Annual Sustainability Report

2023

OAK RIDGE National Laboratory

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Oak Ridge National Laboratory Annual Sustainability Report

Sustainable ORNL Program

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OAK RIDGE NATIONAL LABORATORY

Solving Big Problems

Oak Ridge National Laboratory (ORNL) delivers scientific discoveries and technical breakthroughs needed to realize solutions in energy and national security and provide economic benefit to the nation. ORNL addresses national needs through impactful research and world-leading research centers. A wide range of partnerships with other US Department of Energy (DOE) laboratories and programs, universities, and industry pairs ORNL's strengths with others for outstanding contributions to science.

Conducting R&D with Impact

ORNL researchers apply unique facilities, sophisticated tools, and signature strengths in neutron science, high-performance computing, advanced materials, biology and environmental science, nuclear science and engineering, isotopes, and national security research to benefit science and society, making it possible to

- Advance understanding, design, and use of new materials and chemical processes
- Reveal unmatched insights through computing and data
- Ensure safe, clean nuclear power and secure nuclear materials
- Produce rare isotopes for medicine, industry, security, research, and space exploration
- Increase and exploit understanding of biological and environmental systems from genes to ecosystems

6,000+
Staff, representing 75+ countries

$2.7B
Funding by DOE mission

2,600+
Guest researchers annually

#1
World's fastest supercomputer

"For 80 years, ORNL has stewarded the most unique facilities in the world. Today, we are focused on achieving sustainable operations of these leading capabilities, which will ensure we can continue meeting national priorities for years to come."

—*Interim Laboratory Director* **Jeff Smith**

Oak Ridge Snapshot and Sustainability Reporting

LIFE AT OAK RIDGE NATIONAL LABORATORY

ORNL was established in 1943 during the Manhattan Project and, for nearly 80 years, has been a leader in science and energy research. Today, as America's largest science and energy laboratory, ORNL is a thriving multiprogram research campus with world-leading facilities and 6,000+ talented employees from over 75 countries who are innovators in their fields.

ORNL staff have innumerable opportunities to collaborate on cutting-edge scientific, operational, engineering, and support activities. In addition, ORNL offers professional development training at no cost to employees, supports numerous employee resource groups that promote diversity and inclusion efforts across the Laboratory, and provides networking opportunities.

Located near the Great Smoky Mountains of Tennessee, ORNL's campus is just 1 hour away from the nation's most visited national park. Within a day's drive of most major cities on the US East Coast, ORNL provides the best of both worlds: proximity to the great outdoors and growing urban centers with diverse cultural attractions. The city of Oak Ridge has 150 miles of shoreline for water recreation, rowing, and boating. Nearby Knoxville is home to the thriving research campus of the University of Tennessee and a historic downtown known for its dining, theaters, shopping, and cultural and music festivals.

In addition, East Tennessee is affordable, with a cost of living 8% lower than the national average* and no state income tax. It is one of the safest areas in the United States and has excellent school systems. The Oak Ridge Schools system is one of the highest performing school districts in Tennessee and maintains various STEM certifications. Learn More: www.ornl.gov/who-we-are. Oak Ridge National Laboratory is managed by UT-Battelle LLC for the US Department of Energy. ORNL is an equal opportunity employer.

* According to data provided by erieri.com on 1/1/2022

What is Sustainability Reporting?

A sustainability report is an annual document published by a company or organization about the **economic, environmental,** and **social impacts** that result from its everyday activities. A sustainability report also presents the organization's values and governance model and demonstrates the link between its strategy and its commitment to a sustainable economy. Sustainability reporting enables organizations to consider their effects on a wide range of sustainability issues, enabling them to be more transparent about the risks and opportunities they face. GRI (Global Reporting Initiative) is an independent, international organization that helps businesses and other organizations take responsibility for their impacts by providing them with the global common language to communicate those impacts.
Learn more at https://www.globalreporting.org.

Sustainable ORNL and Our Commitment to Sustainable Operations

ORNL, managed under contract by UT-Battelle LLC, is DOE's largest science and energy laboratory and, as such, executes the widest range of mission capabilities. Diverse expertise spans a broad range of scientific and engineering disciplines, enabling research and science achievements to accelerate the delivery of solutions to the marketplace. ORNL supports DOE's national missions of scientific discovery, clean energy, and security. To execute these activities, ORNL has grown significantly over 80 years of continuous operations, consisting of facilities with commissioning dates ranging from the 1940s to the present—an extraordinary set of distinctive scientific facilities and equipment. The complexities of such a variety of facilities require teamwork among divisions, a wide variety of conservation projects, and creative strategies to achieve the desired energy and water savings. Such a diverse and unique set of major facilities, totaling over 5.5 million square feet, with 6,000 employees, requires an innovative plan to accomplish advancements in operational efficiencies.

ORNL is tasked with the management of an extraordinary set of distinctive scientific facilities and equipment for DOE. ORNL is mission-driven, and its mission has grown substantially over the decades. ORNL's core research capabilities provide broad science and technology support for DOE in the areas of energy, environment, and national security. Currently, ORNL is a world leader in materials, neutron, and nuclear science and engineering, and in high-performance computing and data analytics. ORNL's vast portfolio of research facilities must be maintained and carefully upgraded to protect the nation's investment in scientific analysis. The goal of sustainable and resilient operations is to enable more effective execution of ORNL's science and technology mission. Sustainable operational practices and enhanced resilience strive for excellent results while remaining diligent in energy conservation, environmental stewardship, asset management, and community engagement.

The **Sustainable ORNL Program (Sustainable ORNL)** Continuous improvements in operational and business processes must be integrated into the fabric of the ORNL culture to maximize the return from the investment made in modernizing facilities and equipment. The Sustainable ORNL program promotes the legacy of system-wide best practices, management commitment, and employee engagement that will lead ORNL into a future of efficient, resilient, and sustainable operations. ORNL leadership and Sustainable ORNL champions receive regular status reports on the progress of each project and focus area (i.e., roadmap) and periodic summary reports. More information can be found at the program's website.

The Sustainable ORNL roadmap structure endorses 15 vital roadmaps. The figure below summarizes the current project assignments and demonstrates that each project contributes to the wellbeing of the whole. Continuous employee engagement and regular status reports confirm the ideals of the program.

The roadmap structure is not static; as the science mission advances and the needs of the organization evolve, the Sustainable ORNL roadmap structure elements are modified to align with developing priorities. In 2022, Sustainable ORNL made roadmap changes to better align ORNL to support new federal requirements that have been issued.

ORNL's Impact on the Local Economy and Our Communities

The primary mission of ORNL is to deliver scientific discoveries and technical breakthroughs to help solve the world's most compelling challenges, and ORNL has an additional important mission—ensuring that communities thrive, and educational initiatives succeed in East Tennessee and around the world.

Doing Well by Inspiring Good

The value ORNL and our employees bring to communities is only as good as our collective commitment to helping those communities thrive. ORNL supports economic development in East Tennessee; leads science, technology, engineering, and math (STEM) education initiatives; and encourages employees to donate their time to nonprofit organizations. ORNL focuses on a strategy that spurs civic vitality and commerce, sparks a passion for learning, and supports a broad definition of giving that employees find meaningful and gratifying.

Corporate Giving

Corporate giving is the financial and in-kind support that ORNL, through its prime contractor UT-Battelle LLC, provides to nonprofits, foundations, community groups, and educational institutions to deliver value and social impact. Keeping in mind that larger gifts to fewer organizations can lead to greater impact, ORNL has identified a handful of organizations that support altruistic programs connected to ORNL's mission such as STEM education, public awareness, civic/cultural programs, and economic development.

Employee Giving

The power to bring positive, measurable change to communities through workforce programs that incorporate volunteering, financial giving, and in-kind support is at the heart of ORNL Gives, ORNL's employee giving program. We encourage our employees to be actively connected with nonprofits that mean the most to them. For their efforts, we match donations and support participation in a variety of ways because giving back means more than just writing a check.

During an April 2023 volunteer weekend, dozens of ORNL employees raised funds and volunteered their time to further sustainable operations at one of the areas more beloved charities. On the weekend of April 14–16, a team of ORNL staff from eight directorates gathered to perform the much-needed replacement of the drop ceiling at the Love Kitchen in East Knoxville. More than 30 people performed approximately 200 volunteer hours to replace 330 tiles. This was made possible after an intense fundraising effort (to purchase needed supplies) organized by the Energy Science and Technology Directorate.

K-12 STEM Education and Outreach

ORNL reaches thousands of students and educators every year with the goal of enhancing awareness and encouraging interest in STEM careers. This goal is accomplished through ORNL grants, virtual classroom support, and other educational connections in the science disciplines. For more information, visit **https://education.ornl.gov/**

STEM outreach is vital to the nation's development of future scientists, engineers, and innovators. ORNL is committed to serving the public as a valued partner in educational initiatives to promote and expand STEM experiences for the next generation. ORNL offers students, educators, and community members a variety of learning opportunities that correspond to the laboratory's distinct areas of scientific research. Educational outreach efforts are aligned to engage students today with the workforce needs of tomorrow.

School and Community Events

ORNL proudly partners with many schools and community groups in the surrounding area in a variety of events, including school STEM nights, science fairs, career fairs, and teacher professional development. Hands-on activities and demonstrations allow students and community members to gain an understanding of the concepts that fuel scientific research. Employee volunteers visit regional schools for events such as Scientist in the Classroom, Hour of Code, and National Engineers Week. In 2022, employee volunteers shared their passion for science with over 6,000 students at school and community events.

I take great pride in the volunteer efforts of our employees. They have participated in projects like Habitat for Humanity's Brush with Kindness that resulted in the installation of a new HVAC unit for a disadvantaged citizen in Harriman. They also raised funds and provided the "people power" to redo the drop ceiling at the Love Kitchen in Knoxville. These are just two of several examples involving ORNL staff at all levels, especially our skilled craftworkers who supply the expertise. I'm proud to say our employees are an inspiration to many in their dedication to making our community a better place.

—Jimmy Stone

Federal Leadership in Resilient Operations and Climate Response

The federal government, DOE, and ORNL recognize the need to protect the vast investments in federal facilities and infrastructure, to promote sustainable operations, and improve organizational resilience to climate and weather events. In 2021, Executive Order 14008, Tackling the Climate Crisis at Home and Abroad, established broad strategies calling for federal agencies to take the lead in confronting the climate crisis, engage in the formation of a net-zero economy, and enhance operational resilience at federal facilities. To respond to federal and DOE priorities, ORNL is engaged in a comprehensive crosscutting process to enhance climate mitigation efforts. The Sustainable ORNL program established a new Operational Resilience Roadmap to support the Vulnerability Assessment and Resilience Plan (VARP) development process.

In 2022, the Sustainable ORNL program also made efforts to better align the Sustainable ORNL Roadmap structure with DOE principles. Net-zero initiatives do not operate in isolation; rather, they work in conjunction with other priorities to reach a number of agency objectives. Throughout ORNL, projects are evaluated on several sustainability priorities, including energy and water savings (and associated cost savings) from energy conservation measures, net-zero initiatives, and operational resilience. ORNL has an opportunity and a responsibility to lead by example and integrate climate and sustainability into all aspects of its operations. The newly established carbon-free electricity and net-zero goals are crosscutting for all roadmap owners, and the Greenhouse Gas Management and Renewable Energy Roadmaps will capture advancements toward ORNL's holistic approach in achieving these goals.

2022 was a year of increased attention to climate vulnerability and developing solutions to climate challenges and other operational vulnerabilities in federal facilities. With DOE initiatives and increased support from the Office of Science, ORNL is developing updated assessments and planning documents designed for integration into other lab planning processes. Following the release of DOE's VARP guidance and associated timelines, ORNL established a core team to develop a site-specific plan to meet VARP requirements. ORNL's VARP reporting team members participated in training and workshops offered by DOE to employ the new guidance and collective resources to improve vulnerability planning efforts. The VARP team is also part of a self-initiated working group with the other DOE sites in Oak Ridge, Tennessee. Because ORNL is in close geographic proximity these sites, this working group was especially helpful with deliberations concerning the numerous resources suggested by DOE for climate change projections and historical weather event data for the Oak Ridge area. Through collaboration with the working group and use of recommended climate data sources, the following key determinations were made regarding ORNL's climate hazards:

- ORNL is located in a very low-risk area relative to the rest of the United States. Tennessee has seen temperatures rise by 0.5°F since the beginning of the twentieth century compared with the 1.8°F for the United States as a whole. Furthermore, the lab's geographical position (narrow valleys between linear and partitioned ridges) offers separation from and natural protection against environmental hazards.
- However, historically unprecedented warming is projected during this century with temperatures rising as much as 11°F for higher emissions projections. Heat waves are expected to increase in frequency and intensity, leading to more intense droughts, as well.
- Although it is not certain that precipitation events will increase in frequency, they will likely be more intense, which will increase the likelihood of flooding in a region that already experiences challenges from abundant precipitation.

The ORNL VARP is centered on mission-essential facilities and utility infrastructure to ensure that the physical assets will be prepared to demonstrate a high degree of resilience in response to climate change. Operations stakeholders including building engineers, utility engineers and experts, and their management were included in the broader VARP team. Division- and directorate-level leadership in operations provided general direction and support for VARP team activities. Stakeholders provided input to complete the VARP Risk Assessment Tool, which is used to identify the climate vulnerabilities of ORNL's evaluated assets. A portfolio of solutions to address these factors was created and included projects from other lab infrastructure enhancement efforts. With funding from DOE and the Office of Science, ORNL has launched a critical infrastructure modernization program (CIMP). Currently in the planning stages, CIMP is a major effort to upgrade and improve conditions, utilization, mission readiness, and resilience of the facilities and infrastructure that are most critical to mission success and includes upgrades to and/or replacement of water and sewer systems, stormwater, chilled water, steam, electrical, natural gas, compressed air, and telecommunications. CIMP subtasks set to mitigate climate vulnerabilities were added to the portfolio of solutions and will be tracked by the VARP team through communications with the project manager and ORNL's Utilities Division. In recognition of the important goal of addressing operational and climate resiliency on critical missions and operations, ORNL leadership is onboard to ensure that continued collaboration and focus on this topic is maintained. Clear communications and timely responsiveness will be required as this initiative is built upon and improved annually going forward.

Greenhouse Gas Management and a Path Toward Carbon Free Electricity

The sources of greenhouse gas (GHG) emissions at ORNL and the inventory for 2022 are detailed here. After 2 years of curtailed emissions owing to COVID-19 pandemic protocols, GHG emissions are expected to increase in the next 2 years as ORNL establishes a new normal. The science mission at ORNL is growing, and because federal accounting guidance allows no GHG emissions exceptions or exclusions, regardless of mission, emissions are expected to increase in the near term. Federal priorities should work together to provide significant reductions in GHG emissions by 2030, per DOE and other federal programs and initiatives.

By far, the most significant component of GHG emissions is the production and delivery factors associated with electrical power production, netting 71% of ORNL emissions in 2022. As net-zero strategies are positioned by the power plants, more efficient and cleaner energy sources will be used for electricity and as correlated emissions are updated, favorable impacts will develop. In January 2023, a new set of electricity grid factors was released by the US Environmental Protection Agency. Over the past 15 years, GHG emission factors from electricity have shown slow but steady improvements, but the rate of progress is expected to accelerate as carbon-free electricity and net-zero strategies are deployed nationwide by electricity producers. In the coming year, ORNL will explore the possibility of reporting carbon sequestration that occurs on the Oak Ridge Reservation's (ORR's) 25,000 acres of unimproved land. Historically, 40% of the reservation, or 10,000 acres, is attributable to ORNL.

As part of the current lab agenda, an objective was defined to develop a strategy for a net-zero emissions ORNL campus. ORNL now has an opportunity to analyze potential solutions for significantly reducing GHG emissions over the near to long term. Such analysis would also consider measures of economic impact and specifications of factors underlying economic impact (e.g., changes at the lab required to reach net-zero that could affect equipment, personnel, and so on). Although ORNL has already taken early steps to identify possible solutions for emissions reduction, such as in the area of direct discussions with our electricity provider, Tennessee Valley Authority (TVA), the portfolio of potential solutions can be made more comprehensive—including articulations of cost and value for each. ORNL's net-zero carbon emissions campus efforts will include approaches that demonstrate a variety of technologies such as electrical storage, carbon capture, integration of renewables, transition to an all-electric vehicle fleet, and efficiencies gained through infrastructure modernization that reduce or eliminate carbon emissions. Carbon capture research will be conducted in a phased manner, developing prototype technologies, with potential implementation planned across the campus. Disposition of captured carbon will also be evaluated for potential reuse, conversion to fuel, or disposal.

To further ORNL's progress toward net-zero emissions, UT-Battelle has established a memorandum of understanding with TVA focused on decarbonization technologies. Activities considered include the following:

- Point source and direct air carbon capture
- Carbon utilization for a circular economy
- Hydrogen generation and utilization
- Electric vehicle charging and vehicle-to-grid interaction applications
- Light water small modular reactors and fourth-generation advanced nuclear reactors
- Long-duration energy storage
- Electrification of parts of the economy that currently depend on fossil fuel (such as steam from natural gas boilers)
- Grid resiliency and security

Net-zero emissions campus projects will require programmatic and institutional investments. Conventional energy efficiency projects such as lighting improvements, HVAC upgrades, and temperature setbacks are being investigated and implemented to reduce energy consumption. The more aggressive CIMP project will contribute to progress in net-zero strategies, enhance sustainable operations, improve operational resilience, and reduce GHG emissions. In addition to these efforts, deployment of new nuclear generation will help ORNL to reach net-zero emissions. TVA has approved up to $200 million to prepare for the potential construction of a small modular reactor at its Nuclear Regulatory Commission–licensed site in Oak Ridge, which when operational, could provide carbon-free electricity for the entire reservation and the region at large.

Fleet Updates/ Transportation Research

TRANSPORTATION RESEARCH PROGRAM

ORNL has a robust transportation research program. Focus areas include important topics such as battery technology and manufacturing, advanced wireless charging research, electric powertrains, connected and autonomous vehicles, alternative biofuels, transportation planning, and lightweight materials, to name a few. Additional programs are aimed at identifying net-zero fuel solutions for the difficult-to-decarbonize rail, marine, and mining sectors.

Did you know that the National Transportation Research Center (NTRC) is located at ORNL's Hardin Valley Campus in West Knoxville? NTRC is another example of ORNL's commitment to bring sustainable community development to the area. NTRC is the only DOE designated user facility focused on performing early-stage research and development in transportation technologies. This unique designation is a key to bringing research partners to East Tennessee. https://www.ornl.gov/facility/ntrc

ORNL Sustainable Transportation Fleet Vehicle Pooling Program

A developing vehicle pooling program will have approximately 100 fleet vehicles in 10 to 12 pooling locations across the ORNL campus. The initial goal of the program is to optimize vehicle utilization, make vehicles more readily accessible, and have the expectation of reducing our fleet size overall. By consolidating government vehicle parking spaces to the pooling locations, ORNL is preparing for future installation of electric vehicle charging stations. With these changes, we will help lower fuel consumption, costs, and GHG emissions. In addition to the passenger carrying vehicles, we are currently reviewing all available Electrified Low Speed Vehicles and support equipment to again transition from fossil fuels to low carbon electricity.

Collaboration with the University of Tennessee and Pellissippi State Community College

ORNL has resumed a partnership with the University of Tennessee and Pellissippi State Community College to provide a bus service for transportation to and from the campuses of the three organizations. The bus service began as a means to assist students with transportation to ORNL during summer internships. The program was highly successful, with an average daily ridership of more than 30 people and has now been expanded to year-round operation with additional stops at ORNL's Hardin Valley Campus and the Spallation Neutron Source. This service provides opportunities for students to gain experience working at ORNL who might otherwise not be able to participate. Furthermore, the service reduces traffic congestion and carbon emissions associated with vehicles travelling to and from ORNL.

Showcase Project Highlights and Reducing our Carbon Footprint

Each year, the Sustainable ORNL Program provides funding to support proposed showcase projects that focus on creative measures that can advance our sustainability efforts. Typically, the program has funded one project each year, but in 2023, many excellent projects were proposed, and the program invested in three projects. Lab leadership allocated three times more funding than in the past to support projects and research focused on decarbonizing the ORNL campus and improving energy efficiency. The projects are closely aligned with at least one of the Sustainable ORNL roadmaps, and preference is put on those that crosscut multiple roadmaps. In total, 14 proposals were received, indicating that staff are highly engaged with sustainability goals. Lab leadership also prioritized 3 additional operations projects for funding to accelerate progress towards a decarbonized campus.

Sustainable ORNL 2023 Showcase Projects

"Pilot living laboratory demonstration on personalized heating & cooling management for grid-interactive efficient buildings"

This project aims to deliver a low-cost, scalable, interoperable, and occupant-centric load management system that enables small and medium-sized office buildings without Building Automation System (BAS) to easily manage building loads in a supervisory manner for energy-efficient and emission-aware operations. The resulting building performance enhancement will significantly improve ORNL's annual performance assessment in facility management and maintenance. The underlying efforts will greatly advance the establishment of a living laboratory for sustainable campus operations.

Monitoring and replacement of failing 250-gallon natural gas water heater with heat pump water heater for demonstration and quantification of CO2 and energy savings
This project will replace one of the natural gas water heaters at the Spallation Neutron Source with a heat-pump water heater. The project will provide data to quantify the greenhouse gas reductions and operational information to allow similar deployments at other buildings on the ORNL campus. Electrification of gas-fired equipment such as water heaters will help ORNL reduce Scope 1 emissions and reduce energy use to control costs as the electric grid moves towards decarbonization.

5600-5700-5800 Complex Sustainability and Decarbonization using Waste Heat Recovery from Oak Ridge Leadership Computing Facility's High Performance Computing Data Center"

ORNL's supercomputers enable ground-breaking scientific investigation but produce large amounts of waste heat that is currently rejected to the environment through cooling towers. Capturing this waste heat is challenging but offers the potential to significantly offset energy purchases associated with building heating. This project will investigate opportunities for emerging medium temperature heat pumps to be used as a means of capturing and re-using the waste heat from ORNL's computational facilities to reduce carbon emissions associated with purchased electricity.

2023 Projects to Accelerate GHG Reductions

Utilities/LMD Feasibility Assessment of Migrating a Fuel Oil Boiler to Electric Boiler at EGCR Building 7601
EGCR is a facility on the ORNL campus that is served by a fuel oil fired boiler because of its remote location relative to the central steam system. Replacing this boiler with an electric boiler will remove a direct Scope 1 emission from two ORNL buildings, and thus, this project will move ORNL toward the goal of having a net zero campus by 2050.

Fleet Vehicle Pooling Program as First Step Toward Electric Vehicles
Fleet vehicle pooling reduces the number of vehicles assigned to individuals and groups at ORNL and instead places the vehicles in 10-12 centralized locations. Pooling will enable better vehicle utilization and reduction in the size of the ORNL fleet. Pooling is also a first step towards installation of electric vehicle charging infrastructure to support the fleet. This project enables purchase of the necessary hardware and software to accomplish vehicle pooling on campus.

Upgrading lighting fixtures to LED light fixtures in facilities across ORNL
Each year ORNL upgrades light fixtures to more-efficient LED lights as older fixtures require replacement, but ORNL's large campus has a lot of lights! These upgrades reduce ORNL's energy use and carbon emissions associated with electricity generation. This year, ORNL's leadership devoted additional funds to accelerate replacement of older, less-efficient lights across the campus. This project helps reduce ORNL's electricity use and the associated carbon emissions.

Energy and Water Management, Fault Detection and Diagnostics

At ORNL, Energy Management begins with comprehensive understanding through ongoing monitoring and assessments of all energy and water consumption. The site utility services include electrical power, natural gas, fuel oil, steam, chilled water, and potable and process water to support ORNL's mission and research programs. Electrical services include basic power needs, as well as chilled water service and direct cooling applications. Steam and hot water are generated on-site from a combination of natural gas and fuel oil. Natural gas is also used in direct heating applications and research activities. Potable water use supports mission-critical process applications, as well as domestic water use, including restrooms and drinking water. The continued knowledge gained from the analysis of past and current energy consumption will better position ORNL to develop plans for improved energy efficiency and GHG reduction in facility operations. To maintain steady progress toward reductions in energy use intensity, we focus on energy-efficient and sustainable design in new construction projects, as well as smart repurposing of existing facilities and a drive for continuous improvement in facility and utility operations.

The ORNL Facilities Management Division (FMD) successfully attained DOE's 50001 Ready recertification in 2020 and 2021. FMD first received certification in 2019, and at the time of initial certification, ORNL was the third federal location and only the second national laboratory to receive the designation. The certification covers more than 2.5 million square feet in 65 FMD buildings that are equipped with advanced metering. FMD's Energy Efficiency and Sustainability Program (EESP) led the certification effort, and contributions and support from many other divisions were necessary for the achievement of the project goals. DOE 50001 Ready has provided a structure and documentation strategy that identifies areas for improvements while also tracking growth each year as the program progresses. DOE's Better Buildings' website provides more details about 50001 Ready and the ORNL FMD certification case study.

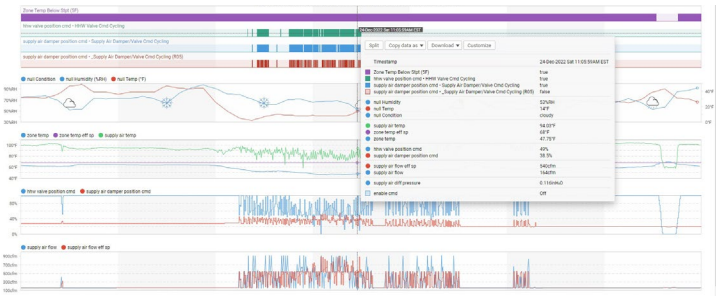
ORNL's 2022 calculated energy use intensity was 234,194 Btu/GSF, which is a cumulative reduction of 35.6% since the baseline year of 2003. ORNL's efforts toward reducing its energy use intensity have resulted in considerable progress by targeting readily applied efficiency & conservation measures in existing buildings. As these types of opportunities become less prevalent, we continue to shift our focus to a deeper level, leveraging the cooperation of data and operations staff to find new, innovative energy savings potential. ORNL will also use DOE 50001 Ready's process for identifying buildings that are significant energy users as a strategy to implement energy conservation measures. ORNL also continues to build a foundation of awareness to integrate energy efficiency as a key consideration in daily operations and decision-making processes, including considerations of energy & water efficiency and life cycle cost benefits.

A Building Control Tool Designed to Move the Needle on Energy Performance at ORNL

As we continue to leverage the power of energy data from existing equipment and metering systems, EESP has implemented Fault Detection & Diagnostics (FDD) as an energy management process for monitoring operational controls in qualifying buildings with significant energy usage. FMD chose SkySpark, created by SkyFoundry, as the platform for FDD integration throughout the campus. The platform pulls control information from the Johnson Control's Metasys system and uses customized fault detection to continuously detect and report operational, equipment, system, energy, and comfort faults that may occur in ORNL buildings. Faults and key performance indicators are in place to identify opportunities for improved performance and energy savings.

EESP energy engineers and members of FMD's Campus Support Complex are leading the effort of integrating SkySpark FDD into the energy performance process at ORNL. A 2021 pilot program was expanded and now includes 15 buildings and more than 1.5 million gross square feet with the connection of over 32,000 data points.

Programmable analytical tools like SkySpark provide flexibility, enabling experienced engineers to implement rules based on institutional knowledge and experience with their specific equipment. The customized rules are not limited to the algorithms and software provided by the equipment manufacturer. This FDD system uses 15-minute interval data for early detection alerts, identifying potential operational issues in a timely manner. SkySpark is highly configurable and allows for easy visibility and downloading of trending control information.



Facility Metering: Quality Data is the Key to Data-Driven Performance

Over the past 10+ years, ORNL has implemented and improved upon an extensive site-wide metering plan that includes all utilities on the campus. The metering plan is a comprehensive document that charts a course for ORNL's continued advanced metering deployment, which is consistent with federal metering guidance and with current DOE directives focused on advanced utility metering where cost-effective and appropriate. The metering plan considers variables such as square footage, space use design, and energy consumption estimates (current and future). The metering platform is continuously updated to document progress that has been made and to note any shift in priorities.

In 2022, ORNL installed 75 additional advanced utility meters across all utilities, including electrical, steam, chilled water, natural gas, and potable water. We also migrated seven new data streams from other systems across the lab and replaced six existing meters. The meters were connected to the ORNL Central Energy Data System (CEDS) to ensure quality energy performance data. CEDS can record multiple parameters from each meter on a standard 15-minute interval. This system also enables meter data trend analysis, report generation, and energy awareness dashboard deployment, as well as data export for use in other analyses.

To enhance data-driven decisions, we have deployed a new module for the CEDS system, Resource Advisor (RA), to enhance data archiving and decision analysis. ORNL utility and energy engineers use RA's advanced configuration capabilities to easily calculate and quickly display total building energy consumption using data from the advanced utility meters. RA provides comprehensive dashboard and energy analysis capabilities that align with ORNL's continued maturation in energy data collection and analysis. The RA system directly feeds metered energy data into the US Environmental Protection Agency's ENERGY STAR Portfolio Manager for benchmarking and measuring and recording performance for federal reporting.

Intelligent Building Analytics

One of the Sustainable ORNL roadmaps of increasing significance communicates the growth of intelligent building analytics as a system to advance energy efficiency and water use improvements on the campus. We are engaged in continuous efforts to expand the RA platform for energy and demand data management utility sources and estimated building-level energy consumption. This expansion allows for sequencing of operations data collection and improves visibility of data, leading to better real-time decisions and actions. As the system expands, more opportunities become apparent to actively engage field engineers in using meter alerts diagnosing operational issues. ORNL continues to find and document success with meter alert implementation for detecting operational issues such as stuck flush valves and heating valves that fail to open. As ORNL's CEDS, RA, and building automation systems continue to grow in size and operational significance, we are building capabilities for data quality, reporting, and configuration management. Furthermore, ORNL is expanding efforts to prioritize cybersecurity by building a more secure industrial controls system network. This purpose-built network utilizes security measures specific to the sensitivity of facility and energy management systems. The new network ensures that system reliability and data will be protected for years to come.

We recognize a winning resource!

In 2022, Sustainable ORNL nominated Glenn Cross, the CEDS administrator, for the **DOE Sustainability Champion Award**, and he won with accolades. Glenn holds a key leadership role for CEDS management, which supports the submittal of the annual Site Sustainability Plan and other DOE deliverables, all of which are data driven. Glenn was on the lead application team for implementing CEDS at ORNL. He was the CEDS system architect and originator, and he currently serves as the system administrator and manager.

Glenn's talents in systems efficiency were integral in complying with advanced directives, including the need for networking of smart meters in key facilities to a scalable and sustainable energy data system, which became known as CEDS. Glenn was the primary resource employed to stand up this system; he led the technology effort to develop system requirements and specifications, evaluated vendors, and procured software and services to deliver the new system to ORNL. To maximize impact, the system delivered meter management tools, supervisory controls, and visualization, trending, and reporting capabilities to automate energy data.

CEDS continues to be supported by Glenn's perseverance and capabilities, and it remains the backbone of ORNL's energy management efforts. He continues to develop his knowledge of emerging technologies while maintaining CEDS and continuously adding new meters and new data sources and capabilities. His efforts include procuring specified meters, overseeing installation, commissioning, and integration into the various systems and modules, and maintaining the vast network of utility meters at DOE's largest multi-program research laboratory. Glenn continues to manage the ever-growing system, improves trending and reporting interfaces, and oversees data streaming to researchers and operations personnel alike.

Ecology and Sustainable Landscaping at ORNL and ORR

ORNL is located within the 32,000-acre ORR, home to major stands of forests, grassland, and aquatic habitats. The ORNL Nature Resource Management Team is tasked with the conservation efforts for the entire ORR, making ORNL uniquely suited for real-world, practical applications for natural resource management in natural and urban settings. The ORNL Landscaping Committee and Sustainable ORNL promote sustainable landscaping practices.

Ecological landscaping at ORNL uses sustainable practices to improve habitats, protect water quality, minimize erosion, and promote native wildlife. Cultivating local plant species highlights the laboratory's uniqueness, strengthens its relationship with its natural surroundings, and demonstrates its dedication to conserving and showcasing the environment. Over the years, ORNL has greatly reduced mowed turf areas by incorporating native plant beds, planting fields of native grasses, and allowing the beauty of the surrounding ORR to provide a more natural backdrop to the campus. Minimizing turf reduces the need for frequent mowing and maintenance and thus reduces fuel consumption, pollution, and emissions associated with mowing. Furthermore, native landscaping is aesthetically appealing and showcases the benefits of sustainable landscaping with indigenous species.

Incorporating Natural Infrastructure Ecosystem Services into Federal Decision Making is an executive memorandum issued to integrate the consideration of ecosystem services benefits into federal decision making. Sustainable landscaping policy at ORNL provides many of the ecosystem services listed in the memorandum, including improved water quality, increased wildlife habitat, enhanced climate resilience, storm mitigation, pollutant buffering, and ecosystem resilience, as well as aesthetic values and recreation. Recent projects have included stream riparian buffer zone enhancement and increased native grassland areas on campus.

The ORNL Natural Resources Management Program provides land management for the entire ORR. Program objectives include providing high-quality, efficient, and proactive stewardship of the ORR natural resources for DOE; providing natural resources expertise to DOE as needed to comply with federal, state, and other requirements; managing the **Oak Ridge National Environmental Research Park** as a national outdoor laboratory resource for science and education; and serving as a model for exemplary natural resources management among DOE sites.

Tasks undertaken to further our objectives include integrated ecosystems management, wildlife management, wildland fire response, forest stewardship, field access and surveillance, land use planning, Aquatic Resource Alteration Permit preparation for areas outside of facility responsibilities, and management, coordination, and communication with the public, contractors, agencies, and stakeholders. The work that ORNL conducts for DOE and ORR was recently highlighted in **The DOE Science News Source**, a Newswise initiative to promote research news from the Office of Science of the DOE to the public and news media. ORNL's 2020 **Earth Day video** showcases ORNL natural resource management on the ORR.

Earth Day/Earth Week at ORNL

For more than a decade, ORNL has celebrated Earth Day by planning and conducting ORNL's Earth Week, which is a full week of activities designed to promote sustainability at ORNL and engage employees in best practices for work, home, and the community. Participation in 2023 was at an all-time high with more than 1,000 employees visiting the Main Event on Main Street or attending one of three lunch and learn seminars, either in person or virtually. For comments or information please contact **toutonln@ornl.gov**

See how several ORNL Research Programs are Tackling the Plastics Crisis

OAK RIDGE National Laboratory

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