On the cover:
The Multiprogram Research Facility earned the Leadership in Energy and Environmental Design (LEED) Gold certification. The building is one of six in ORNL’s east campus, which is the only fully LEED-certified campus in Tennessee and in the national Department of Energy complex. The LEED Green Building system is the nationally accepted benchmark for the design, construction, and operation of high-performance buildings.
Affordable and Sustainable

A Revitalized Laboratory

Oak Ridge National Laboratory is nearing completion of the largest modernization program in the laboratory’s 65-year history. Since 2002 ORNL has constructed more than 1.2 million square feet of state-of-the-art and efficient office, laboratory, and support facilities. The implementation of a $350 million Facilities Master Plan has helped transform, seemingly overnight, an outdated and costly infrastructure into a modern, sustainable campus for the next generation of great science. A unique combination of federal, state, and private funds made possible the accelerated construction of 13 new buildings that were instrumental in the recruitment of world-class talent. These state-of-the-art facilities were also used to leverage successful competitions for major new research programs in bioenergy, nanoscience, and high-performance computing. The commitment to sustainability that has guided ORNL’s modernization effort has become an integrated principle of the laboratory’s facilities management program.
A Culture of Sustainability

Sustainable design and development form the basis of ORNL’s campus revitalization. The aim of sustainability is to reduce the use of nonrenewable resources and minimize environmental impact in facilities that are practical, attractive, and affordable. Environmental as well as economic elements are integrated into architectural and programmatic plans for the construction of new buildings and the renovation of older facilities.

ORNL has used the modernization program to showcase many of the energy-related technologies developed at the laboratory. These cutting-edge technologies contribute to a significant reduction of overhead costs and thus enable scientists to devote a greater share of their limited resources to research. Equally important, ORNL’s commitment to sustainability had made the laboratory’s modernization program a model for the revitalization of large campuses, both inside and outside the Department of Energy system.

Core principles of a master plan

ORNL’s Facilities Master Plan is guided by core principles that provide a sense of aesthetics and coherence that will shape the laboratory’s long-term growth. The Master Plan’s core principles are

- An open research campus that emphasizes natural landscapes
- Sustainable design for buildings and landscape
- A flexible structure that anticipates phased program growth
- Programmatic centers integrated in a greater campus

An Innovative Partnership

Coordinated by UT-Battelle, the Department of Energy, the state of Tennessee, and the private sector have united in an innovative partnership that has combined resources to finance and greatly accelerate the construction of new facilities. The strategy included seven facilities—three funded by the state of Tennessee and four funded through the private sector—located on land deeded by the Department of Energy within the ORNL campus.
A Dramatic Transformation

The transformation has been nothing short of dramatic. Today new buildings surround acres of green space occupied only 5 years ago by deteriorating structures and parking lots that held a thousand cars. The new facilities transformation reflects not just the short-term needs of ORNL’s scientists, but also a belief that attractive and cost-efficient buildings are a critical part of attracting new programs and growing the laboratory’s research portfolio. The results have exceeded expectations.

In less than a year, the new Center for Computational Sciences became home to the Department of Energy’s Leadership Class Facility, where researchers have developed the world’s most powerful supercomputer for open science research. The computer, which in 2009 will be capable of 1,000 trillion calculations per second, is supported by one of the world’s most sophisticated new facilities.

Across the campus, the new Joint Institute for Biological Sciences was a critical factor in the Department of Energy’s decision to award ORNL a new $125 million Bioenergy Research Center. The new program will be the foundation for ORNL’s leadership role in the emerging bioenergy industry.

In addition to the construction of new facilities, ORNL’s modernization efforts include the removal of legacy wastes inherited from the laboratory’s early years. Located primarily in the central campus, the clean-up and demolition of these facilities will make possible the construction of a new Science and Technology Park and provide room for program expansion in the years to come.

The Spallation Neutron Source (left) and the Center for Nanophase Materials Sciences (right), sited on Chestnut Ridge, incorporate sustainable design features for site development, water savings, energy efficiency, materials selection, and indoor environmental quality.
Aggressive Demolition

As part of the campus modernization, more than 70 facilities, totaling approximately 200,000 gross square feet, have been demolished. An additional 1,800,000 gross square feet of space in aging and inefficient facilities are scheduled to be torn down. Special care is taken to safely remove and dispose of orphan materials from these buildings. Hazardous materials, including asbestos and radioactively contaminated items, are removed or abated before demolition begins to reduce risks to people and the environment. Some materials are literally returned to the earth. Gypsum wallboard waste was donated to local farmers or used on-site to amend soil. Other components are also recycled or reused. The demolition was part of the Master Plan that includes using new space both for new buildings and for natural areas, designed to be sustainable parts of the new campus.
Targeted Renovation

Many campus buildings, despite their age, can provide years of productive life with a policy of targeted and sustainable renovation. Conservation of steam, for example, can be enhanced by replacing aging traps, pressure-relief valves, and heat exchangers and by adding new insulation. ORNL estimates a savings of more than $360,000 annually through recent steam-conservation measures. In one building replacing laboratory fume hood motors with variable-speed drives reduced electrical usage for the fans by 40%. The cost of this renovation paid for itself in savings in about 6 months and will continue to save about $2 million annually. Office space and research laboratories are also periodically revamped to respond to the changing needs of the research community. Renovations that include energy- and water-saving innovations also contribute substantially to ORNL’s ability to meet its overall sustainability goals.
Homegrown Technologies

ORNL's efforts to create a sustainable campus use an array of technologies developed at the laboratory. Sustainable technologies include advances in building and roofing materials, hybrid solar lighting, natural landscaping, and energy conservation.

For years ORNL scientists have been among the leaders in developing technologies that provide energy-efficient buildings. Paints that reflect heat from roofs, efficient heating and cooling systems, and hybrid lighting that brings daylight and photovoltaic energy inside are examples of technologies studied or developed at ORNL and used for campus revitalization.

The outdoor environment also benefits from research performed on the Oak Ridge Reservation and the National Environmental Research Park, which encircles the campus with 20,000 acres of undeveloped land. A sensitivity for protecting rare and endangered plants and animals, ensuring biodiversity, controlling invasive plants, and restoring native plants is an important part of plans for campus growth and sustainability.

As part of the energy infrastructure, supercomputers are cooled from a central machine room that supplies chilled water for air handlers and heat exchangers. As the water warms, it is returned, cooled, and recirculated to provide an energy-saving, reliable environment for some of the world's fastest computers.
In addition to recycling paper and cardboard, ORNL has an aggressive program to recycle steel cans, plastic, and glass.

**Pollution Prevention**

The Department of Energy’s Office of Science has recognized ORNL with three consecutive best-in-class awards for pollution prevention and environmental stewardship. Also, as part of the Battelle family of laboratories, ORNL was recognized with a prestigious White House Closing the Circle Award. In issuing these awards, the Department of Energy cited ORNL’s use of bio-based fuel for vehicles; the reduction of waste generation, including wastewater; the disposition of legacy materials; and the saving of landfill space through the recycling or reuse of 2,400 cubic yards of material.

From 2002 to 2007 ORNL invested approximately $25 million to address legacy issues and to recycle, reuse, or dispose of unneeded materials. These materials and chemicals occupied valuable space, posed safety hazards, and were an obstacle to ORNL’s revitalization program. The laboratory also has avoided potential costs of $9 million through an organized campaign to dispose of materials such as unneeded gas cylinders, pumps and motors, contaminated lead, and chemicals.
Going Native

Native plants and natural landscaping have been a major component of ORNL’s modernization plan. The landscaping plan originally developed for the east campus was expanded to provide continuity throughout the entire ORNL campus. The master landscape plan lists plant types that complement the entire campus greenscape. Stream quality has been improved by more selective mowing and planting native species along the banks. About 500 native bushes and trees have been planted near White Oak Creek, which flows near the eastern boundary of the laboratory. Button bush, elderberry, white dogwood, spice bush, red maple, river birch, and redbud are among the varieties that are helping return the stream bank to a native environment. Bluebird houses on poles mark the border for grounds crews mowing adjacent areas.

Coordinated landscape design provides habitat enhancement, erosion control, water-quality improvements, and restoration of native plants and wildlife. Using native plants not only ensures that the plants will adapt to local conditions once established, but also provides opportunities to restore and highlight native East Tennessee communities. In 2006 ORNL staff donated about 150 native wildflowers from their home wildflower gardens for use in landscaping around the laboratory’s pond.
Top left: Bluebird houses mark the edge of the mowing zone near streams. By not mowing this area, the streams are kept cleaner and labor costs are reduced.

Top right: Drought-resistant native wildflowers accent the courtyard and other landscaped areas.

Bottom left: A low-lying detention basin has been returned to a natural wetlands area. Native cattails and other plants have made the basin attractive and reduce maintenance needed there.

Bottom right: Wild turkeys have made a comeback on the Oak Ridge Reservation and are a common sight on campus.
A LEED Campus

Each of the six new buildings constructed on ORNL’s east campus meets LEED (Leadership in Energy and Environmental Design) standards for sustainability, with numerous “green” elements integrated into their design. The buildings make use of natural sunlight, provide indoor air quality conducive to employee health and productivity, and reduce operating costs through the use of central energy plants. Inside, natural lighting floods interior atriums, and outside, rainwater can seep through pervious pavement.

LEED promotes a whole-building approach to sustainability by recognizing performance in five key areas of human and environmental health: sustainable site development, water savings, energy efficiency, materials selection, and indoor environmental quality.

Low-emissivity glazing on windows makes a big contribution to energy savings. Building walls carry an R-value rating of 15 or greater, and roofs are EnergyStar™ rated and have high reflectivity values.

Sustainable, reliable power to meet the demands of ORNL’s high-performance computing and other electricity needs comes from the Tennessee Valley Authority.
Site Development

A primary principle of site renovation at ORNL is brownfield rather than greenfield development. Much of the east campus building construction replaced a parking area that previously served more than 1,000 cars. Parking has been moved to waste management areas that have been capped but are not suitable for construction. Erosion control is also integrated into the development plan, and the site conforms to the state of Tennessee’s Storm Water Pollution Prevention Plan. The revitalization plan emphasizes increased campus densities to minimize the laboratory’s footprint on the landscape. The east campus is organized around a quadrangle of green space, with access roads closed to vehicular traffic during regular work hours. Walkways and plazas surrounding the quadrangle bring focus to it. An existing man-made pond, fed by an underground spring and surface runoff water, has been incorporated into the landscape design. The pond has been replanted with native plant materials that draw wildlife to the area. A walking trail installed around the pond provides a natural area for exercise and relaxation for employees and guests. A striking waterfall feature has been added to complement the landscape and provide a backdrop to the cafeteria.

Water Savings

Compared to the water needed by similar older buildings, ORNL’s new east campus saves more than 14 million gallons of water annually. Much of this savings comes through the use of low-flow plumbing fixtures. Drought-tolerant native plants make irrigation unnecessary, saving an additional volume of water.
Energy Use

Energy use in ORNL’s new east campus buildings represents a 54% savings over typical existing facilities at ORNL. The heating and air-conditioning systems are 25–35% more efficient than the American Society of Heating, Refrigerating, and Air-Conditioning Engineers 90.1 energy standard. The heating, ventilation, and air-conditioning plant is centrally located and operates using variable-speed drive motors and pumps to reduce energy usage. Window glazing uses low-emissive technology to reflect heat. Sunscreens, roof and balcony overhangs, and vertical fin columns help create shade to reduce the effects of solar heating. Wall and roof insulation exceeds that of conventional construction, with roofs that are EnergyStar™ rated and have high reflectivity values. The campus is the first commercial facility to use hybrid lighting, a new energy-saving lighting technology developed at ORNL.

Local Materials

Steel, concrete, and brick—the three most prominent materials used for buildings and hardscapes—are locally manufactured, and the raw materials for brick and concrete come from local sources. Approximately 85% of the materials used for the east campus development came from local sources. More than 7,000 of the 8,400 tons of construction debris generated were recycled—minimizing demands on area landfills.
Indoor Environmental Quality

A variety of construction and operational measures help ensure the level of air quality necessary for occupant health and productivity. The emission of materials selected for construction was limited to very small amounts of volatile organic compounds. Ductwork was protected from dust during construction. Each building was flushed with outside air before occupation by staff. Carbon dioxide sensors alert the building’s maintenance staff when additional ventilation is needed. Buildings have radon monitoring systems that combine with high-efficiency filters used throughout the ventilation systems. Dust is reduced by using walk-off mats and maintaining the air pressure in buildings at or above ambient pressure. Duct insulation installed on the outside of the metal ductwork prevents undesirable fiber migration to the occupied space.
The Next Challenge

Located about five blocks from the east campus, ORNL’s west campus houses the laboratory’s Environmental and Life Sciences Complex. The goal is to modernize the west campus in a sustainable manner that is aesthetically consistent with the development of the east campus. The construction and landscaping are guided by the commitment to five key areas of human and environmental health: sustainable site development, water savings, energy efficiency, materials selection, and indoor environmental quality.

On the site of a former parking lot, the Joint Institute for Biological Sciences likewise has a variety of sustainability features. Low-flow faucets and fixtures and native landscaping save water. Mechanical systems, as well as the building itself, were designed to exceed minimum industry requirements, resulting in energy savings. The new facility was instrumental in ORNL’s selection by the Department of Energy as the site of a new $125 million Bioenergy Research Center.
The Mouse Genetics Research Facility replaces its predecessor, an outdated and expensive facility located 8 miles away at the Y-12 National Security Complex. The modern 36,000-square-foot “vivarium” is a centerpiece of ORNL’s west campus. The new facility operates at a fraction of the cost of the old facility and was designed to maintain a pathogen-free environment for its 60,000 mice inhabitants. Human inhabitants also enjoy excellent indoor air quality and cost-effective heating, cooling, and water supply.

Affordable Sustainability

Today ORNL’s 4,200 staff can take pride in a modern and attractive campus characterized by the practical application of technologies developed by their coworkers at the laboratory. Their pride comes with the knowledge that the 1–2% premium for the construction cost is returned over time through the conservation of resources and the improvement of air and water quality. Conserving energy, protecting the environment, and managing natural resources are at the heart of ORNL’s research mission and are the beacon for building a sustainable campus for the next generation of great science.
ADDITIONAL INFORMATION

Oak Ridge National Laboratory,
http://www.ornl.gov/

Energy Star,
http://www.energystar.gov/

LEED (Leadership in Energy and Environmental Design),
http://www.usgbc.org/

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