Press) warn of potential geopolitical calamity if rates of car ownership rise in developing nations like China (from nine personal vehicles per thousand eligible drivers today) and India (11 for every 1,000) to even half of the U.S. total (1,148 for every thousand) and gasoline remains the fuel of choice—100 million more barrels of oil per day, greater than the 86 million barrels now used daily worldwide, will be required.

Bob Gibson, CRN manager of the PHEV demonstration project, believes PHEV conversions could pick up in 2008 when Hymotion offers Battery Range Extender Modules for second-generation Priuses and Escapes that could be installed for about $10,000 at a local garage.

"Conversions represent an intermediate step toward getting PHEVs mass produced," Gibson concludes. "The future becomes reality when automobile manufacturers mass produce PHEVs in volume, like any other car or light truck." ■

This article represents the seventh and final installment in a series on how electric co-ops are looking out for their consumers and working to control power costs in an environmentally responsible fashion. Aimed at "closing the reality gap" on public understanding about climate change, the series examines ways electric co-ops are addressing seven Electric Power Research Institute recommendations that will allow the electric utility industry to slow, halt, and eventually decrease carbon dioxide emissions to 1990 levels by 2030 while still meeting demand for affordable, reliable electricity. The seven recommendations (some of which are still on the drawing table) are: boosting energy efficiency, improving the operating efficiency of coal-fired power plants, investing in renewable energy, expanding nuclear power capacity, capturing and storing carbon produced by coal-fired power plants, adding distributed generation resources, and putting plug-in hybrid electric vehicles on the road.