Science & Technology HIGHLIGHTS

Published by Oak Ridge National Laboratory's EERE and OE Programs

No. 1 2007

# ORNL Visualization Center is Bioenergy Research Tool

Bioenergy researchers are using the geographic information system (GIS) and an ORNL supercomputer and 30 × 8 ft video display to visualize and understand environmental factors for regional production of biomass. This combination of tools is expected to boost biomass production success—computer modeling and data collection are being used to help determine the competitive advantage and the logistics of collecting, storing, transporting, and pretreating the feedstocks for specific geographic locations.


*Bioenergy researchers use ORNL's EVEREST display to visualize and analyze environmental factors in growing feedstocks best suited to a specific area.*

One series of complex interactions involves spatial datasets for environment, cropping patterns, available biomass residue, and soils. These data are sometimes available at different spatial scales and are therefore difficult to aggregate or assimilate. In the past, simply understanding county-level data was sufficient, but the ability to analyze data at finer resolutions provides scientists a more complete understanding of the eventual availability of different kinds of biomass for supplying a biorefinery industry.

The capability of visualizing spatial data is an important part of the effort and is a key ORNL contribution to the work of the Regional Feedstock Partnerships. The ORNL facility known as EVEREST (Exploratory Visualization Environment for Research in Science and Technology) is enabling bioenergy researchers to use one of the world's fastest supercomputers along with superior graphics capabilities to view their data on the giant display. Using EVEREST, they can view and analyze data collections in ways that were previously not possible.

Sun Grant Centers of Excellence were created in 2003 by Congress and are funded jointly by the Department of Transportation, DOE, and the Department of Agriculture (USDA) to serve as regional hubs to lead research, education, and outreach efforts to expand U.S. bioenergy

continued on p.2

# FEERC Researchers Put Dual-Fuel Saab to the Test

Researchers at ORNL's Fuels, Engines, and Emissions Research Center (FEERC) are analyzing the performance of the first vehicle on the auto market known to be optimized for ethanol use rather than gasoline or diesel. FEERC recently took delivery of a 2007 Saab 9-5 BioPower flex-fuel vehicle to study its fuel efficiency and emissions performance on various fuels.

Several makes of flex-fuel vehicles are sold in the United States, but they are optimized for gasoline, rather than ethanol. As a result, their tank mileage drops by 30% when they burn ethanol because of ethanol's lower energy content. The BioPower, currently sold only in Europe, reportedly does not suffer the same loss of mileage and produces more power on ethanol than on gasoline.

FEERC is conducting a wide range of analyses of the BioPower. They include quantification of the tank mileage and an assessment of the emissions profile of the car. ORNL researchers will benchmark the vehicle on a variety of gasoline and ethanol blends, measure fuel consumption, and monitor regulated and unregulated emissions.

FEERC, located at ORNL's National Transportation Research Center, has historically purchased unusual, state-of-the art vehicles or engines for

continued on p.4


*The Saab Biopower auto is being tested for fuel efficiency and emissions performance.*

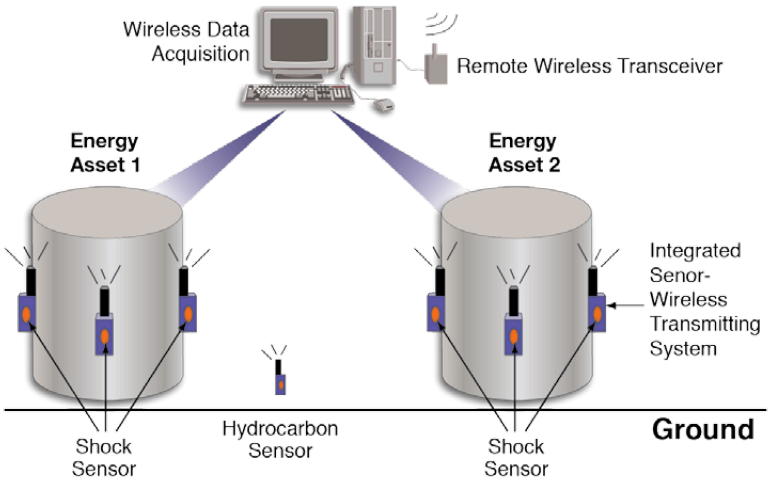
# Wireless Sensor System Protects Energy Infrastructure

A huge network of storage tanks holding billions of gallons of liquid fuels is a vital part of the energy infrastructure of the United States. Protecting these vulnerable energy assets from malicious tampering is the aim of a new wireless sensor system developed by ORNL and its partners.

An API survey estimates there are 700,000 fuel storage tanks nationwide—for refining, marketing, transportation, and production—with a capacity of 2.3 billion barrels of fuels (e.g., heating oil, diesel, gasoline). Such tanks in every part of the country are vulnerable to mischief originating from remote locations. Malicious acts could produce serious consequences such as fire and explosion, loss of life, economic losses due to release of materials and infrastructure damage, and environmental impacts.


*Shock sensor module with wireless communication enclosed in explosion-proof housing.*

Sensor systems that could quickly detect tampering would allow authorities to respond rapidly, mitigating adverse impacts and protecting the U.S. energy infrastructure. Engineers at




*Sensor system integrates shock sensor with hydrocarbon sensor to detect breaches due to impacts.*

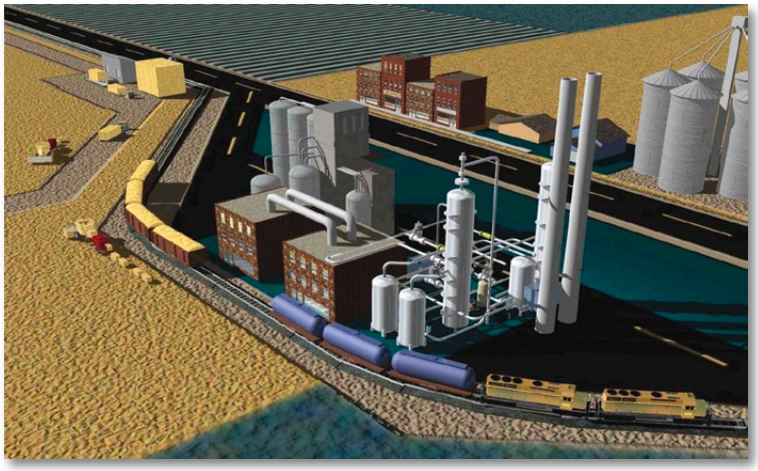
ORNL, working with Pegasus Technologies, Inc., in Lenoir City, TN, and Delphian Corporation in Northvale, NJ, have developed an integrated wireless sensor system that enables monitoring of remote energy storage facilities to detect breaches. The system combines two sensor types—shock sensors that detect physical impacts to a tank and hydrocarbon sensors that detect sudden hydrocarbon releases.

Communication among the sensors and with a remote monitoring facility is through commercial wireless technology, eliminating long wires and the associated costs and risks. Low power consumption, on-board power, and the capability to integrate with renewable power sources reduce operator intervention and maintenance costs for the system. A patent application has been filed for the sensor system, and it is available for licensing.

*Contact: G. Muralidharan (Murali), 865-574-4281, muralidhargn@ornl.gov*

*Sponsor: DOE/EERE Industrial Technologies*

Visualization Center continued from p. 1



*Biorefining plants will process feedstocks that could replace 30% of U.S. petroleum consumption by 2030.*

resources. The University of Tennessee–Knoxville is the Sun Grant Center for the Southeast. The other four Sun Centers are located at South Dakota State, Oregon State, Oklahoma State, and Cornell Universities.

Leaders of the Sun Grant Centers met at ORNL in February 2007 with Bioenergy Program scientists and others to discuss the benefits of scientific collaboration using GIS spatial data. Through DOE's Regional Feedstock Partnerships, the Sun Grant Centers, USDA, Regional Biomass Energy Programs, and national laboratories are working to understand the regional nature of biomass feedstocks, the best ways to procure feedstocks, and their relative costs.

The report *Biomass as Feedstock for a Bioenergy and Bioproducts Industry*, published by DOE/EERE in 2005, estimated a billion tons of biomass per year could replace 30% of U.S. petroleum consumption. (A team of ORNL and USDA scientists produced the report.) Biomass may come from agricultural or forestry residues or from sustainably produced grassy or woody biomass crops. The goal of the U.S. Biofuels Initiative is to replace 30% of the liquid transportation fuels in this country with renewable fuels from biomass by the year 2030.

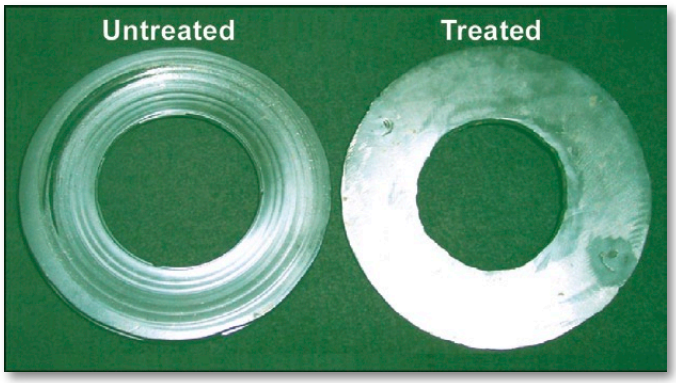
*Contact: Mark Downing, 865-576-8140, downingme@ornl.gov*

*Sponsor: DOE/EERE Biomass Program*

# Swagelok Steel Treatment Process Excels in Industrial Trials

The low-temperature colossal supersaturation (LTCSS) method for carburizing austenitic stainless steels, developed by ORNL scientists and Swagelok Company, is increasing component life and reducing energy use in industrial trials. Treatment of pump clutch plates fabricated from 304 stainless steel at the Sonoco paperboard plant in Newport, Tennessee, has shown a 3× life extension in severe-wear operation, enabling pump motors to run at lower loads. This improvement saves 56 million Btu annually per 10-hp pump and can save up to 1120 million Btu annually for larger pumps.

The joint research project between ORNL's Industrial Technologies Program (ITP) (Vinod Sikka, Dane Wilson, and Peter Blau) and Swagelok received the ASM 2006 Engineering Materials Achievement Award for this surface-hardening technology. The novel carburization method produces hard-surface steels without compromising corrosion resistance. Surface carbon concentrations of over 12% are routinely achieved, and surfaces become four to five times harder. Sonoco will next install treated pump impellers. The Swagelok process is currently used to manufacture fittings, and the ITP project is pursuing commercial applications not only for pumps but also for bearings, fasteners, water treatment, and analytical and process instrumentation. The pulp and paper industry is also testing the LTCSS technology.




*New LTCSS coatings enhance the wear resistance of stainless steels, as shown by the worn surface of the untreated and the smooth surface of the treated plate.*

*Contact: Vinod Sikka, 865-574-5112, sikkavk@ornl.gov*

*Sponsor: DOE/EERE Industrial Technologies*

# ORNL Alloy Project Wins Ohio Governor's Energy Award


*Skirts made of aluminum bronze outlast conventional carbon steel skirts.*

The Industrial Technologies Program project "Improving the System Life of Basic Oxygen and Electric Arc Furnace Hoods, Roofs, and Side Vents" was awarded the 2006 (Ohio) Governor's Award for Energy Efficiency.

Traditionally, components used in basic oxygen process (BOP) and electric arc furnaces are fabricated from carbon steels that require frequent repair, have a short working life, and become fouled because of slag accumulation. The project investigated alternative component materials, with a goal of extending component life by a factor of two and reducing maintenance-related downtime by up to 95%.

Research at ORNL determined that aluminum bronze exhibits superior resistance to thermal stresses and is less reactive. Project partner Republic Engineered Products agreed to install an aluminum bronze skirt on a BOP vessel and immediately saw positive results. After 20 months in service, the first installation has outlived skirts made from conventional materials, does not accumulate slag, and has operated without leaking. While conventional materials would require as many as 50 shutdowns for maintenance over this period, the new equipment required none. Reduction in maintenance on the skirt has saved Republic 5.3 billion Btu/year, and the company expects to save an additional 4 billion Btu/year by fabricating other components from the new alloy. The increase in productivity has generated an estimated $12 million in revenue annually for Republic.

The award from the Ohio Governor to Republic was the only winner in the industrial category in 2006.

*Contact: Vinod Sikka, 865-574-5112, sikkavk@ornl.gov*

*Sponsor: DOE/EERE Industrial Technologies*

*Vinod Sikka and Steven Zinkle of ORNL hold the Ohio Governor's Award. Also pictured are Bob Brown, Ohio Coal Development Office (left) and Robert Purgert, Energy Industries of Ohio (right).*

# ORNL BestPractices Leads Industrial Energy Savings Push

Large industrial plants use a lot of energy. Finding out how these plants can get the job done using much less energy is the focus of DOE's Energy Savings Assessment (ESA) Initiative. In its first year, the initiative identified more than $457 million in potential savings.

ORNL's BestPractices staff was instrumental in the success of this program. In October 2005, Secretary of Energy Bodman directed the EERE Industrial Technologies Program (ITP) to conduct 200 ESAs in the most energy-intensive industrial plants in the United States. The ESAs conducted in 2006 focused on steam and process heating systems, the source of more than 70% of the energy used in large industrial plants. ORNL led the effort to coordinate the performance of these ESAs.

ESAs are 3-day energy assessments conducted by technical experts trained to use DOE energy-efficiency software tools. These experts are trained in the use of the DOE steam and process-heating tools and are certified DOE "Qualified Specialists." ORNL directed much of the development of the software tools used in the ESAs and directed the training in performing ESAs. Each ESA focuses on identifying energy savings opportunities for the plant being assessed, as well as on training the plant's own staff to use the DOE software tools.

The aggressive schedule began in early October 2005. Within 2½ months, ORNL's BestPractices team conducted a solicitation and selected personnel to receive training required for certification as DOE energy experts, capable of performing the ESAs. Also in this timeframe, ORNL organized the actual training so experts could begin assessments in early January 2006.

When training was complete, ORNL's BestPractices team led all major aspects of conducting the steam and process heating ESAs completed in 2006. This included identifying and scheduling the experts to perform the ESAs, collecting all of the reports and deliverables from the ESAs, conducting technical reviews of all ESA reports received to ensure the technical quality of the results, and directing efforts to conduct follow-up surveys to identify the extent of implementation of ESA results. As Barry Oland from the ORNL BestPractices staff remarked in January 2006, "All we have to do is ensure that four assessments are performed every week, all year!"

Key results obtained to date include the following:

- 203 ESAs were completed by the end of 2006.
- A total of 48 trillion Btu/year of potential plant natural gas savings were identified for the first 188 plants reporting results. This is equivalent to the natural gas used by almost 666,000 U.S. households. The total value of the energy savings—including savings from natural gas, electricity, and other fuels—identified for the first 188 plants reporting results is more than $457 million dollars a year. This energy savings can potentially reduce U.S. carbon emissions by more than 0.8 million tons per year.
- Implementation of ESA recommendations is proceeding well. Seventy-one of the ESA plants were asked, 6 months after their ESAs were completed, about their implementation of the identified ESA results. The plants reported that more than $140 million dollars/year of ESA energy savings recommendations have either been completed, are in progress, or are planned.

*Daryl Cox of ORNL scales a tank to obtain a pressure measurement for a pump discharge as part of an energy efficiency assessment at a paper mill.*

*Contact: Tony Wright, 865-574-6878, wrightal@ ornl.gov*

*Sponsor: DOE/EERE Industrial Technologies*

FEERC Researchers continued from p.1

benchmarking or research. In addition to good looks, the Saab BioPower has significant research value because it is the first vehicle on the consumer market to be optimized for a biofuel.

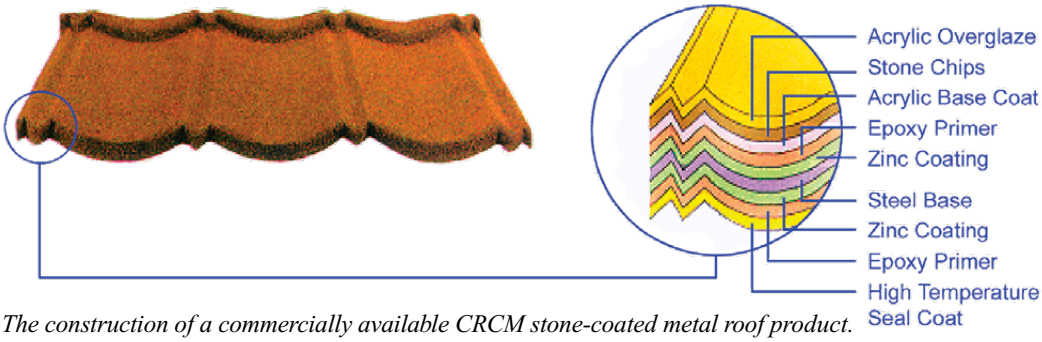
The car was purchased by DOE's Office of the Biomass Program with full cooperation from the Office of FreedomCAR and Vehicle Technologies.

Interest in the research is high both inside and outside DOE. Andy Karsner, EERE Assistant Secretary, mentioned the ORNL project in remarks at the annual AutoShow in Washington, D.C. The story was picked up in several media outlets, and *MotorWeek* plans to publish an article.

This study is part of a broader effort to improve the efficiency of ethanol vehicles that will continue for several years. For more information see http://feerc.ornl.gov.

*Contact: Ron Graves, 865-946-1226, gravesrl@ornl.gov*

*Sponsors: DOE/EERE Biomass Program and FreedomCAR and Vehicle Technologies Program*




*The construction of a commercially available CRCM stone-coated metal roof product.*

# Field Tests Reflect Success of "Cool Roof" Research

Roofs that reflect the sun's heat can save consumers money, and ORNL has been working with the roofing industry to test "cool-color" pigments that help reduce the amount of energy needed to cool homes and other buildings.

The pigments—which are used to color roof paints—are part of a new generation of roofing products that can bring relief to homeowners and utilities alike.

Benefits to homeowners include greater comfort inside the building, longer roof life because cool roofs are protected from ultraviolet and thermal degradation, longer life for cooling equipment, and the potential to downsize cooling equipment.

With a reduction in the amount of energy needed for cooling, power companies can reduce hot-weather energy consumption. The use of cool-color pigments will also positively impact the environment by helping reduce carbon dioxide emissions, metropolitan heat buildup, and urban smog.

Industry researchers, including those working with the Department of Defense, developed the first prototype cool color pigments for military camouflage to match the visible and the near-infrared reflectance of background foliage. The high infrared reflectance of these pigments can be used to manufacture roofing materials that reflect more sunlight than conventional-pigmented roofing products. Therefore, ORNL and the Lawrence Berkeley National Laboratory (LBNL) initiated a 3-year "Cool Roof Color Materials" (CRCMs) project to bring cool-colored roofing materials to the roofing market.

ORNL, with assistance from LBNL and in conjunction with pigment and roof manufacturers, selected appropriate CRCMs, applied them to roofing materials, and field-tested the roof products. Testing has occurred at demonstration homes and seven weathering farms in California and at the campus of the Buildings Technology Center (BTC) at ORNL using the steep-slope attic assembly on the Envelope Systems Research Apparatus (ESRA).

Data from the California homes indicated that summer attic temperatures in the homes with "cool-brown" concrete roofing tiles or metal roofing shingles were from 5.4 to 12.6 degrees cooler than the temperatures in homes with regular brown roofing materials.

The BTC completed two years of field-testing clay and concrete tile on the ESRA and reported the results for the Public Interest Energy Research project "Cool-Roof Colored Materials" sponsored by the California Energy Commission.

Field results for the combination of sub-tile venting and improved solar reflectance offered by CRCMs are proving that tile and metal roofs can be energy-efficient cool roof products, suggesting that the Environmental Protection Agency, Leadership in Energy and Environmental Design, and state energy offices should offer energy credits for roofs using sub-tile venting and cool pigmented colors.

The success of these experiments and other data led Pacific Gas and Electric (PG&E) and Southern California Edison (SCE) to offer rebates to homeowners selecting cool color residential roofs. Rebates from $200 to $500 are offered depending on the size and type of roof. California's Sacramento Municipal Utility District (SMUD) already has a rebate program for customers installing Energy Star® roof products. SMUD estimates that homeowners can expect to save between 400 and 700 kWh each year.

Most important, the program helps PG&E, SCE, SMUD, and the state reduce demand for electricity during hot summer days. This means the utility companies will not have to buy as much electricity in the high-priced wholesale energy market. For more information, see www.pge.com/news/news_releases/q4_2006/061002.html.

ORNL researchers have discovered that it's not just light colors that are more reflective; they have identified and characterized dark yet highly reflective color pigments and calculated their potential energy benefits. For example, a calcinated mixture of black pigment chromic oxide and ferric oxide increases the solar reflectance of a standard black pigment from 0.05 to 0.26. These infrared-blocking color pigments are dark in color, but highly reflective in the near-infrared spectrum.

*Contact: Bill Miller, 865-574-2013, millerwa1@ornl.gov*

*Sponsor: DOE/EERE Building Technologies*

*South-facing steep-slope attic assemblies placed atop the roof-testing facility.*

# Phase Change Materials + Cellulose = High-Tech Green Insulation

Cellulose, used as a building insulation for over 100 years, has undergone a technological transformation because of a new thermal enhancement developed at ORNL. A phase change material (PCM) injected into conventional cellulose creates a thermal mass effect, greatly increasing the ability of the insulation to shield building interiors from heat loss or gain.

The technology is based on encapsulating microscopic droplets of a paraffinic material inside hard acrylic polymer shells of about 2–20 micrometers. The PCM, called Micronal, melts at about 78.5°F. Initially, it performs like conventional materials: its temperature rises as it absorbs heat. However, as the PCM melts, it continues to absorb large amounts of heat without a significant temperature rise. Then when the ambient temperature around the liquid Micronal falls, it solidifies again, releasing the heat it has stored.

ORNL researchers expect this new generation of PCM-enhanced cellulose insulation to have a high potential for successful adoption by the U.S. building market because of its energy efficiency, compatibility with traditional wood and steel framing technologies, and potential for application in retrofit projects.

A key issue for the technology was whether the PCM-enhanced cellulose would be more susceptible to combustion. A series of flammability tests were performed to determine whether the new material would increase the danger of fires. Smoldering combustion tests (ASTM C-739) demonstrated the cellulose-PCM blend didn't compromise the fire resistance of the tested sample of the PCM-enhanced insulating material.

A heat flow testing apparatus and ORNL's hot-box test equipment were used to test the effectiveness of the PCM-enhanced materials at reducing heat transfer and peak loads. Experiments using the heat flow apparatus indicated energy savings of up to 25% can be realized through the use of PCM during periods of dynamic temperature change. These tests also showed that the thermal conductivity of cellulose insulation is not compromised by adding up to 30% PCM.

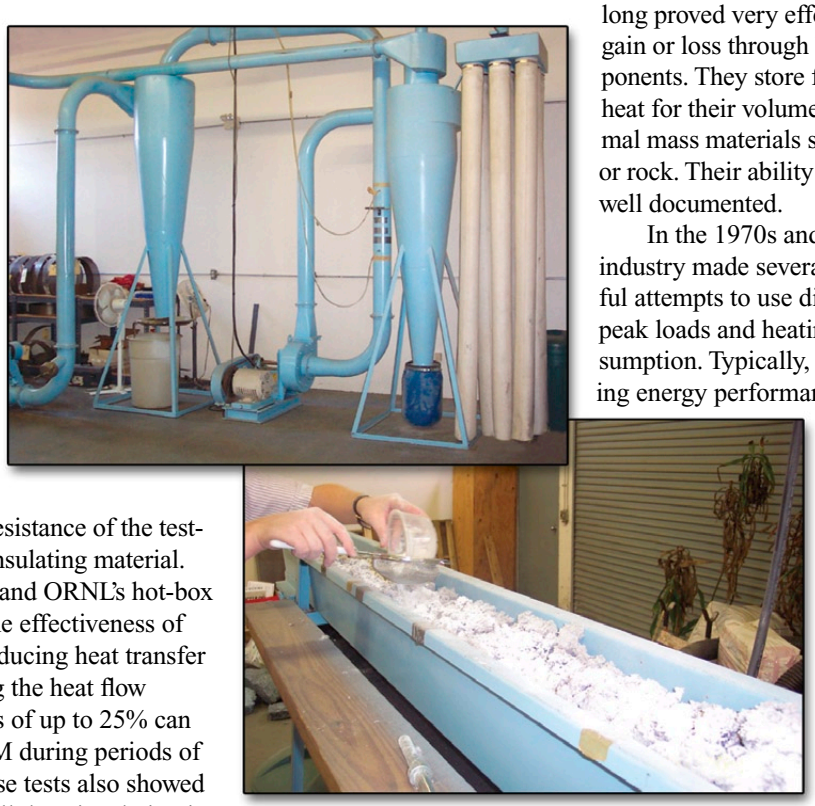
In hot-box tests at ORNL, the PCM-enhanced cellulose reduced total heat flow through the wall in a 5-hour-long thermal excitation period by over 40% (most temperature excitations generated by climate are no longer than 5 hours). Tests over the entire 15-hour period that it takes to charge the PCM showed a reduction of almost 20% in heat transfer. Field demonstration studies performed in 2006 in Oak Ridge, TN, and in Charleston, SC, facilities on 2 × 6 wood frame walls insulated with PCM-enhanced cellulose showed a 30–40% reduction of the peak cooling loads and a 2-hour time delay in peak load transmission. ORNL researchers also achieved very good agreement between experimental data and computer simulations of the material.

The first samples of the cellulose-PCM material were produced at an Advanced Fiber Technology (AFT) pilot plant. AFT partnered with ORNL's Building Envelopes Program and BASF, which produced the PCM. Microcapsules of PCM were introduced into lightweight natural cellulose fiber as part of the manufacturing process. Because existing manufacturing lines already are set up to add dry chemicals to cellulose insulation, it should not be difficult for insulation makers to incorporate the PCM into the process.

Cellulose is made from recycled paper and is therefore a "green" insulating product. Insulation made from materials such as glass fiber, rock wool, and plastic requires as much as 50 to 200 times more energy to produce than cellulose insulation. In North America, cellulose insulation has about 10 to 15% of the residential market, and, in some U.S. regions, cellulose is the dominant type of insulation for residential attics.

Within the human comfort range of 68 to 86°F, PCMs have long proved very effective at controlling heat gain or loss through building envelope components. They store from 5 to 14 times more heat for their volume than conventional thermal mass materials such as water, masonry, or rock. Their ability to reduce peak loads is well documented.

In the 1970s and 1980s, the housing industry made several moderately successful attempts to use different PCMs to reduce peak loads and heating/cooling energy consumption. Typically, PCMs enhanced building energy performance; however, problems such as high initial cost, loss of phase-change capability, corrosion, and sweating hampered widespread adoption.



*Using a pilot-scale production line (top) different cellulose-PCM blends (bottom) were produced at AFT. ORNL determined that cellulose with 30% added PCM maintains its thermal conductivity.*

Paraffinic PCMs were one of the best performers, but they tended to increase the flammability of the insulation. However, chemical additives provide resistance to combustion as well as to corrosion and fungal growth. The current ORNL research shows that the most effective locations for the PCM-enhanced cellulose insulation are interior cavities (floors, walls, etc.) or residential attics where it is least likely to compromise fire resistance.

ORNL is developing two recipes for PCM-enhanced cellulose insulation—one for wet application to walls and one for dry application in attics.

*Contact: Jan Kosny, 865-574-9353, kosnyj@ornl.gov*

*Sponsor: DOE/EERE Building Technologies*

# ORNL Review Launches Space Center Energy Efficiency Project

When a project to replace inefficient boilers at the Kennedy Space Center was proposed, National Aeronautics and Space Administration (NASA) officials were initially cool to the idea. But an independent review by ORNL's Building Technologies staff convinced them to move forward with the project, which now is projected to save the federal government more than $820,000 a year.

*More energy-efficient boilers are projected to save $800,000+ yearly at Kennedy Space Center.*

Under the Federal Energy Management Program, ORNL's Commercial Buildings and Industrial Energy Efficiency Group routinely provides such technical assistance to federal agency sites seeking to make their buildings more energy efficient.

"ORNL reviewed a project proposal the utility company had sent to NASA," said Julia Kelley, leader of the ORNL group. "Because our team had done previous work for NASA, the NASA reps trusted the unbiased opinion of the ORNL researchers, and that led them to place more trust in the proposal."

The project, proposed by Florida Power and Light, involves the design and construction of packaged modular boiler systems at 12 facilities in and around the industrial area of the Space Center, including the space station, operations and checkout, and administrative buildings. The 12 facilities are being decoupled from an inefficient central plant by installing 29 individual boilers and 6 water heaters sized to meet the space heating, dehumidification, and water heating needs of the areas where they are located.

NASA management questioned elements of the proposals and were considering shelving the project. But in light of the favorable ORNL review early in 2006, the Space Center signed the agreement in December 2006. The project is financed with a Utility Energy Services Contract; payments for the improvements will be offset, in total, through the energy cost savings. NASA will reap additional benefits from replacing and abandoning deteriorated or failed infrastructure, thus reducing maintenance requirements and mission risk, avoiding future capital outlays, and improving safety.

*Contacts: Mike MacDonald, 865-574-5187, macdonaldjm@ornl.gov; Julia Kelley, 865-574-1013, kelleyjs@ornl.gov*

*Sponsor: DOE/EERE Federal Energy Management Program*

# More Than 250 University Students, Faculty at "Day of Science"

More than 250 students and faculty from 45 U.S. colleges and universities, including many historically black colleges and universities (HBCUs) and minority education institutions (MEIs), gathered at ORNL for the fifth annual Day of Science and DOE-sponsored Minority Education Technical Assistance Workshop.

Charles Greene, executive director of the White House Initiative on Historically Black Colleges and Universities was the keynote speaker for the event. Greene discussed the importance of nurturing relationships among students, faculty, and administrators at the nation's HBCUs. He stressed that educators and administrators must be supportive of students who wish to pursue education in math or science. While major universities are often sustained by large endowments, he noted, HBCUs and MEIs often rely solely on tuition income, which creates a major financial challenge. Support from institutions such as ORNL is extremely helpful.

Many participants said they had never heard of ORNL before signing up for the event. Their visit to the Laboratory included talks and presentations, a tour of the EVEREST visualization lab and other research laboratories, and several demonstrations of cutting-edge technologies. Some students participated in "pre-interviews" for possible internships.

*Contact: Patrick Martin, 865-574-5159, martinpm@ornl.gov*

*Day of Science visitors watch a demonstration of superconducting technology by materials researcher Patrick Martin.*

# Hybrid Solar Lighting Installed at New ORNL Building

ORNL's Solar Technologies Program is having five hybrid solar lighting (HSL) systems installed at ORNL's new Multiprogram Research Facility (MRF). The areas equipped with the HSL include a large open lobby, a conference room, and two sets of four offices each.

HSL is a technology for collecting and distributing sunlight via optical fibers and hybrid light fixtures into the interior space of a building. ORNL has been developing the fully integrated hybrid lighting system to provide the benefits of natural light (energy savings and improved lighting quality) with flexibility that complements present skylight systems. The hybrid fixtures being installed will include standard fluorescents, incandescent can lights, and individual task lighting at the desktop.

*HSL systems atop ORNL's Multiprogram Research Facility.*

The MRF (slated for final completion in spring 2007) will have approximately 214,000 ft$^2$ to house chemical, material, and electronics laboratories; fabrication and training spaces; offices; and support infrastructure. The routing of much of the optical fibers for the building is being done below the drop ceiling to highlight the HSL technology. Each system can provide sunlight to approximately 750 to 1000 ft$^2$ and is expected to displace approximately 1 kW of fluorescent or 3 kW of incandescent lighting. The installation is sponsored by ORNL's Office of Technology Transfer and Economic Development.

*ORNL's Multiprogram Research Facility.*

In addition to the HSL systems being installed at the MRF, ten systems were installed as part of ORNL's nationwide field trial program in California, Hawaii, Minnesota, Nevada, New York, Tennessee, Texas, and Washington. At the Wal-Mart store in McKinney, Texas, the newly installed system displaces electricity associated with 25 halogen track lights. Testing over the next year will quantify the system's delivered energy savings as well as any correlation between increased natural lighting levels and increased sales. For more information on HSL, see www.ornl.gov/solar.

*Contact: David Beshears, 865-576-0175, beshearsdl@ornl.gov*

*Sponsor: DOE/EERE Solar Technologies Program*

# C$^3$ Moving on Campus to Manage Work with ORNL

C$^3$ International, LLC, a collaborator with ORNL on the R&D 100 award winning MIST (metal infusion surface treatment) technology, plans to open an office near ORNL in 2007 and an R&D center on or near the campus in 2008 to pursue its collaborations with the Laboratory.

The primary function of the Oak Ridge location will be to manage projects C$^3$ expects to have under way with ORNL, other national laboratories, and a number of Fortune 500 companies interested in using the company's research to gain a competitive advantage. The company is currently exploring research with staff members in the High Temperature Materials Laboratory (HTML) on the applicability of C$^3$ oxide films as electrolytes in solid oxide fuel cells.

*MIST greatly extends the life of casting tools, outperforming conventional coatings by up to 40 times.*

C$^3$, located in Alpharetta, Georgia, illustrates the value of collaborations between DOE, ORNL, and industrial partners. It began its partnership with ORNL with user projects at HTML and MPLUS (the Metals Processing Laboratory User Center). That work

resulted in the joint R&D 100 award in 2006 for the MIST nano-diffusion film technology that produces an extremely thin, strongly bonded coating on a tool surface. Cutting tools and casting molds coated via MIST are lasting 10 to 50 times longer than those with conventional coatings in industrial applications. Companies using MIST include Alcoa, Heinz foods, Hayes-Lemmerz International, and more than 35 aluminum die-casting companies. It is estimated that the technology will save the steel industry alone $300 million per year.

The company will continue to work with ORNL in 2007 to optimize applications for the petrochemical, aluminum, and steel industries. Next year, the collaborations may include research in high-temperature superconductors, semiconductors, micro-electromechanical systems (MEMS), photovoltaics, fiber optics, telecommunications, and corrosion-resistant materials for high-temperature, high-caustic applications. $C^3$ is also working with the Environmental Protection Agency, DOE, and the Department of Defense on initiatives to eliminate diesel engine emissions.

*Contact: S. M. Robinson, 865-574-6779, robinsonsm@ornl.gov; E. Lara-Curzio, 865-574-1749, laracurzioe@ornl.gov*

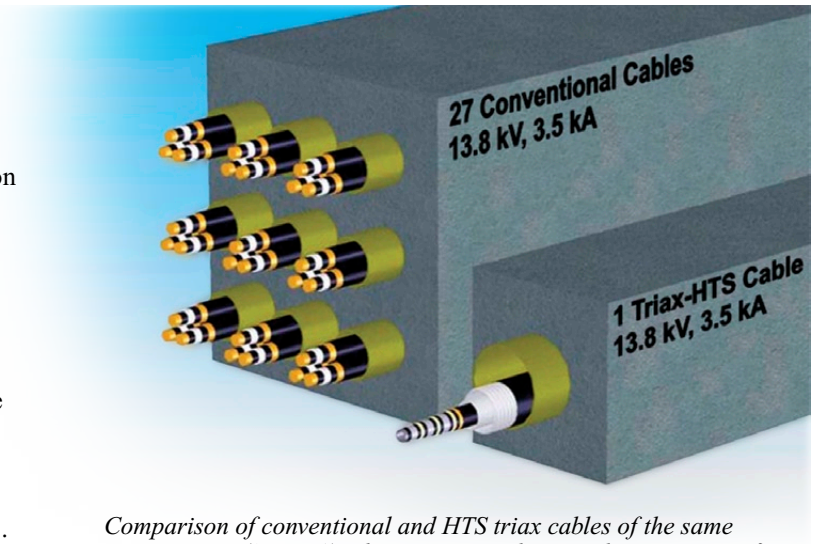
*Sponsor: DOE/EERE FreedomCAR and Vehicle Technologies and EERE Industrial Technologies*

## Columbus Cable Field Test Is a Big Step Forward for HTS

A major field test of high-temperature superconducting (HTS) transmission and distribution cables is performing flawlessly and providing reliable power to more than 8000 American Electric Power (AEP) customers. At the heart of this future grid being tested in suburban Columbus, Ohio, are HTS cables that form the backbone of the infrastructure. HTS technology is expected to bring reliable and secure service to the nation's power grids.

Rated at 13.2 kV and 3000 Arms, the 200-m-long Columbus HTS cable manufactured by Southwire Company has thus far experienced a peak current of 2400 A during a hot summer day. This HTS cable will be operated continuously for at least a year to demonstrate the reliability of the HTS technology and auxiliary systems, generating valuable operational and maintenance data necessary for the successful broad commercialization of the HTS technology.

After considerable testing, the innovative triaxial cable was tied into the grid and energized in August 2006. Because of its triaxial design, the Columbus HTS cable is the most compact and highest-current-density cable in the world. No special expensive technique is necessary to lay down HTS triaxial cables, and existing underground ducts can be used effectively for expected growth.




*Comparison of conventional and HTS triax cables of the same power rating (84 MVA). The conventional system has nine sets of three-phase cables situated in separate 6-in. ducts; the HTS cable can be located in a single 10-in. duct.*

*AEP Bixby substation where the Columbus HTS cable is installed. The photo shows the cable emerging from an underground duct, termination, and overhead tie-ins to the AEP grid.*

A formal commissioning ceremony was held at the Bixby substation in September 2006 that was attended by representatives from DOE, local and state governments, and project partners, as well as media representatives and various stakeholders. In addition to ORNL and Southwire Company, other collaborators on this project were Ultera, AEP, American Superconductor Corporation, and Praxair.

For more information, see www.supercables.com and www.ornl.gov/sci/fed/applied/ornl_projects.shtml

*Contact: Mike Gouge, 865-576-4467, gougemj@ornl.gov*

*Sponsor: DOE/OE Superconductivity Program*

# CALENDAR

### Nano Nexus 2007, ORNL, April 2–4, 2007

Nano Nexus 2007, hosted by ORNL, is a nanotechnology event with an emphasis on education for all the critical parties in nanotechnology commercialization. ORNL contact: S. M. Robinson, 865-574-6779, robinsonsm@ornl.gov. For more information: www.nanonexus.org/.

### GridWeek 2007, Washington D.C., April 23–26, 2007

With a global focus on energy, DOE is holding the first event to bring together technology players involved in grid modernization and to focus on the role technology can play in untangling the U.S. energy problem. Themes include policy matters requiring change for grid modernization, benefits of a smart modern grid, enabling technologies, interoperability of devices and systems, and financial models. ORNL contact: T. J. King, 865-241-5756, kingtjjr@ornl.gov. For more information: www.gridweek.com/2007/default.asp.

### Southeast Solar Summit, ORNL, October 24-26, 2007

ORNL, the Southern Alliance for Clean Energy, and other organizations are hosting the first Southeast Solar Summit in Oak Ridge, Tennessee, October 24-26, 2007. Participants from across the Southeast will share research and pathways to the marketplace through papers, workshops, and discussions on solar power. ORNL contact: M. V. Lapsa, 865-576-8620, lapsamv@ornl.gov. Details will be available at www.ornl.gov/solarsummit.

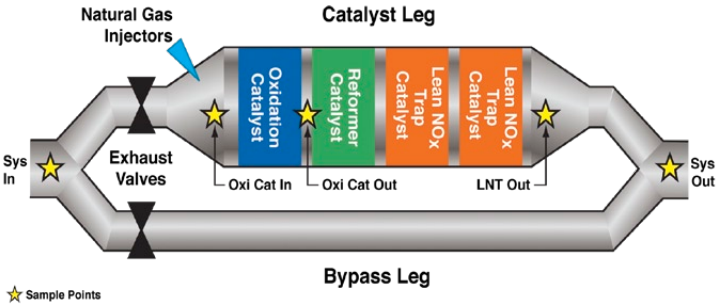
# Hybrid Solar Lighting Wins Tech Transfer Award

The Hybrid Solar Lighting technology has been selected as a national winner of the 2007 Award for Excellence in Technology Transfer by the Federal Laboratory Consortium for Technology Transfer (FLC). The award recognizes laboratory employees who have accomplished outstanding work in the process of transferring a technology developed by a federal laboratory to the commercial marketplace.

The awards ceremony will be held in May 2007 at the FLC national meeting in Arlington, Texas.

# ORNL Demonstrates Technical Viability of Lean NOx Traps

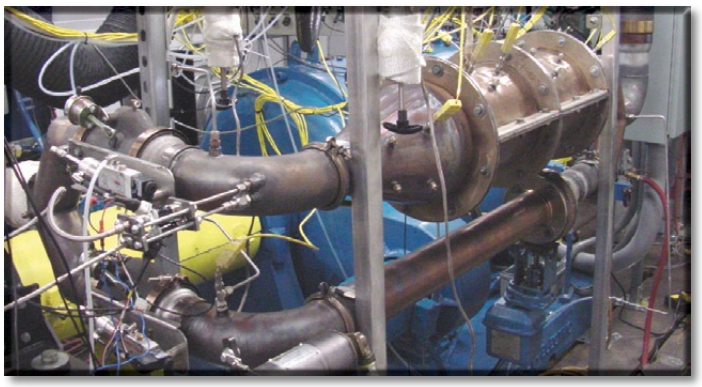
ORNL researchers in the Fuels, Engines, and Emissions Research Center (FEERC) have successfully demonstrated a technique for reactivating lean NOx (nitrogen oxides) trap (LNT) catalysts poisoned by sulfur emissions. The technique removes the last technical barrier to the use of LNTs to treat NOx emitted by lean natural gas engines.




*Schematic of the experimental LNT system. The valves were used to reduce the fuel penalty during catalyst regeneration.*

FEERC has been testing and analyzing the LNT technology as part of DOE's Advanced Reciprocating Engine Systems (ARES) program. The work is an attempt to determine whether LNTs are a viable method of treating NOx emissions from lean-burning natural gas reciprocating engines for power generation. Lean-burning engines are more fuel efficient, but their use will be limited if emissions (including NOx) cannot be reduced sufficiently to meet regulations.

Sulfur is a known poison for LNTs, but ORNL has demonstrated in an accelerated aging study that a catalyst-washing technique recovers lost performance due to sulfur poisoning. The washing technique is low in cost and environmentally friendly, making it an ideal service process that could extend the useful



*The LNT catalyst system in an engine dynamometer lab. A Cummins C 8.3 G engine was used for the studies.*

life of LNTs in industrial applications. Catalyst poisoning of LNTs is the final potential technical show stopper being addressed in the ARES program.

EmeraChem, a small local company, has been a partner on the project and supplied the catalysts for the study. ORNL

demonstrated a >90% reduction in NOx emissions using LNTs and achieved a primary ARES goal of <0.1 g/bhp·h of NOx emitted. Experiments performed in late 2006 focused on addressing durability issues that are of interest to the ARES industrial partners (Caterpillar, Cummins, and Waukesha).

ORNL's work has demonstrated that LNTs are technically viable. ORNL will present the results of its research to the engine and aftertreatment community for their use in deciding whether to pursue commercialization of the technology.

*Contacts: Jim Parks, 865-946-1283, parksjeii@ornl.gov; Tim Theiss, 865-946-1348, theisstj@ornl.gov*

*Sponsor: DOE/OE Distributed Energy Program*

## Lara-Curzio Is New HTML Director

*Edgar Lara-Curzio*

Edgar Lara-Curzio was recently named the director of the High Temperature Materials Laboratory at ORNL. Lara-Curzio holds a B.A.Sc. degree in engineering physics from Autonomous Metropolitan University in Mexico City and a Ph.D. in materials engineering from Rensselaer Polytechnic Institute. After coming to ORNL as a post-doc in 1993, he became a member of HTML's Mechanical Characterization and Analysis Group. His research has focused on characterization of advanced materials, ceramics, composites, and their constituents. He has more than 150 publications.

Lara-Curzio replaces Arvid Pasto, director of HTML since 1995. Pasto had been a researcher at ORNL for 24 years when he retired in February 2007.

*S&T Highlights* is a communication of Oak Ridge National Laboratory's *Energy Efficiency and Renewable Energy (EERE), and Electricity Delivery and Energy Reliability (OE) Programs*

Websites: **www.ornl.gov/eere** and **www.ornl.gov/etd**
Managing editors: Robert Hawsey and Penny Humphreys
Technical editors/writers: Deborah Counce and Jeanne Dole
Designer: Jane Parrott

Your comments are invited and should be addressed to Penny Humphreys, ORNL, humphreyspm@ornl.gov, 865-241-4292; fax 865-576-7572

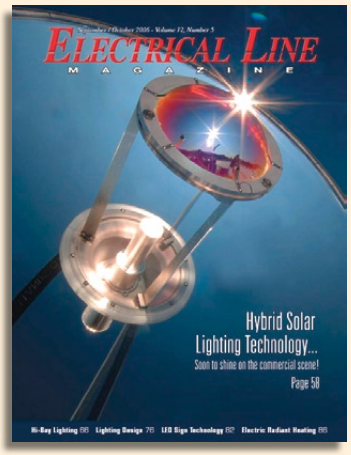
Oak Ridge National Laboratory is operated by UT-Battelle for the U.S. Department of Energy under contract DE-AC05-00OR22725.

OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

## COVER STORIES

Several energy-related technologies have made the covers of prominent industry journals recently.

### "Hybrid Solar Lighting Technology ... Soon to shine on the commercial scene,"




*Electrical Line* **12**(5) (September/October 2006). Three years ago when hybrid solar technology was covered in this magazine, it sounded like a distant fantasy. But now five HSL systems have been installed and another 20 are scheduled. www.electricalline.com

### "Electrical Properties of Epoxy Resin Based Nano-composites,"


*Nanotechnology*, **18**(2) (January 2007). The authors, all from ORNL and the University of Tennessee, investigated the electrical properties of composite materials prepared as nano- and sub-micron-scale metal-oxide particles embedded in a commercial resin. The results showed resin samples containing nano and sub-micron particles were more electrically insulating than resin with embedded particles.

### "Infrared Heats Up,"


*Industrial Heating: the International Journal of Thermal Technology*, June 2006. The article describes ORNL's efforts to develop high-temperature applications of infrared treatment using custom-developed infrared systems powered by tungsten-halogen lamps. The Lab's R&D 100 award–winning "advanced heating system for aluminum forgings" is cited as an example. www.industrialheating.com/

# News Briefs

## Garland Wins CHP Leadership Award

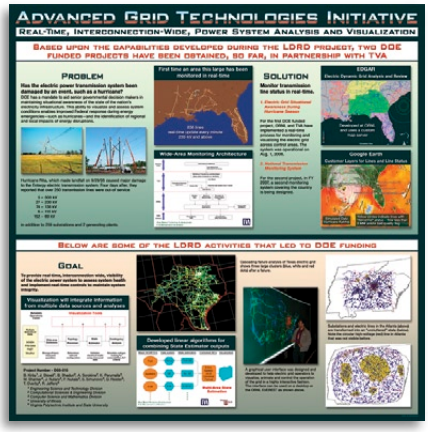
Patti Garland, the Distributed Energy Research–Cooling, Heating, and Power program manager, recently received the U.S. Combined Heat and Power Association Champion Award. The award, presented by leaders in the cooling, heating, and power community, recognizes her "outstanding leadership toward greater national use of clean, efficient and reliable combined heat and power." She was recognized at the recent CHP Roadmap Meeting in Seattle.

## Graves Is SAE Distinguished Fellow

Ron Graves of ORNL's Fuels, Engines, and Emissions Research Center has been elected a Distinguished Fellow by the Society of Automotive Engineers (SAE). This membership grade recognizes and honors Graves's significant impact on mobility technologies through his research, innovation, and creative leadership at ORNL. Election to the position of Fellow is reserved for only about 20 persons each year. There are currently fewer than 600 SAE Fellows. Candidates are elected via nominations submitted by SAE members and fellow-grade members.

## Stovall Displays Winning Poster

John Stovall, a member of ORNL's Cooling, Heating, and Power Group, created the winning poster for the recent Laboratory Directed Research and Development Poster Session. Stovall's poster covered the Advanced Grid Technologies Initiative project on grid visualization with real-time data.




## Clean Fuels Coalition Awards ORNL

The East Tennessee Clean Fuels Coalition (ETCFC) recently recognized ORNL, a founding partner of the group, for its support during 2006 and its leadership in integrating alternative fuels into East Tennessee. Mark Downing received the award on behalf of ORNL and the National Transportation Research Center. He has been the ORNL Technical Advisor to the Clean Cities Programs in Tennessee since ETCFC, based in Knoxville, was established in 2002. Since then, Middle and West Tennessee have established Clean Fuels Coalitions, also.

## State Energy Advisory Board Visits ORNL

The State Energy Advisory Board (STEAB) visited ORNL in October 2006. STEAB was established to advise DOE and Congress on the operation of federal grant programs. It also advises on energy efficiency and renewable energy (EERE) programs in general and on DOE efforts relating to research and deployment of EERE technologies. Members include Susan Brown, William Even, Elliott Jacobson, Alexander Mack, James Nolan, James Ploger, Elizabeth Robertson, Harold Smedley, Patricia Sobrero, Janet Streff, William Taylor, Steven Vincent, David O'Connor, Daniel Zaweski, Gary Burch (DOE), Sunny Choi (DOE), Pat Malone (DOE), and David Rathbun.

### Included in This Issue:



**Science and Technology Highlights**
P.O. Box 2008
Oak Ridge, TN 37831-6186