

Oak Ridge National Laboratory FY 2024 Site Sustainability Plan With FY 2023 Performance Data Prepared November 2023



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November 2023

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Facilities and Operations Directorate
Facilities Management Division
Sustainable ORNL Program

**OAK RIDGE NATIONAL LABORATORY
FY 2024 SITE SUSTAINABILITY PLAN
WITH FY 2023 PERFORMANCE DATA
PREPARED NOVEMBER 2023**

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November 2023

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Oak Ridge, TN 37831
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**US Department of Energy
Sustainability Performance Office**

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ABBREVIATIONS

AFFECT	Assisting Federal Facilities with Energy Conservation Technologies
AFV	alternative-fuel vehicles
ASER	annual site environmental report
BAS	Building Automation System
C&D	construction and demolition
CEDS	Central Energy Data System
CEM	Certified Energy Manager
CFE	carbon pollution-free electricity
CIMP	Critical Infrastructure Modernization Project
CNMS	Center for Nanophase Materials Sciences
DOE	US Department of Energy
EAC	energy attribute certificate
EAct 20	Energy Act of 2020
ECM	energy conservation measure
EE&S	Energy Efficiency and Sustainability
EFP	Excess Facilities Program
eGRID	Emissions & Generation Resource Integrated Database
EISA	Energy Independence and Security Act of 2007
EO	executive order
EPA	US Environmental Protection Agency
EPAct	Energy Policy Act
EPEAT	Electronic Product Environmental Assessment Tool
ESPC	energy savings performance contract
EUI	energy use intensity
EV	electric vehicle
EVSE	electric vehicle supply equipment
F&O	Facilities and Operations
FAR	federal acquisition regulation
FCA	facility condition assessment
FDD	fault detection and diagnostics
FEMP	Federal Energy Management Program
FIMS	Facilities Information Management System
FMD	Facilities Management Division
FY	fiscal year
G-WH	gas water heater
G/GSF	gallons per gross square foot
GHG	greenhouse gas
GIS	geographic information system
GP	Guiding Principle
GPP	General Plant Project
GSA	General Services Administration
GSF	gross square foot
GWP	global warming potential
HEMSF	high-energy mission-specific facility
HFC	hydrofluorocarbon
HFIR	High Flux Isotope Reactor
HP-WH	heat pump water heater
HPC	high-performance computing

ILA	industrial, landscaping, and agricultural
IT	information technology
JCI	Johnson Controls Inc.
LED	light-emitting diode
LEED	Leadership in Energy and Environmental Design
M&V	measurement and verification
MTHP	medium-temperature heat pump
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
NZEB	net-zero-energy building
ORNL	Oak Ridge National Laboratory
OTC	once-through cooling
PHEV	plug-in hybrid electric vehicles
R&D	research and development
RA	Resource Advisor
REC	renewable energy credit
SA	sustainable acquisition
SC	Office of Science
SF ₆	sulfur hexafluoride
SLI	Science Laboratories Infrastructure Program
SME	subject matter expert
SNS	Spallation Neutron Source
SPO	Sustainability Performance Office
SSP	site sustainability plan
TVA	Tennessee Valley Authority
VARP	vulnerability assessment and resilience plan
WUI	water use intensity
ZEV	zero-emissions vehicle

1. ABOUT THIS REPORT

1.1 ANNUAL DEVELOPMENT OF THE OAK RIDGE NATIONAL LABORATORY SITE SUSTAINABILITY PLAN

At the close of each fiscal year, the US Department of Energy (DOE) Sustainability Performance Office (SPO) issues guidance documents and technical resource aids/tools necessary for DOE sites and national laboratories to complete sustainability reporting requirements. SPO is part of the DOE Office of Asset Management. As required by DOE Order 436.1A, *Departmental Sustainability*, each site develops and commits to an annual site sustainability plan (SSP) that identifies its respective contribution toward meeting DOE's sustainability goals. SPO collects and compiles information reported by each site to develop an agency-wide sustainability report and implementation plan, which is used to report DOE sustainability progress to the federal government as required by all major federal agencies.

DOE launched a formal Sustainability Office and annual SSP process in 2011. Each year, Oak Ridge National Laboratory (ORNL), in concert with the DOE Office of Science (SC), provides the resources essential to fulfill its commitment to deliver a complete and accurate SSP and quality performance data for entry into the DOE Sustainability Dashboard managed by SPO. The performance data entered by each DOE site are then combined to disclose the progress of each DOE program office and are further combined to show comprehensive progress for the agency.

The Office of Asset Management assists program offices in sustaining their missions, freeing up resources by reducing waste, avoiding excess expenditure on utilities, maximizing productivity, and improving the efficiency of facilities and processes. By focusing on mission needs, programs and associated DOE sites can help the agency meet its sustainability goals as outlined in federal statutory and regulatory requirements. In FY 2022, the SSP Guidance/Instructions (US Department of Energy, Sustainability Performance Office) was updated to capture requirements from Executive Order (EO) 14008, *Tackling the Climate Crisis at Home and Abroad*; the Energy Act of 2020 (EAct 20); actions outlined in DOE's *Climate Adaptation and Resilience Plan* and *Sustainability Plan*; and EO 14057, *Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability*. Updates in SSP guidance help to minimize and streamline reporting while simultaneously addressing updated federal requirements.

Per DOE, each SSP should provide an overview of the site's planned actions and of efforts and accomplishments during the reporting period. SPO collects and compiles information reported by each site to develop DOE's *Annual Sustainability Report*, *Climate Adaptation and Resilience Plan*, and *Annual Energy Management Report* to Congress. The agency goal has been to lower the reporting burden for sites and increase and improve the consistency of information available to decision-makers, allowing them to better identify projects and potential for increased efficiency and to reduce waste, lower emissions, and enhance operational resilience. Sites may elect to produce more polished publications for their leadership and stakeholders, but this step is no longer required.

The ORNL SSP narrative report (this document) and the reporting of DOE SPO Sustainability Dashboard performance data is a collaborative effort of approximately 30 subject matter experts (SMEs) from ORNL facility management, mission support, and research divisions. Annually, these associates come together to provide a report that can be used by DOE to demonstrate continued agency progress in energy efficiency and sustainable federal operations.

2. EXECUTIVE SUMMARY

2.1 WHO WE ARE

2.1.1 ORNL Mission

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.

“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.”

—Director’s message, Jeff Smith, interim laboratory director

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 the research and science achievements needed 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 with 80 years of continuous operations; it comprises an extraordinary set of distinctive scientific facilities and equipment with commissioning dates ranging from the 1940s to 2023. 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 ft² with more than 6,000 employees, requires an innovative plan to accomplish advancements in operational efficiencies.

ORNL is tasked with managing an extraordinary set of distinctive scientific facilities and equipment for DOE. ORNL is mission-driven, and its mission has grown significantly 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 (HPC) and data analytics. These systems are further identified within various sections of this report. ORNL’s vast portfolio of research facilities must be maintained and carefully upgraded to protect the country’s investment in scientific analysis. The goal of sustainable operations is to enable more effective execution of ORNL’s science and technology mission. Sustainable operational practices strive for enhanced results while remaining diligent in energy and environmental stewardship.

2.2 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, sustainable operations.¹ 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.

The Sustainable ORNL roadmap structure endorses 15 vital roadmaps. Figure 1 summarizes the current project assignments and was designed to convey that each sustainability area contributes to the well-being

¹ More information is available at the Sustainable ORNL website: <https://www.ornl.gov/sustainable-ornl>.

of the whole. Continuous employee engagement and regular status reports confirm the ideals of the program.

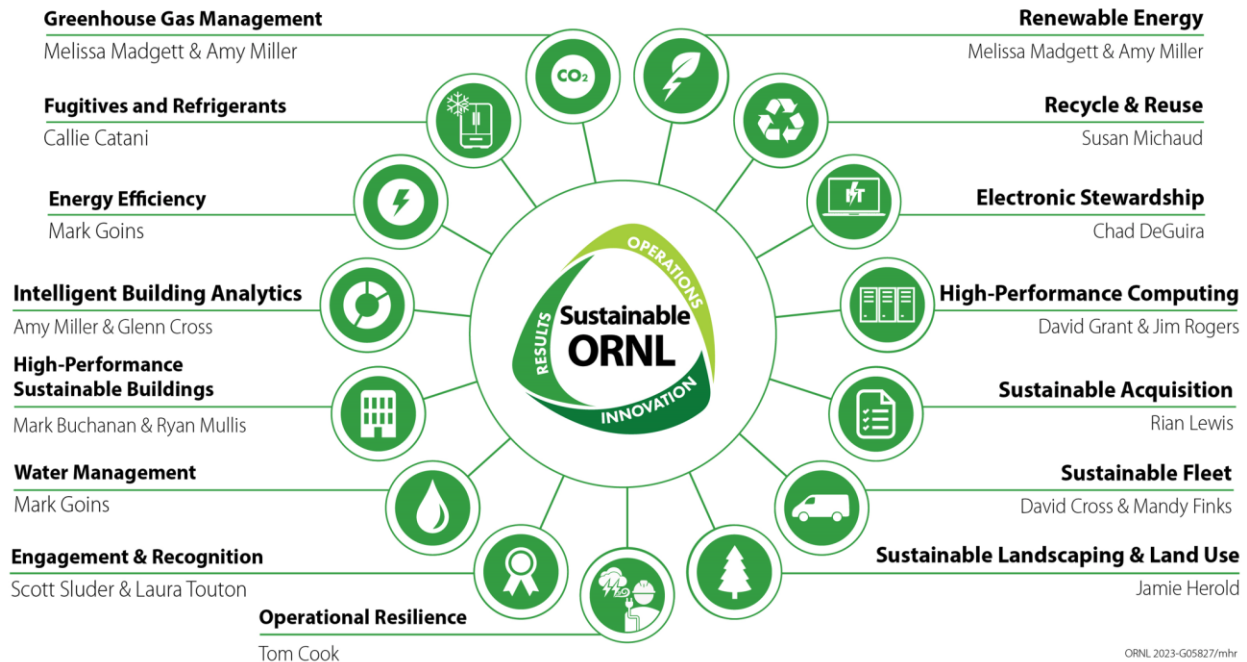


Figure 1. Sustainable ORNL focus areas (roadmaps) and subject matter experts for FY 2023.

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 FY 2022, Sustainable ORNL made roadmap changes leading into FY 2023 to better align ORNL to support the new requirements that have been issued.

In 2021, EO 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 DOE priorities, ORNL requires a comprehensive cross-cutting process to respond to EO 14008 and enhance climate mitigation efforts. The Sustainable ORNL program established a new Operational Resiliency Roadmap (shown in Figure 1) in FY 2022 to support the vulnerability assessment and resilience plan (VARP) that came from EO 14008.

Sustainable ORNL also made efforts to better align the structure with the SSP requirements. In doing so, two new roadmaps were added: (1) Fugitives and Refrigerants and (2) Electronic Stewardship (Figure 1). These additions align most of the roadmaps with supporting the critical topics of the SSP and greenhouse gas (GHG) reporting. The carbon pollution-free electricity (CFE) and net-zero goals are cross-cutting for all roadmap owners, but the Greenhouse Gas Management and Renewable Energy Roadmaps capture ORNL’s holistic approach toward achieving these goals.

Net-zero initiatives do not operate in isolation; rather, they work in conjunction with other priorities to reach several agency objectives. Throughout the ORNL campus, projects are evaluated on several sustainability priorities, including energy and water savings (and cost savings) from energy conservation measures (ECMs), 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.

2.3 ORNL SSP SUMMARY OF GOALS AND PERFORMANCE

Many DOE sustainability goals build on prior successes and strive for additional annual improvements. Table 1 summarizes these goals and related actions and information.

Table 1. Executive Summary of SSP DOE Goals and Statuses

DOE goal	Current performance status	Planned actions and contribution	Overall risk of non-attainment
<i>Energy management</i>			
Reduce energy intensity (British thermal units per gross square foot [GSF]) in goal-subject buildings by 50% by the end of FY 2030.	ORNL’s FY 2023 calculated energy use intensity (EUI) is 237,514 Btu/GSF. This is a cumulative reduction of 34.7% since FY 2003, a reduction of 1.43% from the FY 2021 baseline, but an increase of 1.41% from FY 2022. ORNL continues to improve identification of energy-consuming facilities as the mission expands.	Continued EUI reduction for goal-subject facilities is seen as attainable by concentrating on the best mix of ECM projects for energy savings and by incorporating net-zero strategies into all levels of lab planning efforts.	High
Achieve a net-zero emissions building portfolio by 2045 through building electrification and other efforts.	ORNL is currently looking into buildings that have dedicated boilers (not associated with the ORNL steam plant) to remove from fuel oil. There is a mini-campus that would be made all electric if a project is pursued to remove the fuel oil-powered boiler to electric-power boiler.	ORNL is looking into the possibility to conduct an electrification study for the campus in the future.	High
EISA Section 432 continuous (4-year cycle) energy and water evaluations.	In FY 2023, ORNL started the third year of the 4-year energy audit cycle by conducting 22 building audits throughout the year to cover a quarter of the buildings that are qualified for audit inclusion.	ORNL will continue the current 4-year cycle of auditing and assessments to align with work priorities. In FY 2024, ORNL will start the final year of the 4-year energy audit cycle.	Low
Meter individual buildings for electricity, natural gas, steam, and water to adhere to Federal metering guidance.	In FY 2023, ORNL added 23 new advanced utility meters (including computational metering and electrical utility distribution metering), migrated 1 new data stream from other systems across the lab, and replaced 3 meters. ORNL meter installations include electrical, steam/hot water, natural gas, chilled water, and potable water.	ORNL will continue to use the metering-tracking process and plan for guidance in installation of additional advanced utility meters on all utilities per the new federal metering guidance.	Medium Cost, installation connections, and configurations combine to create a challenging task for meter installations.

DOE goal	Current performance status	Planned actions and contribution	Overall risk of non-attainment
Water management			
Reduce potable water use intensity (Gal per gross square foot).	Annual water consumption resulted in a WUI of 148.2 G/GSF in FY 2023, which is an increase of 8.7% from FY 2022, missing the 0.5% reduction goal compared to the previous year. Continued improvements in the identification of water-consuming facilities yielded a 1% decrease in GSF in support of the WUI calculation.	ORNL's WUI is subject to rise because of increased demands for cooling tower makeup water to support growth of HPC systems. With continued modernization activities that include the elimination of old facilities and the addition of new facilities, ORNL will consider more water-efficient systems and maintain a focus on water management best practices to meet future WUI reduction goals.	High Without exclusions, the potential to meet WUI goals is not obtainable for DOE sites with critical mission growth.
Reduce non-potable freshwater consumption (Gal) for industrial, landscaping, and agricultural (ILA).	N.A. No ILA usage at ORNL.	No change expected.	N.A.
Waste management			
Reduce non-hazardous solid waste sent to treatment and disposal facilities.	In FY 2023, ORNL's diversion rate for municipal solid waste reached 65.7%.	ORNL will continue to identify source reduction opportunities.	Medium
Reduce construction and demolition (C&D) materials and debris sent to treatment and disposal facilities.	In FY 2023, ORNL's C&D diversion rate for waste building materials and deactivation and decommissioning debris is 94.1%.	ORNL will continue to employ terms and conditions within construction contracts to manage construction waste and recycling. C&D recycle rates will vary as the proper characterization of debris dictates.	Medium
Fleet management			
Reduce petroleum consumption.	ORNL continues to optimize utilization, purchase vehicles with improved fuel economy and electric vehicle (EV) options when available, and purchase vehicles with anti-idling technology.	ORNL will launch a passenger-carrying vehicle-pooling project, encourage using the ORNL taxi service, and continue replacing vehicles with improved fuel economy vehicles.	Low
Increase alternative fuel consumption.	80% of all ORNL vehicles are alternative-fuel vehicles (AFVs), with 88% of all replacements since FY 2020 being alternative fuel or EVs. Also, 93% of light-duty vehicles operate on alternative fuels.	ORNL will continue to purchase AFVs and limit accessibility for non-alternative fuel at ORNL gas pumps.	Low

DOE goal	Current performance status	Planned actions and contribution	Overall risk of non-attainment
Achieve 100 percent zero-emission vehicle acquisitions by 2035, including 100 percent zero emission light-duty vehicle acquisitions by 2027.	ORNL is currently meeting the AFV requirement. If an AFV or EV has been available and meets mission requirements, it has been purchased or leased during the replacement process.	ORNL will continue the effort of replacing vehicles with any AFVs or EVs if available and meet the mission requirements.	Low
Clean & renewable energy			
Achieve 100 percent carbon pollution-free electricity on a net annual basis by 2030, including 50 percent 24/7 carbon pollution-free electricity.	ORNL purchased 48,400 MWh renewable energy credits (RECs) to supplement on-site renewable energy generation. These RECs represent 8.6% of the lab's electrical energy consumption, exceeding the 7.5% statutory requirement. Tennessee Valley Authority's (TVA's) specific percentage CFE with the 7.5% REC equivalent results in 58.5% CFE.	ORNL will remain compliant with the Energy Policy Act (EPA) of 2005 7.5% renewable electric energy requirement via REC purchases. ORNL will continue to explore innovative renewable energy projects. REC purchases will reflect significant mission growth in the near future but will transition to energy attribute certificates (EACs) as ORNL works toward CFE requirements. ORNL will continue to consider TVA's specific percentage CFE to better reflect grid-provided CFE.	Medium The numbers of RECs/EACs to purchase will increase with mission growth. REC/EAC pricing may become volatile and create budgetary issues as the market attempts to meet increasing demand for EACs.
Increase consumption of clean and renewable non-electric thermal energy.	N.A. under current statutes.	N.A.	N.A.
Sustainable buildings			
Increase the number of owned buildings that are compliant with the Guiding Principles for Sustainable Buildings.	ORNL's Sustainable Buildings inventory did not increase in FY 2023. With the new requirement of a 25,000 ft ² building, ORNL has 7 sustainable buildings that are Guiding Principle (GP) certified.	ORNL plans to have at least two new construction buildings to add to the sustainable building count in the next 2 years. ORNL plans to reassess the 7 sustainable buildings in the next 2 years, maintaining the 7 GP-certified buildings inventory.	Medium
Acquisition & procurement			
Promote sustainable acquisition and procurement to the maximum extent practicable, ensuring all sustainability clauses are included as appropriate.	ORNL maintained 100% compliance in FY 2023. All subcontracts contain multi-statutory terms and conditions that invoke requirements for sustainable acquisitions as defined in the UT-Battelle prime contract as flow-down requirements.	ORNL will continue mission commitment to include all applicable federal acquisition regulation (FAR) clauses and provisions in each new contract. ORNL will maintain compliance with DOE Order 436.1A and assist with the	Low

DOE goal	Current performance status	Planned actions and contribution	Overall risk of non-attainment
		supply chain risk assessment moving forward.	
Investments: improvement measures, workforce, and community			
Implement life-cycle cost effective efficiency and conservation measures with appropriated funds and/or performance contracts.	The ORNL Energy Efficiency and Sustainability (EE&S) program on average funds over \$500,000/year toward ECMs. DOE has a current contract with Johnson Controls Inc. (JCI) for an ORNL energy savings performance contract (ESPC) project. The delivery order was July 31, 2008, with a term of 24 years and 7 months. It includes ECMs consisting of steam system decentralization, building management system improvements, advanced meter installations, energy-efficient lighting upgrades, and domestic water conservation.	ORNL's ECMs need to be evaluated to determine which are life cycle cost-effective, and if found to be so, fund and begin installation to the maximum level of funding available. ORNL plans on expanding the auditing process and integrating this process with the facility condition assessments (FCAs). ORNL will then continue to investigate the best potential funding pathway strategies as the life cycle cost-effective ECM list grows moving forward.	Medium
Electronic stewardship			
Increase acquisition of sustainable electronics and promote sustainable operations and end of life practices.	ORNL maintained 100% compliance in the acquisitions of environmentally certified products. ORNL actively maintained power management features on 100% of all eligible IT devices in operations. Disposition of 100% of end-of-life electronics was preformed through government reuse programs and certified recyclers.	ORNL plans to maintain 100% compliance with all electronic stewardship goals and categories. There are no foreseen obstacles to the goal.	Low
Adaptation & resilience			
Implement climate adaptation and resilience measures.	In response to EO 14008 and DOE directives, ORNL submitted the VARP in September 2022 along with a portfolio of actionable resiliency solutions. For FY 2023, ORNL has updated the resiliency project status. One project was funded and completed in FY 2023.	Updates of the implementation status of ORNL's solutions will be reported annually to SPO.	Low
Multiple categories			
Reduce scope 1 & 2 GHG emissions.	The FY 2023 scope 1 and 2 GHG inventory is 237,169 MTCO ₂ e (net after RECs), year-over-year an increase of 11%. Purchased electricity (scope 2) comprised 76% of ORNL GHG emissions. US Environmental Protection Agency (EPA) Emissions & Generation Resource Integrated	Mission growth as described in several sections in this report will limit the ability to realize lower emissions in the next 5 years. However, forward-looking DOE priorities such as those combined for net-zero	High

DOE goal	Current performance status	Planned actions and contribution	Overall risk of non-attainment
	Database (eGRID) emissions factors and rebounding from COVID-19 levels contributed to ORNL's scope 2 GHG increase.	initiatives will reverse the trend of higher emissions.	
Reduce scope 3 GHG emissions.	The FY 2023 scope 3 GHG inventory is 25,536 MTCO ₂ e, an 8% increase from FY 2022. Scope 3 activities at ORNL included distribution losses from purchased electricity and increased employee commuting and business travel.	Employee commuting and business travel categories are returning to pre-COVID-19 levels, which has reversed the scope 3 reductions as experienced in FY 2020 and FY 2021.	High

3. GREENHOUSE GAS (GHG) PERFORMANCE

3.1 GHG EMISSIONS IN METRIC TONS OF CO₂ EQUIVALENCY (MTCO₂E)

3.1.1 Performance Status

The sources of GHG emissions at ORNL and the inventory for FY 2023 are detailed in Table 2. After 2 years of curtailed electricity demands from many businesses during COVID-19 operations, regional GHG emission factors are expected to increase in the next 2 years as businesses resume and exceed prior electricity needs. 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 reduce GHG emissions significantly by 2030 per EO 14008, EO 14057, and other federal programs and initiatives. Most significantly, national CFE goals will result in lower emissions for each megawatt of electricity consumed by ORNL.

Table 2. Sources of GHG emissions at ORNL in FY 2023

Source of GHG emissions	FY 2023 inventory (MTCO ₂ e)	Percentage of total (%)
Purchased electricity (net after RECs)	198,911	76%
Natural gas, facilities	34,070	13%
Employee commuting	15,551	6%
Transmission and distribution losses	8,631	3%
Fugitive gases and refrigerants	2,624	1%
Business air travel	1,205	Less than 1%
Fleet fuels (reported for FY 2022)	751	Less than 1%
Fuel oil, facilities	471	Less than 1%
Nonfleet vehicles and equipment fuels	329	Less than 1%
Business ground travel	149	Less than 1%
Wastewater treatment	13	Less than 1%
ORNL total GHG emission sources	262,705	100%

3.1.2 Plans and Projected Performance

By far, the most significant component of GHG emissions is the production and distribution factors associated with electrical power production, netting 76% of ORNL emissions in FY 2023. As CFE 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 regional electricity grid factors was released by the US Environmental Protection Agency.²

Over the past 15 years, GHG emission factors from electricity have improved slowly but steadily, but the rate of progress is expected to accelerate as clean energy strategies are deployed nationwide by the producers of CFE. As DOE works toward a data-reporting process that reflects emissions factors associated with explicit electricity production, ORNL will be able to exact the more relevant (and favorable) output emissions from its wholesale provider, TVA.

In the coming years, ORNL will explore the feasibility of quantifying and reporting carbon sequestration that occurs on the Oak Ridge Reservation's 25,000 acres of unimproved land. Historically 40% of the reservation, or 10,000 acres, is attributable to ORNL operations.

² These factors are available at <https://www.epa.gov/egrid>.

4. ENERGY MANAGEMENT

4.1 ENERGY MANAGEMENT PROGRAM OVERVIEW

The ORNL Energy Management program 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/process water to support ORNL's mission and research programs. Electrical services include basic power needs, 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 and domestic water use, including restrooms and drinking water. ORNL's utility consumption and costs reflect the ORNL main campus, the Spallation Neutron Source (SNS) site, various research and support facilities throughout the property, and leased spaces, primarily the National Transportation Research Center at the Hardin Valley Campus. 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.

The ORNL Facilities Management Division (FMD) successfully attained DOE's 50001 Ready recertification in FY 2019, FY 2020, and FY 2021. FMD first received certification in FY 2019, and at the time of initial certification, ORNL was the third federal location and only the second national laboratory to receive the certification. The certification covers over 2.5 million ft² in 65 FMD buildings that are equipped with advanced metering. FMD's EE&S program led the certification effort, but contributions and support from many other divisions were necessary to achieve the project goals. DOE 50001 Ready has provided a structure and documentation strategy that identifies areas for growth while also tracking growth each year as the EE&S program progresses.

Although FY 2022 was a year of major change, ORNL focused on becoming familiar with the ambitious goals established via EOs issued by the current administration and new laws such as EAct 20. DOE 50001 Ready certification was not pursued in FY 2022, but a majority of the documentation was updated to position ORNL for recertification in future years.

DOE's Better Buildings website provides more details outlined in the ORNL FMD certification case study, [ORNL's DOE 50001 Ready Case Study](#).

4.1.1 Utility Consumption

Electricity, the largest energy commodity for ORNL, currently accounts for approximately 75% of ORNL's total energy consumption (Figure 2). Electrical services dominate ORNL's energy, primarily because of critical operations at high-energy mission-specific facilities (HEMSFs). Electricity accounts for 88% of the utility provider commodity budget at ORNL (Table 3).

Heating energy makes up the remaining 25% of fuels at ORNL. Natural gas is the primary fuel used for steam generation at the ORNL steam plant and the Melton Valley steam plant and for hot water generation at the Central Utilities Building supporting SNS. Natural gas is also used in direct natural gas heating and research applications. Fuel oil, which is used for steam generation during curtailment and maintenance periods and for heating at the Energy System Test Complex, accounts for less than 0.5% of the total energy consumed.

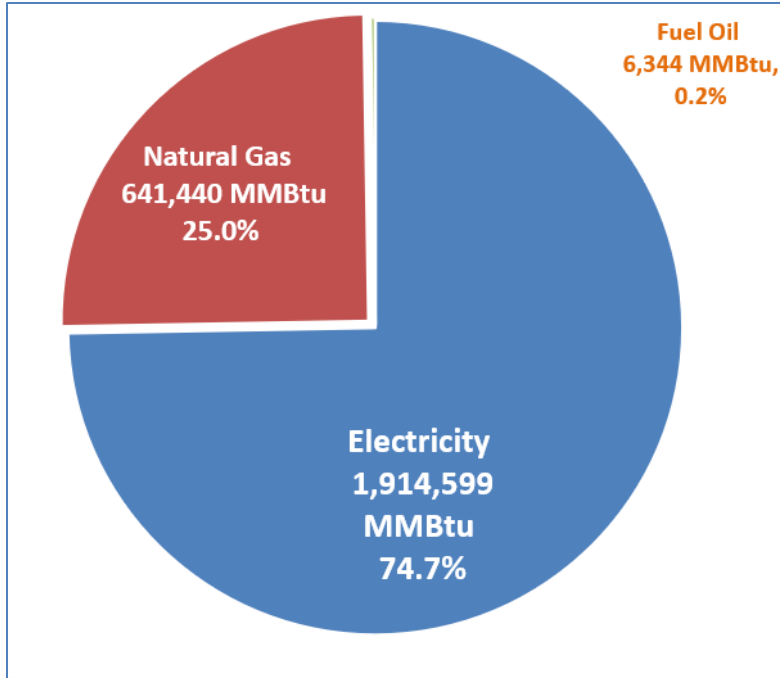


Figure 2. FY 2023 total utility consumption breakdown.

Table 3. ORNL FY 2023 utility consumption and cost

Utility	Consumption	Cost (\$ x 1,000)
Electricity	561,051 MWh	\$36,262
Natural gas	625,185 MCF	\$3,544
Fuel oil	46 kgal	\$136
Potable water	666.5 Mgal	\$1,315

4.2 PROGRAM INFORMATION FOR ORNL HEMSFS

ORNL’s unique research mission results in energy efficiency challenges not seen in conventional office and laboratory buildings. DOE and SC have designated a unique facility category for these exceptional operations, defined as HEMSFSs. ORNL currently designates and tracks four unique facility/research systems as HEMSFSs. The following contains brief program information for ORNL HEMSFSs and is offered to better document this challenge in terms of energy and water performance improvement efforts.

High Flux Isotope Reactor (HFIR)

The neutron scattering research facilities at the High Flux Isotope Reactor (HFIR) allow scientists to study the molecular and magnetic structures and behavior of a variety of materials, including high-temperature superconductors, polymers, metals, and biological samples (Figure 3). These studies are leading to scientific and technical advances in a wide range of fields, such as physics, chemistry, materials science, engineering, and biology. The reactor is also used for isotope production, materials irradiation, and neutron activation analysis.



Figure 3. ORNL’s HFIR.

Computational Sciences Building



Figure 4. ORNL’s Computational Sciences Building.

The HPC mission includes the Computational Sciences Building (Figure 4), part of the Oak Ridge Leadership Computing Facility, which gives the world’s most advanced computational researchers an opportunity to tackle problems that would be unthinkable on other systems.

To date, the Oak Ridge Leadership Computing Facility has produced four supercomputers, each bearing the title “world’s fastest computer” in its time. In May 2022, Frontier came online as the first exascale machine in the world. Exascale is the next

level of computing performance. By solving calculations more than five times faster than today’s top supercomputers—exceeding a quintillion, or a billion billion, calculations per second—exascale systems will enable scientists to develop critically needed technologies for energy, medicine, materials, and more. As supercomputing strategy continues to evolve, the design features championed at ORNL will ensure that DOE remains positioned at the forefront of HPC on the international stage.

Spallation Neutron Source (SNS)



Figure 5. ORNL's SNS.

SNS is an accelerator-based neutron source that provides the most intense pulsed-neutron beams in the world for scientific research and industrial development (Figure 5). The beams deliver short pulses of protons—60 times a second—to a target system where neutrons are produced through a process called *spallation*. SNS gives researchers more detailed snapshots of smaller samples of physical and biological materials than ever before possible. The diverse applications of neutron scattering

research are providing opportunities for exploration into the structures and dynamics of materials in practically every scientific and technical field. Each year, more than 1,000 scientists from around the world compete for valuable research time at the SNS facility. SNS will expand with a Second Target Station in the coming years.

Center for Nanophase Materials Sciences (CNMS)

The Center for Nanophase Materials Sciences (CNMS) is one of five DOE Nanoscale Science Research Centers (Figure 6). The centers provide leading-edge tools and scientific expertise for synthesis, characterization, and computation for interdisciplinary research at the nanoscale. CNMS's unique capabilities enable scientists worldwide to “see,” make, control, and understand nanoscale matter. Nanoscience aims to understand advantageous yet sometimes strange physical and chemical behaviors that arise in structures 1 to 100 nanometers (nm) wide that do not occur in larger structures. The CNMS program integrates nanoscale science with neutron science; synthesis science; and theory, modeling, and simulation. The facility is



Figure 6. ORNL's CNMS.

equipped with a wide range of specialized tools for synthesis, characterization, and fabrication of nanoscale materials and assemblies, including the integration of hard and soft materials.

4.3 ORNL HEMSF ENERGY USE AND PROJECTIONS

The current and projected values for total energy consumption in millions of British thermal units (Btu), by all sources at ORNL are shown in Figure 7 in comparison with the energy consumed by the HEMSF systems. HEMSF energy consumption accounted for approximately 53% of ORNL’s total energy use in FY 2023. It is expected to grow to 65% of total energy use by FY 2030. As shown previously in Figure 2, electricity is the dominant utility at ORNL (75%) for all of ORNL, both at the HEMSFs and the base site (or overall campus).

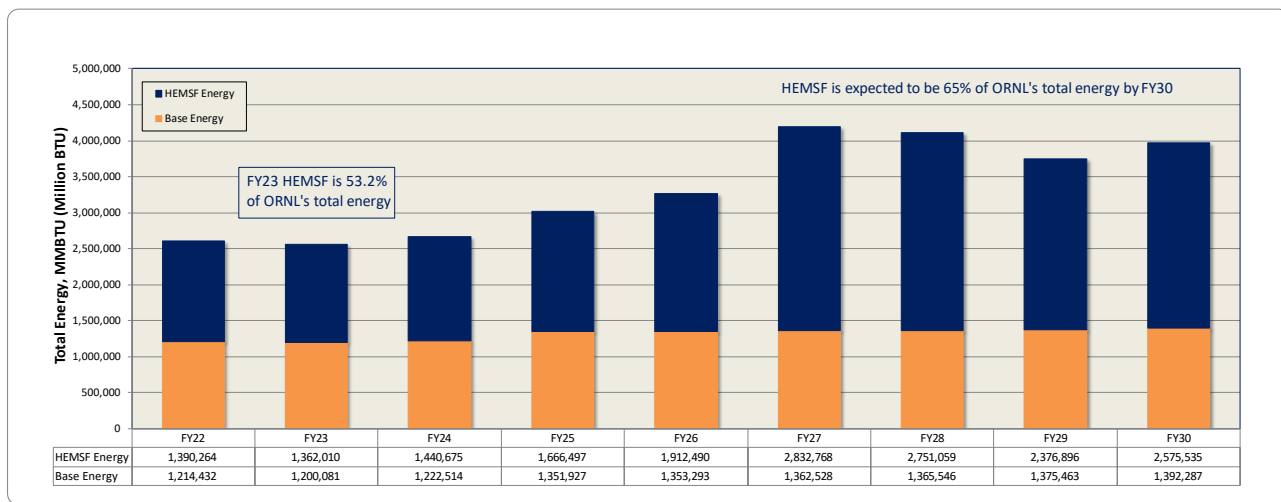


Figure 7. Total Base energy use at ORNL vs. the HEMSF energy use for HEMSFs.

The top section of the bar graph includes all HEMSFs. Other ORNL energy is shown on the bottom section of the bar graph and is identified as Base Energy consumption. For all comparisons, Base Energy includes electricity and other fuels used for basic facility operations and not consumed at HEMSF systems.

The HEMSF electrical energy use and projection bar graph in Figure 8 is provided to demonstrate the importance of electrical energy at ORNL. Electricity consumption is the largest component of HEMSF energy. Around 68% of all ORNL electricity is consumed at these HEMSF research facilities. Electrical consumption is expected to increase slightly because HFIR operations are projected to return to a normal number of cycles in FY 2024. Likewise, SNS operations are expected to be limited in FY 2024 and return in FY 2025 because of the implementation of the Proton Power Upgrade project. As the mission continues, HEMSF electrical consumption is projected to grow from 68% to nearly 77% by FY 2030 based on projections for HPC expansion and infrastructure improvements for SNS’s Second Target Station.

The bar graph in Figure 8 shows the electricity use and projections for each of the four ORNL HEMSFs. All other electricity consumption is also shown on the bar graph as Base Site Usage.

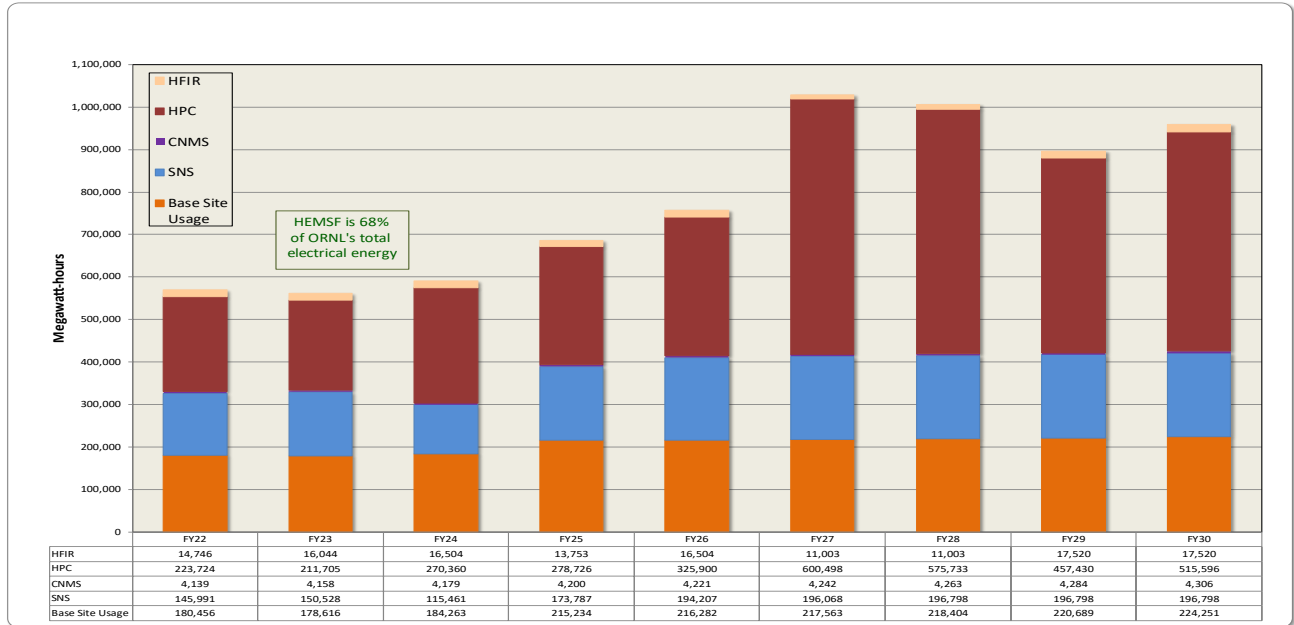


Figure 8. Electricity consumption of the four identified HEMSFs at ORNL.

Thermal energy consumption is also expected to increase with ORNL mission growth as HEMSF research needs increase (Figure 9); however, electricity will remain the dominant energy source. All other heating energy values are shown on the bar graph as Base Site Usage.

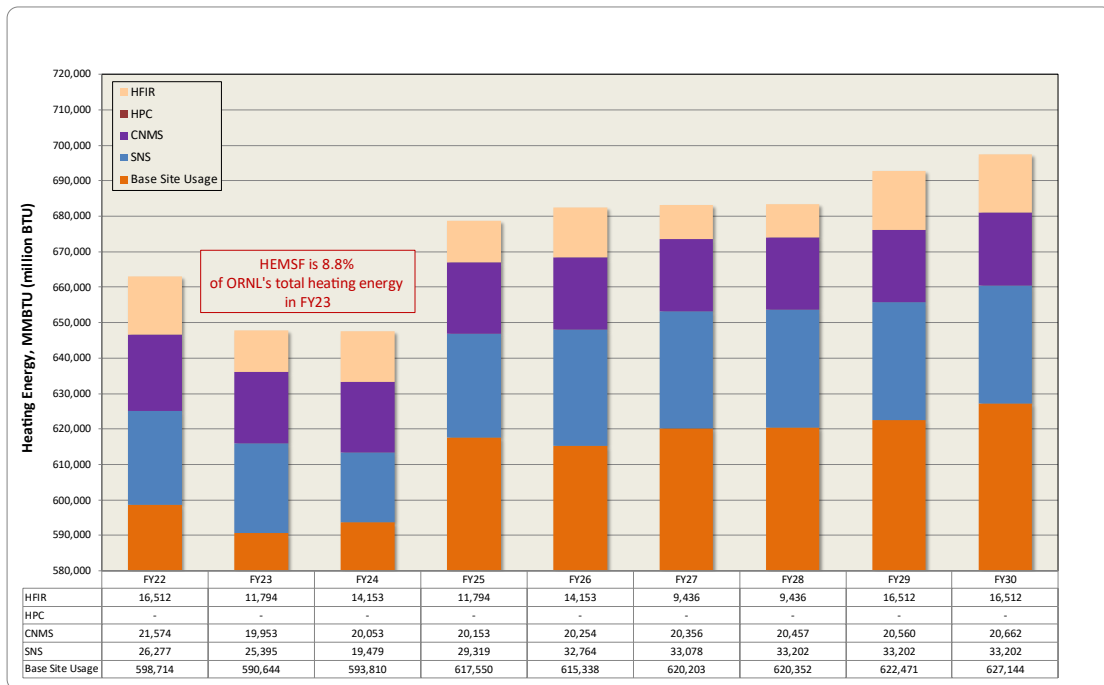


Figure 9. Projections of thermal energy consumption for the HEMSFs at ORNL.

4.4 ORNL GOAL ENERGY USE INTENSITY (EUI) AND EXCLUDED ENERGY USE AND PROJECTIONS

4.4.1 Performance Status

Based on FY 2023 data, energy use in the buildings category at ORNL is 1,037 billion Btu, not including ORNL’s excluded facilities as defined by the Energy Policy Act (EPAct) of 1992. Given an area of 4,365,438 GSF of energy-consuming buildings, trailers, and other structures and facilities identified in the Facilities Information Management System (FIMS), the FY 2023 calculated energy use intensity (EUI) is 237,514 Btu/GSF. This results in a cumulative reduction of 34.7% since FY 2003, a reduction of 1.43% since FY 2021 baseline, and an increase of 1.41% from FY 2022 (Figure 10).

ORNL managed resources during extreme winter weather conditions in December 2022 to continue to deliver reliable utility services, consuming additional energy and fuel and thus affecting the FY 2023 EUI.

ORNL’s energy increased for goal-subject buildings, due in part to an increase in employees on campus and increased mission as a return from COVID impacts. The goal-subject gross square feet remained steady with only a 0.25% decrease, resulting in a 1.41% increase in EUI from FY2022.

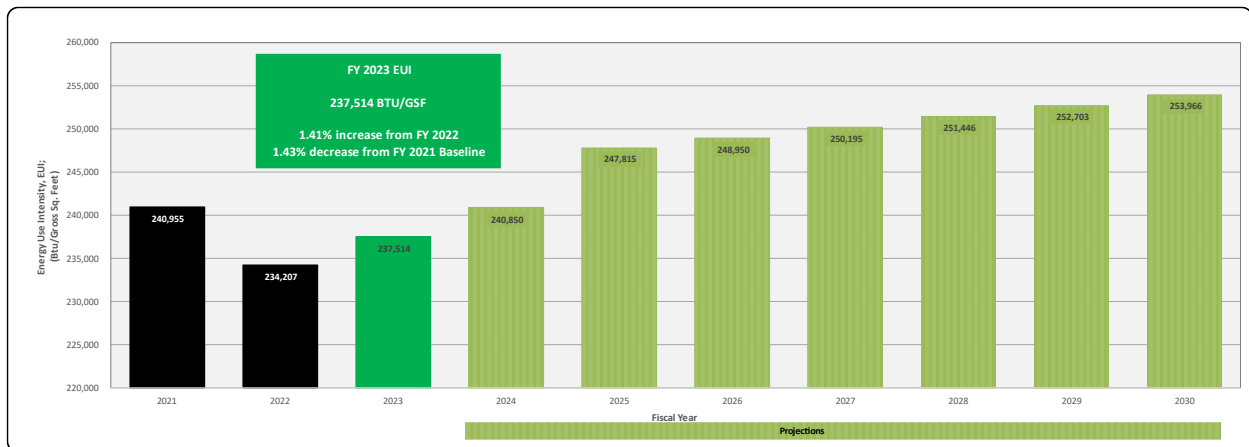


Figure 10. Historical, current (FY 2023), and projected EUI at ORNL.

ORNL’s electrical consumption is used primarily by mission-critical buildings and systems. Approximately 75% of the total electrical load is formally assigned to the Excluded category, as is 12% of the thermal energy (natural gas and fuel oil). These mission-critical systems are not subject to conventional energy conservation methodologies.

The Excluded category energy and fuel projections are expected to increase as ORNL’s HPC and SNS target station missions grow. Additional maintenance schedules for HFIR in FY 2024 are also reflected in the electrical projections. In FY 2023 and FY 2024, SNS will have limited operations because of the Proton Power Upgrade project.

ORNL anticipates more buildings being constructed by FY 2025. These buildings are expected to be in the Goal Subject category, and they include the Craft Resources Support Facility (43,000 ft²) and the Translational Research Capability Building (90,000 ft²) with building completion status realized in FY 2025. Additional new construction and modification are being considered by SC for ORNL’s annual laboratory plan.

4.4.2 Plans and Projected Performance

ORNL's efforts toward energy intensity reduction have resulted in considerable progress by targeting readily applied ECMs in existing buildings. As these types of opportunities become less prevalent, ORNL will shift 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 for ECM implementation.

ORNL is continuing to build a foundation of awareness to make energy efficiency increasingly part of daily operations. Energy managers cannot be a part of all decisions, so it is important that the decision-making process includes considerations of energy efficiency and life cycle cost.

ORNL will continue to leverage the power of building operations data from existing systems, including the Building Automation System (BAS) and metering systems. New sensors and meters will be added in strategic locations, and new capabilities will be built out in existing systems or layered with new systems, as necessary. Focus will be placed on developing tools for operations staff to maintain building systems in a way that supports reliability, meets the needs of building occupants, and achieves energy efficiency.

The Utilities Division will continue to evaluate utility systems for improving operations, improving reliability, and reducing maintenance costs. Future activities in planning include the following:

- Additional electrical service infrastructure and cooling tower optimization is underway to support the HPC mission and improve efficiency and reliability.
- Further chilled water system improvements are expected from two additional chiller rebuilds and utilization of reduced condenser water temperatures at Building 6018.
- The Utilities Division will prioritize potential projects and support the design of the Critical Infrastructure Modernization Project (CIMP) for improved operations, resiliency, and efficiency.

EO 14008 calls for federal agencies to take the lead in tackling the climate crisis, to engage in the formation of a net-zero economy, and to enhance operational resilience at federal facilities. The ORNL Carbon Reduction Team was chartered in FY 2021 to bring R&D scientists and operations SMEs to the same table and to align with SC as it amplifies net-zero as part of its business methods and in the budget planning process. Net-zero initiatives work in conjunction with other priorities to reach several objectives. Throughout ORNL, projects are evaluated on several sustainability priorities, including energy and water savings (and cost savings) from ECMs, net-zero initiatives, and enhanced operational resilience.

4.5 ENERGY MANAGEMENT: INITIATIVES, PROJECTS, STRATEGIES, AND PROCEDURES

4.5.1 Performance Status

To maintain steady progress toward EUI reductions, ORNL focuses on energy-efficient and sustainable design in new construction projects, smart repurposing of existing facilities, and a drive for continuous improvement in facility and utility operations. Efforts throughout ORNL that have an impact on energy consumption are described here.

4.5.1.1 Fault detection and diagnostics

EUI reduction in existing ORNL facilities is data-driven, and efforts are made to quantify and bring awareness to building energy performance so that operations staff can make informed decisions. ORNL pursues approaches to energy consumption awareness using data visualization and reporting. Building

data analytics, including fault detection and diagnostics (FDD), have been added to ORNL’s energy conservation tools. In FY 2021, ORNL piloted SkyFoundary’s SkySpark FDD system in two buildings. In FY 2022, ORNL utilized awarded Science Laboratories Infrastructure (SLI) General Plant Project (GPP) funding to successfully add 13 buildings to SkySpark, bringing the total number of buildings to 15, with more than 1.5 million GSF covered and nearly 32,000 data points connected (Table 4). The additional 13 buildings were chosen because they are significant energy users. Many are also very aged and/or complex and thus stand to benefit greatly from commissioning with improved monitoring and analytics. In FY 2023, ORNL worked to put faults and key performance indicators in place to identify opportunities for improved performance and energy savings. In FY 2024, ORNL will continue to reevaluate and optimize the established faults and key performance indicators for these buildings with input from facility operators.

As personnel changes occur throughout the years, ORNL knows it is beneficial to regularly review the BAS setbacks that may have been added and removed because of operational changes or system needs. ORNL is working to identify and track all setbacks in place throughout the campus. With the SkySpark FDD system, ORNL hopes to use the controls-monitoring capabilities to successfully implement and monitor more HVAC setbacks and identify any deviations from such controls.

Table 4. ORNL buildings with SkySpark FDD

ID	Name	Year built	Size (GSF)	Data points
1505	Environmental Science Laboratory	1978	88,843	785
1520	Joint Institute for Biological Sciences	2007	35,543	1,409
2033	Measurements & Controls Facility	1990	31,286	844
4100	Chemical & Materials Sciences Building	2011	155,712	8,413
4501	Radiochemistry Laboratory	1951	75,738	360
4508	M&C Laboratory	1962	97,781	1,245
4515	High Temperature Materials Laboratory	1987	65,093	1,610
5100	Joint Institute for Computational Sciences	2003	51,451	2,737
5200	ORNL Conference Center	2004	1,265	1,265
5600	Computational Sciences Building	2003	98,348	2,945
5800	Engineering Technology Facility	2003	77,492	1,742
7130	Research Operations Support Center	2020	29,049	371
8630	Shull Wollan Center	2010	32,046	1,712
4500N	Central Research & Administration - North	1952	363,758	3,865
4500S	Central Research & Administration - South	1961	317,258	2,612
Total			1,573,341	31,915

4.5.1.2 LED implementation and standardization of energy-efficient equipment through division policies

Although many LED upgrade projects were pursued as ECMs in FY 2023, significant efforts were also made within the facilities to upgrade to LEDs when old, more inefficient lighting failed. These efforts were not captured as an ECM but rather as general maintenance. ORNL used the Esri ArcGIS system to track LED upgrade information such as energy savings, for the lighting projects that are conducted for general maintenance, not dedicated ECMs. In FY 2022, the LED tracking tool was established to track the details of LED upgrades throughout the ORNL campus (including those associated with ECMs and those

not associated with ECMs). Information tracked in the LED tracking tool using ArcGIS includes location, old lamp count, new lamp count, wattage difference, type of replacement (e.g., retrofit kits, instant fit bulbs, new fixtures), and occupancy sensor status (before and after upgrade). With this information, a simple energy savings of each light replaced at ORNL can be calculated. The data are sorted by year and per building as shown in Figure 11. Figure 11 also shows the data input for FY 2023, but this application can show reported LED data for all years since this effort began (FY 2018–FY 2023). This dashboard helps show the overall effort ORNL is making in its facilities that is not directly funded directly with ECM funding.

In FY 2022, the FMD director implemented a new policy for 100% LED replacement of any lighting that needs to be replaced within ORNL FMD facilities moving forward. This policy was communicated to the division and to all those who purchase lighting for the facilities. This policy implementation can be tracked via the LED tracking tool. However, this tracking method is only as good as the data that are reported. If a group does not report their LED installations, but LEDs are still installed in workspaces, ORNL does not capture the benefits even though the energy savings benefits will accumulate over time.

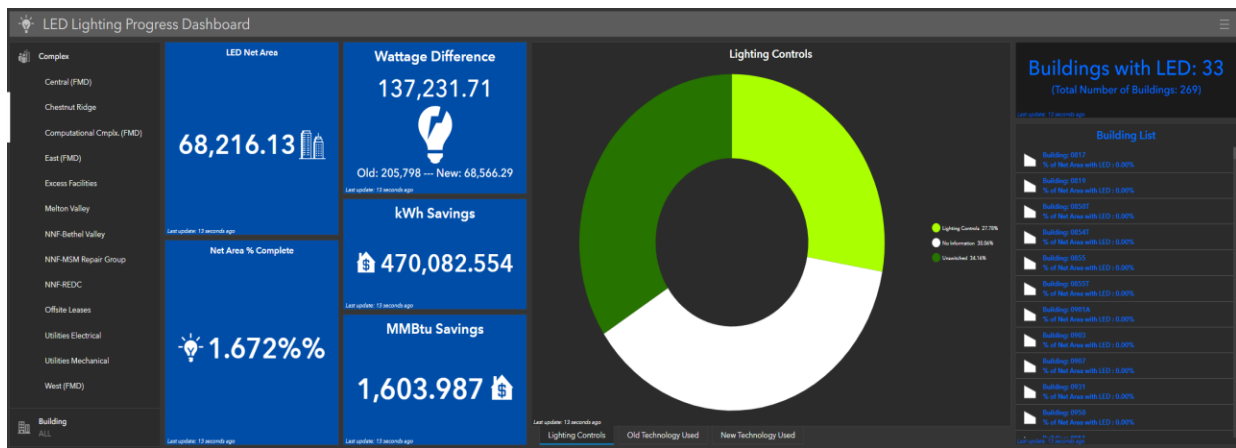


Figure 11. LED lighting upgrade tracking dashboard in Esri ArcGIS for FY 2023.

4.5.1.3 Excess facilities

ORNL continues to modernize its campus by demolishing shutdown facilities that are underutilized or no longer needed to support the mission. ORNL’s Excess Facilities program (EFP) works with FMD and other building-owning organizations to mitigate energy waste after assets have been transitioned to excess. The EFP demolition plan is based on the availability of monetary and human resources, organizational and operational needs, and strategic modernization plans for the campus. On a case-by-case basis, after a facility is transitioned from operating to shutdown (excess) status, an analysis is performed to determine suitability for de-energized status. EFP typically demolishes these older, energy-inefficient facilities to make way for newer, more efficient buildings that better serve ORNL’s mission.

EFP did not perform any physical building demolitions in FY 2023. A few facilities were planned for demolition, but these projects were postponed or cancelled for various reasons. EFP was involved with the demolition and renovation of several laboratory spaces within Buildings 4500N and 4500S. Ten laboratory spaces in these buildings were demolished in FY 2023. Nine laboratories and four associated spaces (three of which were demolished in FY 2023) have been renovated or are in the process of being renovated. In addition to the demolition and renovation of the laboratories, the old associated lab hood exhaust fan systems in the attics were removed from most of these laboratories, as was the selected

exhaust fan equipment from previously renovated laboratories. The FY 2023 demolition and renovation space was approximately 8,620 GSF.

As part of the renovation of these spaces, it is EFP's policy to install new LED lighting as these laboratories are rebuilt. Utilities will be installed as required by the researcher.

4.5.1.4 Utility Improvements

Improvements in utility services have resulted in nearly 100% system availability and reliability in FY 2023. Utilities personnel continued to serve ORNL's mission during extreme winter weather conditions during December 2022.

Electric Utilities

Electrical Utilities personnel worked with subcontractors to install three new 13.8 kV switchgears and transformers as part of the Proton Power Upgrade project at SNS. In addition to adding more power capacity, the switchgears are totally enclosed and gas insulated, increasing operator safety and reducing nature-induced outages (and thus improving reliability).

Electrical Utilities personnel worked with subcontractors to install two transformers to feed in support of the newly constructed Translational Research Capability facility. Permanent power is fed from the 13.8 kV system in the area for improved system reliability.

Electrical Utilities personnel supported a prime contractor in the removal of trees and overgrown vegetation in the 3000 Area to reduce the potential for impacts to the 2.4 kV electrical distribution system in the area, thereby improving reliability.

Mechanical Utilities

Repairs of steam, condensate, and compressed-air lines located within the east campus steam trenches were completed in FY 2023. Because of significant degradation of the piping and trench lids in the area, evaluation and repair of approximately 400 ft of piping from Steam Pit 58 to Steam Pit 59 are underway to improve system efficiency and reliability.

Automated controls for the condensate-return system were installed to control pumps, levels, and flows. These installations improve system operations and position utilities to return more condensate to the 2519 steam plant, thereby improving fuel efficiency and water reduction.

Phases 7–10 of the steam pit refurbishment plan were completed. Examples include replacing heavy, aged steel grating with lighter aluminum grating; upgrading access with new ladders; and adding more convenient retrieval equipment.

Utilities support continued FY 2023 for OLCF-5 commissioning and improvement efforts involving chilled water to make the facility safer and operate more efficiently.

Recommendations were made for the equipment, configuration, and requirements for the mechanical systems pertaining to chilled water in support of the design and construction of the new Translational Research Capability facility.

4.5.2 Plans and Projected Performance

4.5.2.1 Standardization of energy-efficient equipment through campus policies

Moving forward, FMD is considering other energy-efficient policies similar to the LED policy, such as standardizing energy-efficient packaged terminal air conditioners. FMD will assess the LED policy implementation and determine whether ORNL wants to take further steps to institutionalize certain energy-efficient equipment for the energy benefits and the general knowledge of maintenance across the division that comes with standardizing equipment.

4.5.2.2 Electrification

ORNL will continue to discuss options and strategies for electrification as the lab moves forward with its CFE and net-zero discussion. ORNL will continue to include electrification in discussions for its net-zero assessment.

ORNL is currently conducting a feasibility study to develop a plan to replace the current fuel oil boiler at the Experimental Gas-Cooled Reactor campus with an electric boiler. If feasible, this upgrade would electrify all heating requirements at this location, making the entire Experimental Gas-Cooled Reactor campus all electric.

ORNL is conducting GHG scope 1 and 3 assessments to determine the best path forward to a Net Zero emissions campus. Electrification strategies will be evaluated as a part of this assessment.

4.5.2.3 Refrigerant HVAC systems

ORNL will continue to pair electrification and refrigerant investigation. When looking for ECMs, ORNL will look for HVAC systems that still use older, higher GHG-emitting refrigerants and try to upscale to new systems that can use refrigerants that emit less GHGs.

In FY 2023, ORNL FMD added a new position for an ORNL refrigerant management specialist. The position was added to review current refrigerant use across the campus with the intent of developing a plan to reduce applications of higher GHG-emitting refrigerants where possible.

4.5.2.4 Future utilities projects

Steam pit refurbishment will continue. This includes piping repairs from Steam Pit 58 to Steam Pit 59.

Mechanical Utilities will replace fill and drift eliminators in select East Campus cooling towers to provide more efficient cooling and improve chiller efficiency.

Mechanical Utilities plan to rebuild 5600-CH-4 for chiller efficiency improvements and savings.

Mechanical Utilities plans to install and commission trim cooling system for Frontier computing to sub-cool high temperature water to extend life of Cray/HP computers and enable higher speed of operation.

4.6 NET-ZERO ENERGY BUILDINGS

4.6.1 Performance Status

The Oak Ridge Reservation (inclusive of ORNL and Y-12) constitutes a small city ideal for the demonstration and deployment of a carbon-neutral test bed. ORNL's net-zero carbon campus efforts will include approaches that demonstrate a variety of technologies such as electrical storage, carbon capture, integration of renewables, transition to an all-EV fleet, and efficiencies gained through infrastructure modernization that reduce or eliminate carbon emissions. Carbon capture research will be conducted in a phased manner; prototype technologies will be developed with potential implementation planned across the campus. Captured carbon will also be evaluated for potential reuse, conversion to fuel, or disposal.

In addition to these efforts, deployment of new nuclear generation will help ORNL to reach net-zero. TVA has approved up to \$200 million to prepare for the potential construction of a small modular reactor (SMR) at its Nuclear Regulatory Commission-licensed site, which could provide CFE for the reservation and the region.

To further ORNL's progress toward net-zero, 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
- Hydrogen generation and utilization
- EV 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 are currently fossil fuel based
- Grid resiliency and security

Net Zero carbon campus projects will require programmatic and institutional investments. Traditional ECMs such as lighting improvements, HVAC upgrades, and temperature setbacks are being investigated and implemented to reduce energy consumption and the GHG footprint. The SLI-LI (Line Item) CIMP (CD-1 in process) will contribute to GHG reduction, resiliency, and energy/fuel efficiency.

4.6.1.1 Sustainable ORNL showcase projects that supported Net Zero Energy Buildings (NZEB) in FY 2023

Each year, Sustainable ORNL makes funding available to support showcase projects that focus on creative measures that can improve ORNL's sustainability. The projects need to be closely aligned with at least one of the Sustainable ORNL roadmaps, and preference is put on those that crosscut multiple roadmaps, such as Net Zero Energy Building (NZEB) projects.

In FY 2023, the program invited studies in the following areas:

- Studies that demonstrate innovative opportunities to reduce the GHG emissions associated with steam generation, process heating, or building heating on campus and that focus on means/methods that can be deployed at demonstration scale within 5 years (e.g., waste heat recovery and heat storage systems)
- Studies to demonstrate load management devices or components in a microgrid with energy storage and grid-interactive efficient building systems

- Studies and/or demonstrations of Net Zero GHG solutions for off-road vehicles and equipment used to support operations at ORNL
- Other topics that represent creative means to mitigate GHGs or further the sustainability of ORNL that are directly tied to one of the Sustainable ORNL roadmaps

The showcase projects selected for FY 2023 were as follows.

“5600-5700-5800 complex sustainability and decarbonization using waste heat recovery from Oak Ridge Leadership Computing Facility’s high performance computing data center”

This project focused on an innovative solution that used water-water medium-temperature heat pump (MTHP) technology to leverage the low-grade waste heat recovered from HPC data center to produce 85°C hot water for water heating or space heating in the 5600-5700-5800 complex. The project embodied multiple Sustainable ORNL initiative topics, including the following:

- **Energy Efficiency:** The project focused on a sustainable design for building water and space heating with EUI reduction. The proposed water-water MTHP saves more than 74% compared with current energy usage. The optimal solution directly reduces fossil fuel consumption by up to 1.0 MW.
- **Greenhouse Gas Management:** The adopted water-water MTHP technology recovers waste heat. The electrification will reduce direct GHG emissions by 4.3 TCO_{2e} daily and support national priorities such as energy independence and an equitable transition to a Net Zero GHG emissions economy by 2050.
- **Fugitives and Refrigerant Reduction:** The mandated hydrofluorocarbon (HFC) phasedown continues at ORNL. Natural or low-global warming potential (GWP) refrigerants help reduce GHG emissions in many existing HVAC applications in aged equipment and new building designs, reducing direct and indirect GHG emissions.

The project also supported other Sustainable ORNL initiative topics like High-Performance Sustainable Buildings and High-Performance Computing. The project utilized waste heat recovery from the HPC data center and provided an optimized cooling system for sustainable operations, leading to long-term utility cost savings and energy-efficiency improvements. The solution will enable the 5600-5700-5800 complex to achieve carbon footprint reduction and improve indoor environmental quality.

“Monitoring and replacement of delinquent 250-gallon natural gas water heater with heat pump water heater for CO₂ and energy savings demonstration”

One of the two natural gas water heaters (G-WH) at Building 8600 was broken, and there appeared to be full redundancy. This is an excellent opportunity for a demonstration project on the energy, CO₂, and cost savings of using a heat pump water heater (HP-WH). HP-WHs have been researched at ORNL for the past 40 years and are a technology that won an R&D 100 award. The deployment of residential HP-WHs in the United States is <1%, and this project aimed to demonstrate the benefits of HP-WHs at the commercial scale.

The HP-WH design included in this proposal is applicable for replacing G-WHs. The feasibility of replacing a 250 gal malfunctioning G-WH at Building 8600 will be demonstrated via this project. The project will monitor the energy, water, and costs associated with heating water in Building 8600 by instrumenting the functioning 250 gal G-WH and the replacement air-source HP-WH. The room contains two boilers, and some of the heat lost from these devices will be recovered by the air-source HP-WH and lifted to provide hot water at the required delivery temperature. The energy and water usage will be recorded for 6 months into the next fiscal year while the system alternates between G-WH or HP-WH only. If shortages of hot water are reported, a hybrid system will be deployed.

“Pilot living laboratory demonstration on personalized heating & cooling management for GEBs”

In response to Sustainable ORNL program’s goal of identifying opportunities to optimize energy and environmental performance, reduce waste, and cut costs by building partnerships between the R&D staff and ORNL mission support organizations, this project team consisting of both R&D and F&O staff proposed to study and showcase advanced load management for the HVAC systems and, if any, EV charging systems of grid-interactive efficient buildings (GEBs) to enable demand flexibility, increase energy efficiency, and reduce carbon footprint.

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 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.

4.6.1.2 Leadership Funded Projects

ORNL’s leadership provided funding for three projects to aid in ORNL’s GHG Net Zero endeavors in FY 2023. Funding provided internally for these three projects totaled \$630,000.

The first leadership-funded project was to develop a design to allow migration of a legacy fuel oil boiler to an electrified boiler solution at Building 7601. Shifting this boiler to an electrified boiler will reduce maintenance costs and ORNL’s scope 1 GHG emissions. The replacement boiler will allow this facility and adjacent buildings to move toward net-zero GHG as ORNL’s electricity supply moves closer to being completely carbon free.

The second leadership-funded project was to purchase hardware and software needed to implement a vehicle-pooling program for ORNL’s government fleet vehicles. Once implemented, fleet vehicles will be pooled in several locations across ORNL’s campus rather than being assigned to individuals or groups at the laboratory. This change will enable ORNL to right-size its fleet, decreasing scope 3 GHG emissions. Furthermore, this system will enable a smooth transition to EVs as the fleet transitions away from internal combustion engine-powered vehicles, as the pooling locations will also eventually provide charging services for EVs.

The third leadership-funded project aimed to accelerate the transition of lighting at ORNL to energy-efficient LED fixtures in support of the EAct 20. ORNL continues to replace light fixtures with LEDs as part of its ongoing implementation of energy conservation measures on an annual basis. This project accelerates the replacement by funding additional lighting replacements beyond those that were originally scheduled for replacement this year.

4.6.1.3 NZEB tables

From the showcase projects, ORNL completed the following tables for projects that apply to the electrification of existing buildings (Table 5), to the electrification of new construction (Table 6), and to deep energy retrofits (Table 7). ORNL plans to assess the new construction projects to identify any buildings that could run solely on electricity.

Table 5. ORNL electrification retrofit projects to existing buildings.

FIMS real property unique ID (RPUID)	Building name	Building gross square footage	Planned electrification completion year	Project Name	Funding source	Full building electrification? (Yes/No)
200843	Building 8600 - Central Laboratory and Office Building	268,600	FY 2023 or FY 2024	Replace existing 250 gal natural gas water heater with a research-driven electric heat pump water heater	Lab	No
97462	Building 7603 - Energy Systems Laboratory Facility	50,000	FY 2026	Replace fuel oil steam-to-hot water boiler with a new electric boiler	Direct; AFFECT ^a potential	Yes
Multiple buildings	Multiple buildings	Multiple buildings GSF	FY 2038	Perform a study to develop a fuel-to-electricity conversion strategy for steam plant and natural gas equipment	Lab	No

^a Assisting Federal Facilities with Energy Conservation Technologies

Table 6. ORNL planned new construction to run solely on electricity

Anticipated building name or brief descriptor	Estimated square footage	Actual/anticipated construction completion year	Project name
Multiple buildings	Multiple Buildings	Study completion in FY 2026	Study new construction projects in planning, in design phases, and under construction for potential conversion to 100% electrical service
Building 7996 (RPUID 221619)	11,719	2022	All Electric Multi-Program Office Building
Building 7745 (RPUID 223156)	4,045	2023	All Electric New Construction Research Facility Building
Building 2719A (RPUID 220857)	6,087	2024 or 2025	All Electric Building Major Renovation. The Steam Plant Storage Building is being converted to a Power Operations Consolidations Building.
Building 6009	Approximately 12,000	Unknown	ORNL 6000 Area support facility will be all electric

Building 3147 was upgraded starting in 2022 with smart controls for packaged terminal air conditioner (PTAC) replacements and rooftop unit replacements as a Sustainable ORNL showcase project that continued into 2023. Energy savings are expected but still need to be studied via this project. However, most likely savings will be under the 40% deep energy retrofit limit. This case study task can be used to

develop a best practice methodology for additional SmartLab opportunities at ORNL for energy management and carbon reduction.

Table 7. ORNL building deep energy retrofits

FIMS RPUID	Building name	Building gross square footage	Planned retrofit completion year	Project name	Funding source (Direct or lab funded (e.g., IGPP))
97247	Building 3147 - Buildings and Power Technologies Offices	13,400	FY 2024	Building 3147 Renovation and Energy Upgrades *** (Potential to lead to a case study in developing a SmartLab program/strategy throughout the ORNL campus***)	Lab

4.6.2 Plans and Projected Performance: ORNL Net-Zero Assessment

ORNL is presently evaluating a holistic path to eliminating its GHG emissions, beginning with an assessment of steps to eliminate scope 1 and scope 3 emissions on campus. This assessment is a critical part of successfully achieving net-zero carbon emissions because ORNL has a relatively large, complex campus that includes a substantial number of legacy buildings and infrastructure. ORNL also has an existing ESPC involving its central steam system that will impose constraints on changes to this system through 2032. ORNL is actively working to identify suitable projects for the AFFECT Bipartisan Infrastructure Law funding program, and several potential projects are currently under development.

ORNL also plans to continue providing internal funding for the Sustainable ORNL showcase projects in FY 2024.

4.7 ENERGY MANAGEMENT: EISA SECTION 432 BENCHMARKING AND EVALUATIONS

4.7.1 Performance Status

In FY 2023, ORNL started the third year of the 4-year energy audit cycle by conducting 22 building audits throughout the year to cover a quarter of the buildings that are qualified for audit inclusion. Most audits were done internally by using ORNL’s Central Energy Data System (CEDS) data for energy benchmarking and by interviewing facility operations staff. For each facility audit, a report was drafted outlining the significant energy users, recent or impending operational changes, and potential ECMs for the facilities identified by facility personnel. Throughout the year, ORNL leveraged technology in the form of meter data analytics and BAS data for audits.

The EE&S program provides facility engineers with a list of information that they must be prepared to discuss before the audit. Thorough walk downs of the facilities may be necessary moving forward, especially in mechanical and electrical rooms to identify ECMs and calculate life cycle cost effectiveness. The EE&S program will work to establish a consistent auditing structure to ascertain the following available information before and during all building audits:

- Meter data
- BAS data
- FDD data
- Drawings needed for discussion
- LED tracked information (to baseline and update information)
- Old audits and commissioning reports
- Old benchmarking data (for the prior year and the prior year audited on the 4-year cycle)
- FCA information

EISA benchmarking of buildings is performed by using ORNL's Resource Advisor (RA) system, addressed in the Energy Management: Facility Metering Section 4.8, to configure building utility meters to automatically report building utility consumption to the ENERGY STAR Portfolio Manager. Once the reporting connection is set up between the two systems, the process does not need any more effort for reporting except for ensuring data quality and proper configuration within RA and the ENERGY STAR Portfolio Manager.

ORNL uses an internal high-level project tracking system, RESolution, to track all ECMs identified via the audit process or communication with facility engineers. RESolution is used to track major project core details such as time, budget, and scope. ORNL's EE&S program tracks the progress of the ECMs according to these project core details. As part of the scope, the EE&S program includes measurement and verification (M&V) when possible. If it is a more intricate project, it may require a walk down or analysis of the controls, but for simple projects such as LEDs, the installation of LEDs is confirmed to verify the details used in the calculation of the life cycle cost effectiveness prior to project start. When possible, processes will also be developed to embed M&V into the maintenance and operations workflow.

ORNL's M&V process for implemented ECMs aims to balance the rigor, time, and cost of M&V with the scope, scale, and data availability associated with each project. Advanced utility meter data will also be used when the meter data are available, and the projects are impactful enough to be seen in the building-level utility metering. M&V measures for the ORNL ESPC are discussed in the Investments: Energy Savings Performance Contract Section 9.1.2.

ORNL complies with the 5-year FCA cycle to identify and document maintenance that is needed within designated facilities throughout the ORNL campus. During FCAs, various SMEs are contacted to perform the FCA for each building. Meeting with the different individuals creates a bridge of knowledge with respect to equipment repairs, repair costs, and energy improvements. The knowledge transfer and documentation of these FCAs provide those responsible with helpful resources and necessary information for identifying and prioritizing maintenance issues, including some that may have energy-efficiency impacts on buildings. ORNL's FCA program has a custom system programmed for tracking assessments. This program tracks the date and assessment details, allows for the upload of information to create a formal assessment report, and tracks actionable deferred maintenance.

In FY 2023, ORNL's EE&S program worked with the FCA system programmers to integrate tracking energy and water audits within the same FCA tracking system shown in Figure 12. This building energy evaluation tracking system could be set up to track and report the data needed for the EISA reporting file that ORNL must submit each year to DOE. The building energy evaluation tracking system can also generate evaluation reports based on the data input into the system. ORNL also worked with programmers to incorporate an ECM tracking system for all identified ECMs discussed in the Investment: EAct 20 in Section 9.1.1.

Edit Building Energy Evaluation		EIC	EUA	ESC
Facility Information				
Evaluation Status:	Complete	(Evaluation Cycle: 2021-2024)		
Site:	332 - Oak Ridge National Laboratory - SC			
Property Name:	Central Research & Administration North			
Property ID:	4500N			
Real Property Unique ID:	97301			
Ownership:	DOE Owned (O)			
FUA Description:	<input type="button" value="Import Text from FUA"/>			
EISA S432 Covered Characteristics				
Covered Facility?:	Covered			
Covered Changed Justification:				
Benchmarked with Portfolio Manager:	No			
Energy Consuming Sq. Ft.:	363758.00			
Prior FY Energy Use (10*6 x Btu/Yr):	74881.10739000			
Prior FY Water Use (10*3 x Gal/Yr):	499.61900000			
EISA S432 Evaluation Status (Combined)				
Previous 4-Year Evaluation Cycle Date:	09/30/2017			
Current 4-Year Evaluation Cycle Date:	04/15/2021			
Evaluation Type/Level:	ASHRAE Level 1			
EISA S432 Cx & Notes				
Retro/Re-Commissioning Assessment:	Yes			
Notes:				
Additional ORNL Information				
Building LED Coverage:				
Lighting Controls:	(Select)	Comments:		
HVAC Setbacks:	(Select)	Comments:		
Re-Commission Date:				
SkySpark Integration:	(Select)	Comments:		
<input type="button" value="Save & Close"/> <input type="button" value="Apply Changes"/> <input type="button" value="Cancel"/>				

Figure 12. Building energy evaluation tool input screen.

4.7.2 Plans and Projected Performance

In FY 2024, ORNL will start the fourth year of the 4-year energy audit cycle. This will be the first year that all building audits will be completed using the newly developed building energy audit evaluation tool shown in Figure 12. This tool is a major first step in ORNLs planed approach to enhance documentation of energy audits and ECMs. The new application will streamline ORNLs ECM and project funding decision matrix by compiling all decision criteria in one central location, thus aiding in the compliance with EAct 20.

The future vision is for programmers to incorporate a collaborative screen between the two reporting needs, FCAs and EISA audits, to collectively show all the needed projects within a single building. A combined system of actionable projects that could accomplish two designated requirements could allow for improved decision-making data for funding moving forward. ORNL will also include general and deferred maintenance as a factor to consider when prioritizing ECMs each year, along with consideration for safety and environmental benefits.

4.8 ENERGY MANAGEMENT: FACILITY METERING

4.8.1 Performance Status

All facility metering is presently documented and updated in ORNL's work management and enterprise asset management system, Infor EAM. Utilizing the capabilities of Esri ArcGIS at ORNL, asset information is joined with utility distribution system information into a site utilities metering dashboard in Esri ArcGIS. This dashboard provides insight into the facility utility connections that are currently metered across every utility and facility on campus. With this dashboard, which serves as a master meter report, ORNL can determine unmetered facility connections and then prioritize resources toward the installation of additional metering. The metering dashboard serves as a comprehensive document that charts a course for ORNL's continued advanced metering deployment, supporting ORNL's alignment with the October 2022 Federal Metering Guidance (US Department of Energy Office of Energy Efficiency & Renewable Energy, 2022) and with current DOE directives focused on advanced utility metering where cost-effective and appropriate. In using ArcGIS, the metering plan and meter implementation process becomes institutionalized in ORNL's systems so that once a meter is added as an asset, it can be tracked and reported in the meter network (Figure 13).

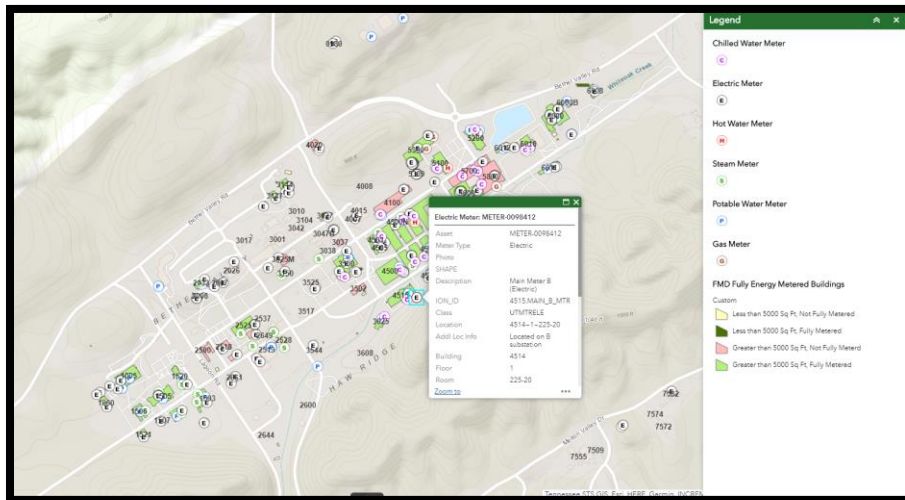


Figure 13. ArcGIS map of the meter network across ORNL.

An electric meter was selected to show the information tracked for each meter.

The total number of facility and distribution meters, the connection points to facilities, the number of facilities that are fully or partially metered, and where these meters are located are now tracked and interconnected between Infor EAM and ArcGIS (Figure 14). All mechanical meters are integrated into this process for inclusion in the meter plan report, and the integration of electrical metering into this process was completed in FY 2023.

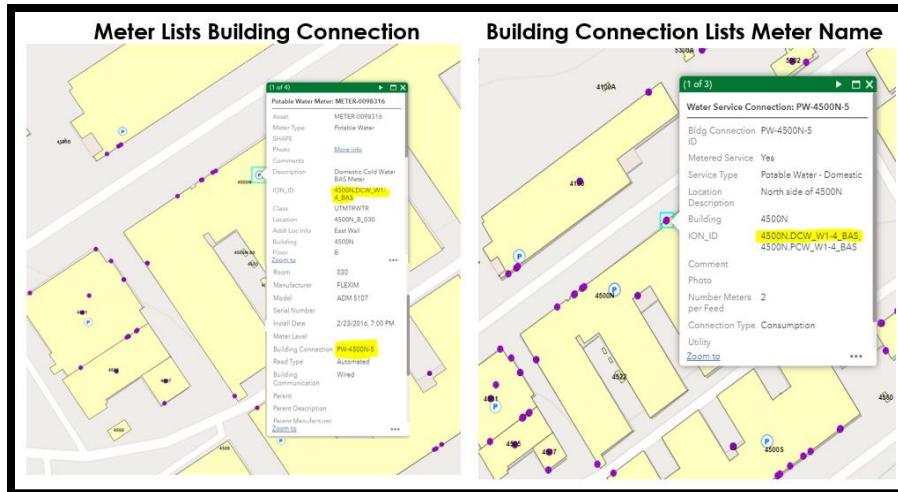


Figure 14. ArcGIS map showing meters connected to utility building connection feeds.
Once a meter is linked to connection points (purple dots), a meter plan (as well as meter gap analysis) can be developed.

In FY 2023, ORNL added 23 new advanced utility meters (including computational metering and electrical utility distribution metering), migrated 1 new data stream from other systems across the lab, and replaced 3 meters. ORNL meter installations include electrical, steam/hot water, natural gas, chilled water, and potable water. The meters were connected to ORNL’s CEDS, which is a network of systems used for data archiving and analysis. CEDS serves to securely collect, archive, and display advanced utility meter data from the network of utility meters installed throughout the laboratory. CEDS logs multiple parameters from each meter on a standard 15 min 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.

RA, the newest tool in CEDS, was deployed in FY 2017. Since its deployment, RA’s advanced configuration capabilities have been used 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 utilization. RA also directly feeds metered energy data into ENERGY STAR for benchmarking.

The meter network and CEDS were crucial assets in achieving the DOE 50001 Ready certification for 65 FMD buildings in FY 2019 and recertification in FY 2020 and FY 2021. The documentation of the meter plan, the use of the energy systems collecting and reporting energy data, RA’s configuration capabilities, and the meter alerts helped ORNL with DOE 50001 Ready tasks such as energy analysis, monitoring and measurement, and corrective actions. As ORNL’s network of advanced utility meters continues to grow, the DOE 50001 Ready platform complements the CEDS system by creating a systematic program for using the energy data and documenting the energy program. The continued development of the CEDS network, combined with the DOE 50001 Ready standards and structure, will help provide management decision tools to attain energy and water efficiency goals and cost savings.

Meters are also used in the following ways:

- ORNL uses its robust meter network to establish a process for continuous energy monitoring using a meter alert capability within CEDS. Alerts are placed on real-time readings for mechanical utility meters, including steam, chilled water, natural gas, and potable water for all buildings that have

mechanical meters. Alert parameters are determined by reviewing meter trend history and analyzing as many months or prior years as possible to obtain an accurate representative trend for each building's utility baseline use. Meter alerts have been used to identify and prevent unnecessary waste.

- Metering at service entrances to ORNL is used to validate services for utility provider payments (electricity, natural gas, and water).
- The service-level meters are used along with building-level metering to distribute utility service costs among programs at ORNL for cost recovery.
- Meters are used for tracking the use of energy, fuel, and water for various data-reporting requirements and to help identify problems and potential conservation opportunities.
- Metering is used in the review of the M&V report for the ESPC with JCI.
- Metering assists with measurements of on-site electrical generation at the solar arrays.

As with any project of this scale, continued meter deployment will not be without barriers. These barriers may include installation funding limitations, alternative prioritizations of the installation labor force, utility outages or service interruptions required to accommodate installations, and other technical challenges.

4.8.2 Plans and Projected Performance

All buildings should have been fully metered by FY 2022 per EAct 20. ORNL is not 100% metered (energy and water) for all buildings per the 2022 federal metering guidance. ORNL is currently working on establishing a plan for achieving fully metered status based on the metering requirements defined in the DOE Order 436.1A Contractor Requirements Document. ORNL will continue to add metering each year to SC-owned buildings that are required to be metered as designated by the DOE Sustainability Dashboard (based on the 2022 federal metering guidance).

The asset management and geographic information system mapping of the utility services and the associated advanced utility meters will continue to be documented, maintained, and expanded upon into the future. The institutionalized meter plan report will be a valuable asset that will help maintain and document the meter network into the future. Specific focus will be on integrating the electric metering network into the report. ORNL will continue to use the metering plan for guidance in installing additional advanced utility meters, where cost-effective and appropriate, on all utilities. All utility meters will be connected to ORNL's CEDS for data analysis and archiving.

RA can be used to expand energy awareness with more robust dashboards and analyses for facility managers, facility engineers, and eventually the greater laboratory population. RA is currently being developed to track energy reporting throughout the year using meter data and allocation data when building-level meters are not available for improved reporting and tracking of EUI throughout the year. Additional metering will expand building-level EUI and WUI tracking for potential project opportunities and reporting metrics and will enhance cost recovery efforts.

ORNL will continue learning more about the 24/7 CFE requirements and determining whether there are metering needs necessary to meet the CFE goals. ORNL is well positioned with electricity metering to support this effort, but further investigation of the goal and further understanding of the metering needs or gaps will be required.

4.9 ENERGY MANAGEMENT: NON-FLEET VEHICLES AND EQUIPMENT

4.9.1 Performance Status

At only a fraction of 1% of all facility energy, non-fleet fuels (for facility vehicles and equipment) are a comparatively minor source of energy usage and emissions at ORNL. ORNL remains in compliance with reporting and tracking the use of these fuels (diesel, biodiesel, gasoline, and oils) for DOE SSP reporting and performance.

For FY 2023, the combined fuel consumption of generators, landscaping equipment, and heavy machinery increased by approximately 52% from FY 2022. Improved methodology for collecting fuel information and better categorization of utility vehicles and equipment resulted in additional fuel consumption for non-fleet vehicles and equipment.

4.9.2 Plans and Projected Performance

ORNL will continue to upgrade equipment with more energy-efficient options. Sustainable ORNL and the Fleet Management team will continue to look for opportunities to upgrade existing non-fleet vehicles. ORNL will consider fuel-efficiency and improved emissions specifications for future generator purchases.

4.10 ENERGY MANAGEMENT: EUI FACILITY IDENTIFICATION

Figure 15 identifies 42 EUIs for buildings in the Goal Subject category that are greater than 5,000 GSF with EUIs of 237,514 Btu/GSF or greater. The FY 2023 EUI of 237,514 Btu/GSF is also identified on the chart. Buildings in excess of the current EUI will be the focus of energy conservation activities in the future because improvements in EUI are necessary to meet several of the DOE energy management and sustainability objectives. As expected, buildings with the greatest EUIs are associated with HEMSF research systems (Excluded category) but are not included in this figure.

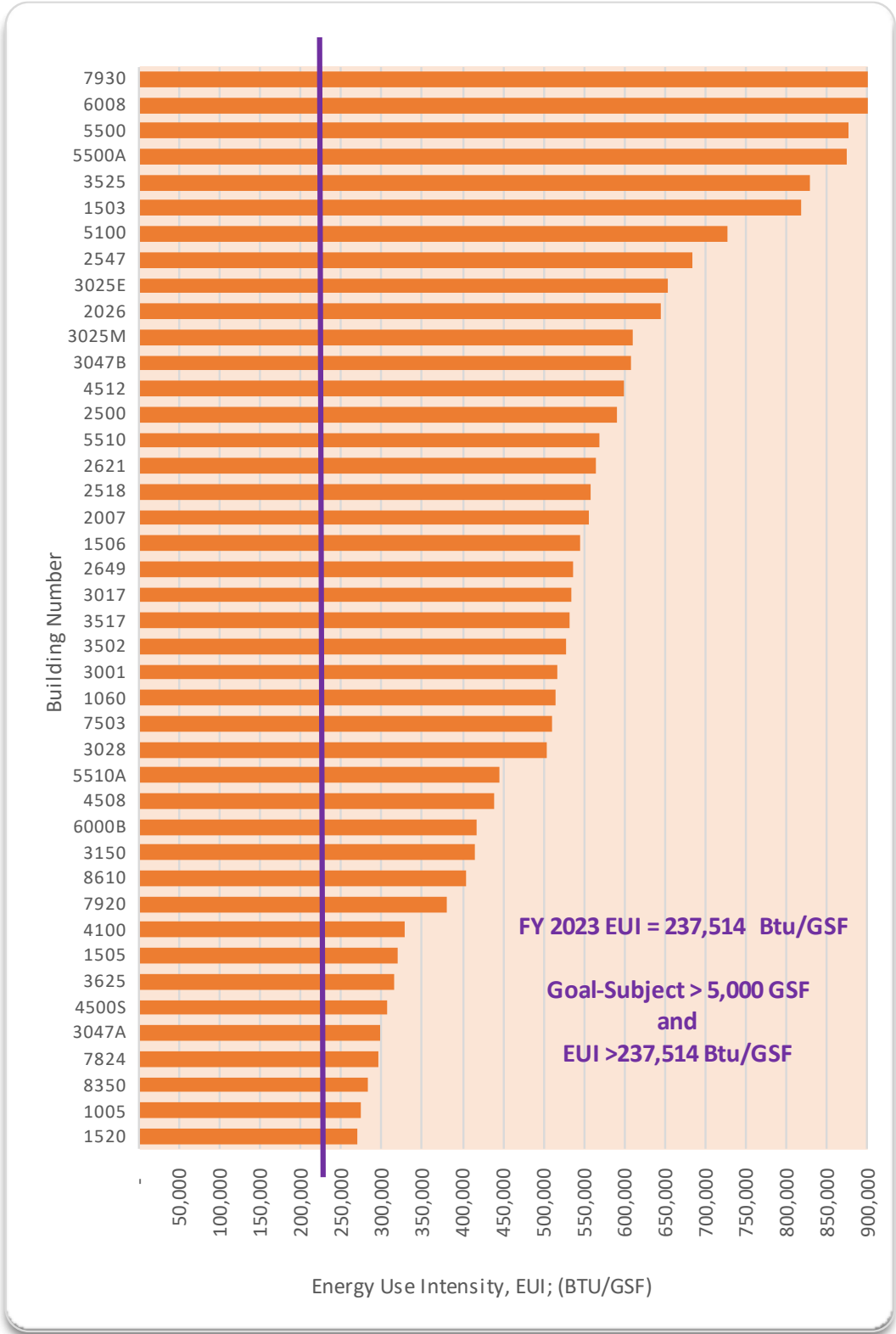


Figure 15. FY 2023 EUI by building at ORNL.

5. WATER MANAGEMENT

5.1 WATER MANAGEMENT: WATER USE INTENSITY

5.1.1 Performance Status

ORNL procures potable water from the city of Oak Ridge for domestic use (e.g., handwashing, flushing), cooling (e.g., cooling towers, chillers), heating (e.g., steam generation, hot water generation), limited landscape irrigation, laboratories, and special research processes. ORNL does not utilize gray water or ILA water.

ORNL has long been aware of the benefits of effective water management, having already experienced a 62.7% reduction in water use compared with its highest level of water use experienced in FY 1985. A firmly established, aggressive plan continues to be deployed. Numerous strategies are engaged to reduce water consumption, including repairing leaks, replacing old lines in the site water distribution system, and eliminating once-through cooling (OTC) where possible. FY 2023 water consumption increased by 8.7% from FY 2022, partially because of increased operations at HFIR and SNS and the increased HPC mission. ORNL’s total water consumption has decreased by 24.0% since the FY 2007 baseline (Figure 16). Water consumption is expected to decrease slightly in FY 2024 and FY 2025 because of limited SNS operations to support the Proton Power Upgrade project, although this decrease will be offset by a growing HPC mission. As SNS returns to normal operations and with an increased HPC mission, ORNL’s water consumption is projected to increase by 17.1% by FY 2030.

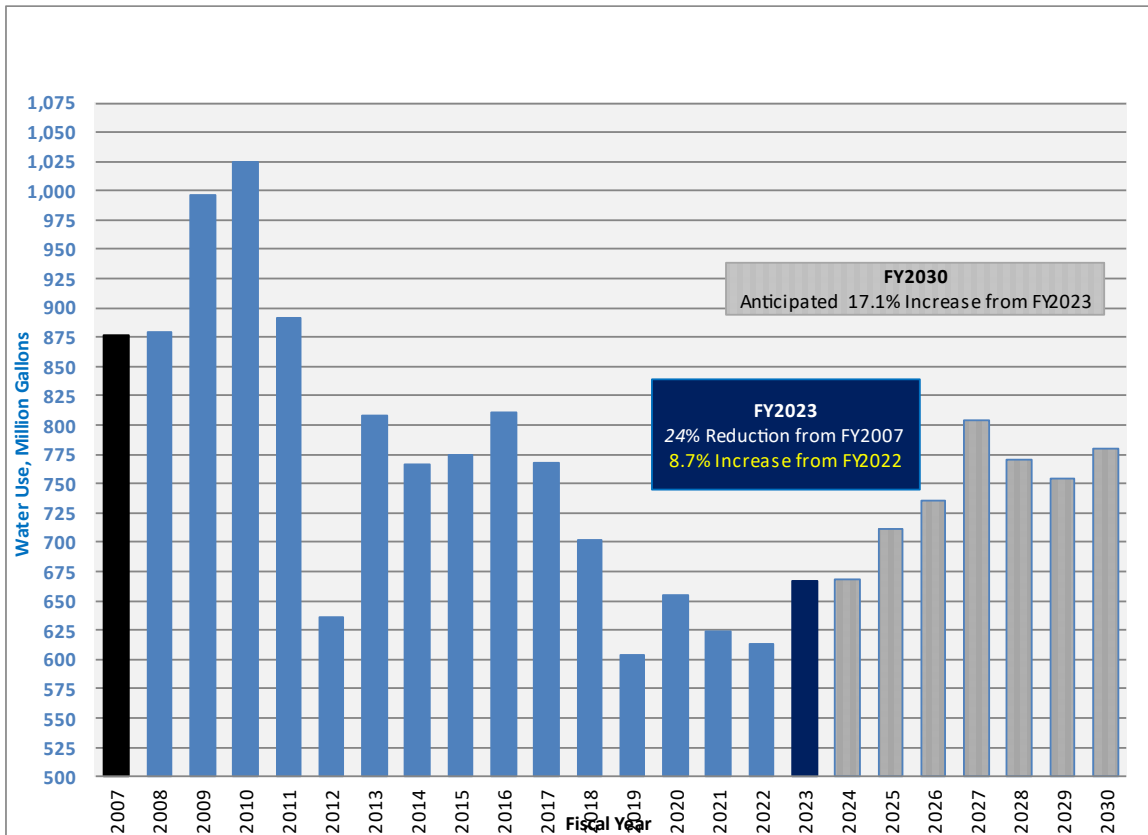


Figure 16. Historical, current (FY 2023), and projected water use at ORNL.

The FY 2023 water consumption yields a WUI of 148.2 G/GSF, which is an increase of 7.7% from FY 2022 (Figure 17), missing the desired 0.5% annual reduction goal.

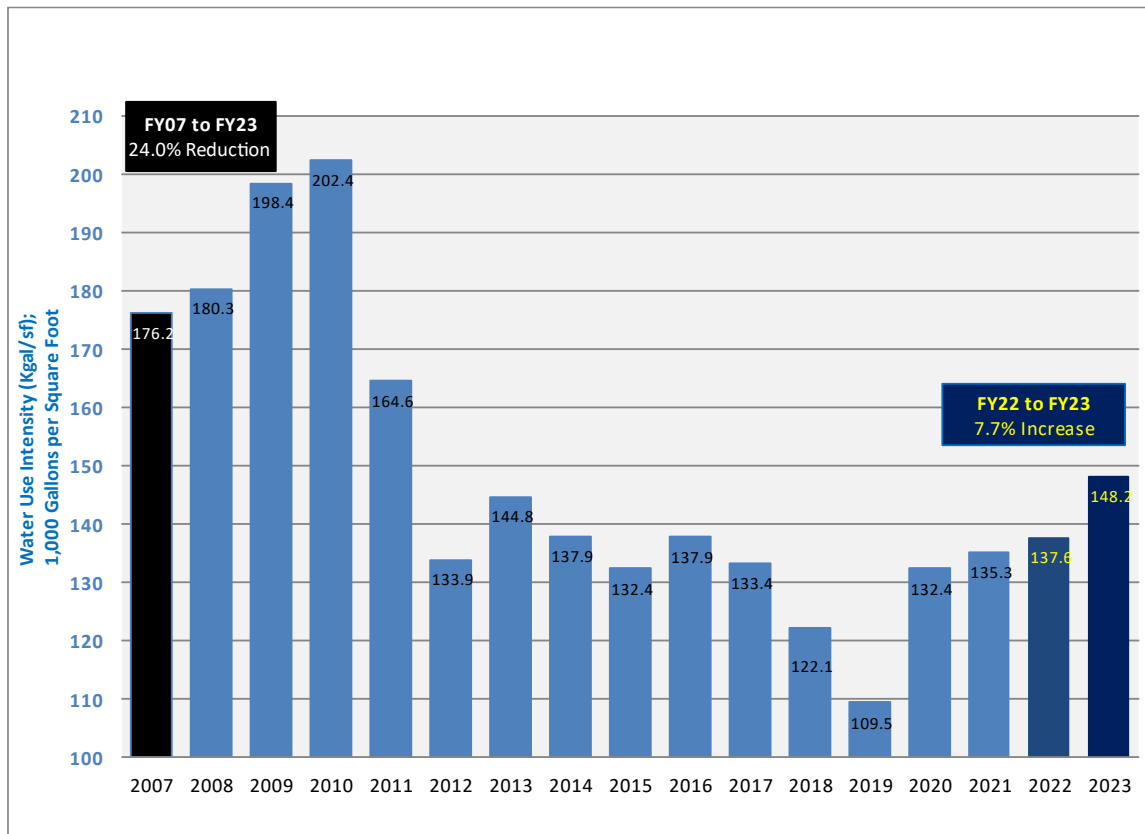


Figure 17. Baseline (FY 2007) to current (FY 2023) WUI at ORNL.

ORNL’s End-Use Water Consumption

Typical site services such as chilled water and steam/heating production share water use across the facilities that receive those services (Figure 18). Base water use (48% of total water use) is considered more typical in conventional offices and standard laboratories for traditional handwashing/flushing and some research-related water use. Base water is a prime target for energy conservation opportunities. OTC processes have been significantly reduced at ORNL.

Although DOE does not permit excluding water consumption for high-intensity processes for WUI calculations, Figure 18 shows that 32% of ORNL’s end-use water consumption is dedicated to research and process activities. This includes dedicated water for cooling tower makeup for HPC (such as Summit and Frontier), SNS processes, and HFIR.

These research/process users and utility service providers have a combined dedicated WUI of 227.8 G/GSF, serving approximately 940,897 GSF. This WUI for special processes is significantly higher than ORNL’s integrated WUI of 148.2 G/GSF. Because of the mission-specific nature of process water consumption and the dedicated service areas, a logical consideration should be made for the exclusion of these intensive areas. If the exclusion procedures were applied to mission-specific water use, ORNL’s WUI would drop to approximately 127.2 G/GSF, which would be a more reasonable metric for targeting water reduction opportunities.

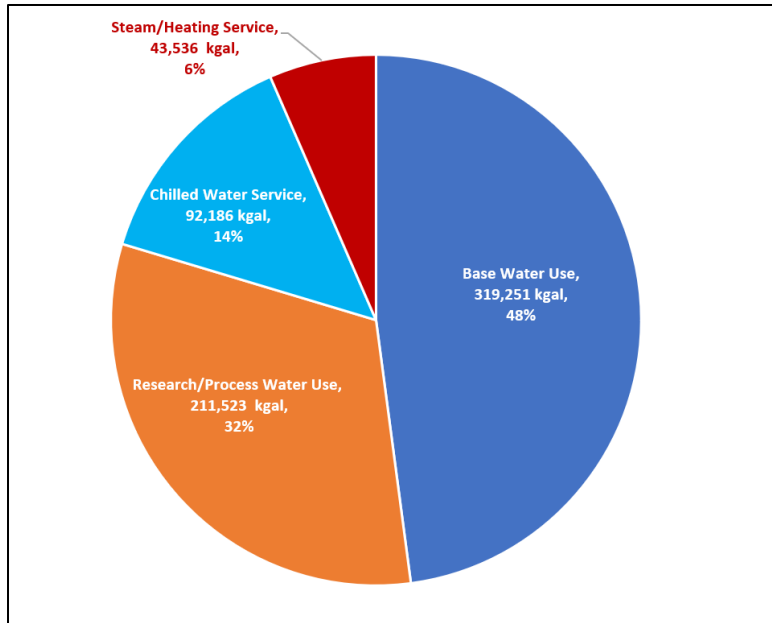


Figure 18. ORNL’s detailed end-use water consumption for FY 2023.

Water Management ECMs and Initiatives in FY 2023

In the past few years, ORNL has reduced OTC processes throughout the campus. Mechanical utilities personnel have been working on water consumption reduction through utilities repairs and upgrades. On occasion, ORNL engineering groups review the feasibility of alternative water options. If there is a potential option for alternative water to be cost-effective in new construction, it can be included as one of the noncore GPs. However, factors such as cost and complexity of water treatment for some of these alternatives make them difficult to implement. ORNL will continue to explore alternative water sources when cost-effective and feasible, but in the meantime, ORNL is focused on overall water consumption reduction when possible.

Environmental compliance specialists have agreed to inform the EE&S program when/if there is a request for water use variances to see whether these needs can be engineered to avoid OTC when possible.

Efforts to maintain WUI-improving measures were initiated in FY 2008 upon the award of an ESPC. Year 11 contract performance indicates a water savings of 170 Mgal/year.

To gain a better understanding of water use at ORNL, a water-metering plan is being implemented. Many of ORNL’s most significant water-consuming facilities and utility processes, such as cooling tower makeup water, have been updated with advanced meters that are connected to CEDS and are collecting interval data. These data are used to understand water end uses, consumption patterns, and potential opportunities for WUI reduction.

The aggressive campaign to repair leaks and to replace failed components in the vintage water distribution system continued in FY 2023.

Design and construction support for the new sewage treatment plant project is ongoing with commissioning planned for July 2024. Tie-in points were completed to interface existing utility systems to the new facility. Support was provided to the contractor for excavation of contaminated soils to maintain the project’s schedule.

Utilities support was provided for the design and procurement team to initiate the replacement of the 3501 lift station. The project will improve the reliability of the sewage collection system and is expected to be complete in FY 2024.

Utilities replacement of 11 aging and damaged fire hydrants has been completed in FY2023, with the last one planned for replacement in early FY 2024.

The DOSAR Pumphouse will be upgraded with new pumps, new panel, and flow meter.

A water balance is in development to better identify facilities with water connections and estimate/meter their water consumption as an improved methodology to collect and project water consumption and highlight water conservation opportunities.

Stormwater Management

Section 438 of EISA of 2007 stipulates that any development or redevelopment project involving a federal facility with a footprint that exceeds 5,000 ft² shall use site planning, design, construction, and maintenance strategies for the property to maintain or restore, to the maximum extent technically feasible, the predevelopment hydrology of the property with regard to the temperature, rate, volume, and duration of flow.

F&O's Laboratory Modernization Division, through the division's environmental compliance representative, evaluates any development or redevelopment project that exceeds the net 5,000 ft² footprint of new impervious area. ORNL's approach to addressing EISA Section 438 requirements for stormwater management was revised. Because of the soil types (low permeability) and karst geology, conditions exist at ORNL that would allow for claiming technical infeasibility as described in technical guidance from EPA Section 2009b. Clay soils have low infiltrative capacities, and the introduction of more water to the subsurface in a karst geology can accelerate the formation of sinkholes. As a result of these two geological conditions at ORNL, the use of subsurface infiltration to address EISA Section 438 is being pursued only on a limited basis. Instead, mitigation strategies (e.g., improvement of streams and their associated buffer zones, installation of water quality systems and devices to improve water quality, and strategies that would allow for additional evapotranspiration) are being pursued. Implementing this revised approach to EISA Section 438 compliance as opposed to claiming technical infeasibility demonstrates ORNL's commitment to environmental stewardship. If projects take place in existing contaminated areas or where an area approach is not feasible, technical infeasibility is claimed to prevent potential movement of contamination within soil or groundwater.

When possible, this environmental stewardship approach is implemented on an area basis at ORNL. Addressing EISA Section 438 on an area basis instead of a project-by-project basis allows for the following:

- Stormwater runoff from adjacent areas can be diverted around developed areas to keep water quality high.
- Water quality structures/devices can be installed to handle runoff from developed areas, thus reducing the number of water quality structures/devices to be installed and maintained.
- Individual projects are not burdened with the costs associated with addressing EISA Section 438 requirements.
- Sustainable landscaping efforts include the use of native plant species which are better adapted to local environmental conditions, therefore reducing overall maintenance and irrigation needs.
- Riparian buffer zones are enhanced through planting of native vegetation and removal of invasive plant species. A healthy riparian zone allows for better stormwater filtration and infiltration.

In FY 2023, no EISA Section 438 projects were completed. There was a project, not a building but rather a parking lot in the 7600 Area, where ORNL installed infiltration swales for water-quality and temperature-reduction reasons. The parking lot is immediately adjacent to the riparian zones of a tributary; therefore, ORNL wanted to reduce first-flush contaminants and the temperature of the stormwater runoff from this newly paved parking lot.

Projects are assessed for applicability of Section 438 by evaluating existing impervious area within the project footprint and then the amount of impervious area the new development will create. If the new impervious area less the existing impervious area is less than 5,000 ft², then Section 438 is not considered to be applicable to the new development. At ORNL, clayey soils severely limit the infiltration of stormwater, and the introduction of additional groundwater to the underlying karst geology could accelerate the formation of sinkholes. Instead of using subsurface infiltration to meet the requirements of Section 438 of the EISA, DOE pursues (1) improvement of streams and associated buffer zones and/or (2) installation of water quality devices/systems to improve water quality and allow for additional evapotranspiration to occur. This approach is typically applied on an area or project-by-project basis at ORNL, depending on the location of the project. Additionally, projects located within contaminated areas will claim exemptions from EISA Section 438 because of the potential for expanding or moving contamination caused by introduction of additional subsurface water flow. DOE uses this approach to show environmental stewardship rather than claiming the “technical infeasibility” allowed under EISA because of the existing soils and underlying geologic conditions.

In the future, ORNL projects Building 6100 will comply with Section 438 for maintaining or restoring predevelopment hydrology.

The ORNL Utilities Division provided a conditions statement for current stormwater systems in use on the campus. The stormwater collection system consists of drainage ditches, catch basins, manholes, and collection pipes that convey stormwater, condensate, and cooling water flows to the receiving streams. White Oak Creek traverses the ORNL site and ultimately receives all the discharges from ORNL as well as normal flows from the four tributaries that feed it. Rainfall, snowmelt, and other authorized flows are directed to the gravity-drainage system that conveys the water from buildings, parking lots, streets, and roofs to specific outfalls. The collection system itself was installed in an unplanned manner over the years as ORNL developed and matured, which has resulted in the existence of 155 National Pollutant Discharge Elimination System (NPDES)-permitted stormwater outfalls discharging into the receiving streams. To comply with current stormwater regulations and ORNL’s NPDES permit, each of these outfalls must be periodically sampled and characterized to determine the makeup of the discharge stream and to ensure that it complies with permit requirements. The condition and performance of the stormwater collection system is very good. Under all but the worst of conditions, the system removes storm flows from the laboratory grounds without flooding or other damage.

5.1.2 Plans and Projected Performance

ORNL is working with a third party to perform a site-wide utility infrastructure assessment. The assessment’s anticipated upgrades to the water distribution system will be identified for water efficiency, maintenance reductions, and reliability improvements.

Current performance and future projections indicate that ORNL’s WUI is subject to rise because of increased demands for cooling tower makeup water to support the growth of HPC systems. Therefore, ORNL must aggressively pursue additional water-savings opportunities to offset mission-specific demands to continue to reduce overall water consumption. With continued modernization activities that include the elimination of old facilities and the addition of new facilities, ORNL must consider more

water-efficient systems and maintain a focus on water management best practices to meet future WUI reduction goals.

Planned growth to support ORNL’s HPC mission is projected to result in additional water consumption for cooling towers. While the HPC mission growth continues, current plans indicate the water use is expected to peak in FY 2030 at 176 Mgal/year.

Building-specific locations and other strategic points across the site’s water distribution system will continue to be evaluated for the installation of advanced metering in accordance with EAct 20. A thorough analysis of accumulated water meter interval data will be a priority in the pursuit of reducing consumption. ORNL is putting a large emphasis on building-level water metering in the next few years because of the EAct 20 metering requirement that now includes water metering. Compared with other energy utilities at ORNL, water metering will need to be a focus to catch up to 100% metered. Water metering will be a priority for ORNL EE&S metering efforts going forward.

Distribution meters for various areas throughout the campus were obtained in FY 2021 with the intent to install them in the near term using a cost-effective approach. Some distribution meters were installed in FY 2022, and more will be installed in the coming years.

Distribution and building-level water meters, facility audits, site-wide water crosstie connection surveys, and ArcGIS water distribution maps help ORNL further understand on-site water usage, which will aid in identifying new water conservation opportunities.

ORNL will continue to identify and repair leaks and replacement component failures in the vintage water distribution system.

5.2 WATER MANAGEMENT: WATER CONSUMPTION AND HEMSF RESEARCH

ORNL’s HEMSF systems accounted for 38% of ORNL’s water use in FY 2023 and are expected to remain around 37% in FY 2030. HPC activities were responsible for 19% of ORNL’s water consumption in FY 2023; that amount is expected to increase by 20% in FY 2030 (Figure 19).

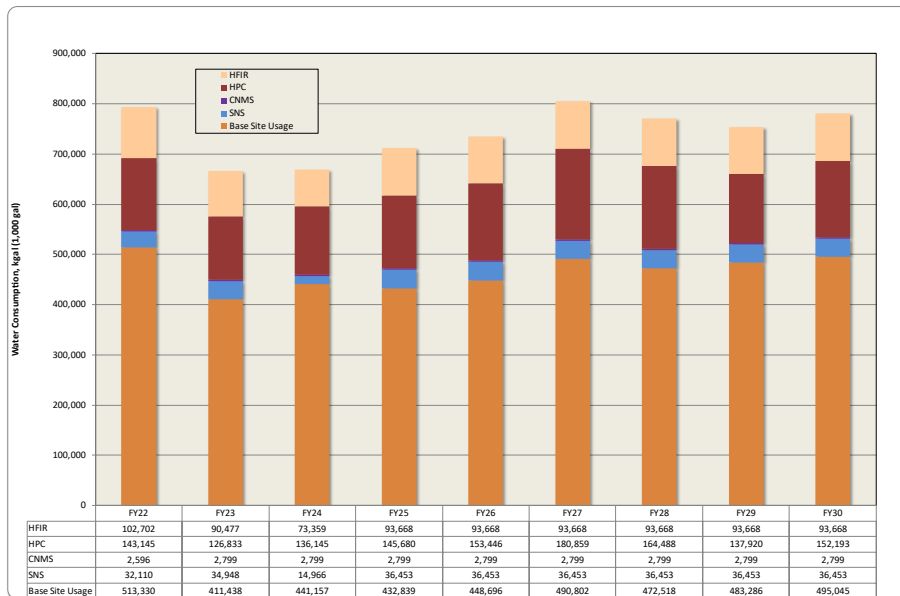


Figure 19. Current (FY 2023) and projected HEMSF water consumption at ORNL.

5.3 WATER MANAGEMENT: WUI FACILITY IDENTIFICATION

ORNL’s mission requires the use of water for processes and cooling services. The 25 facilities identified in Figure 20, several of which are associated with chilled water and steam production, had the highest WUIs at ORNL in FY 2023. As with energy, ORNL’s water consumption is directly tied to mission-critical research growth and is expected to increase in the next 10 years.

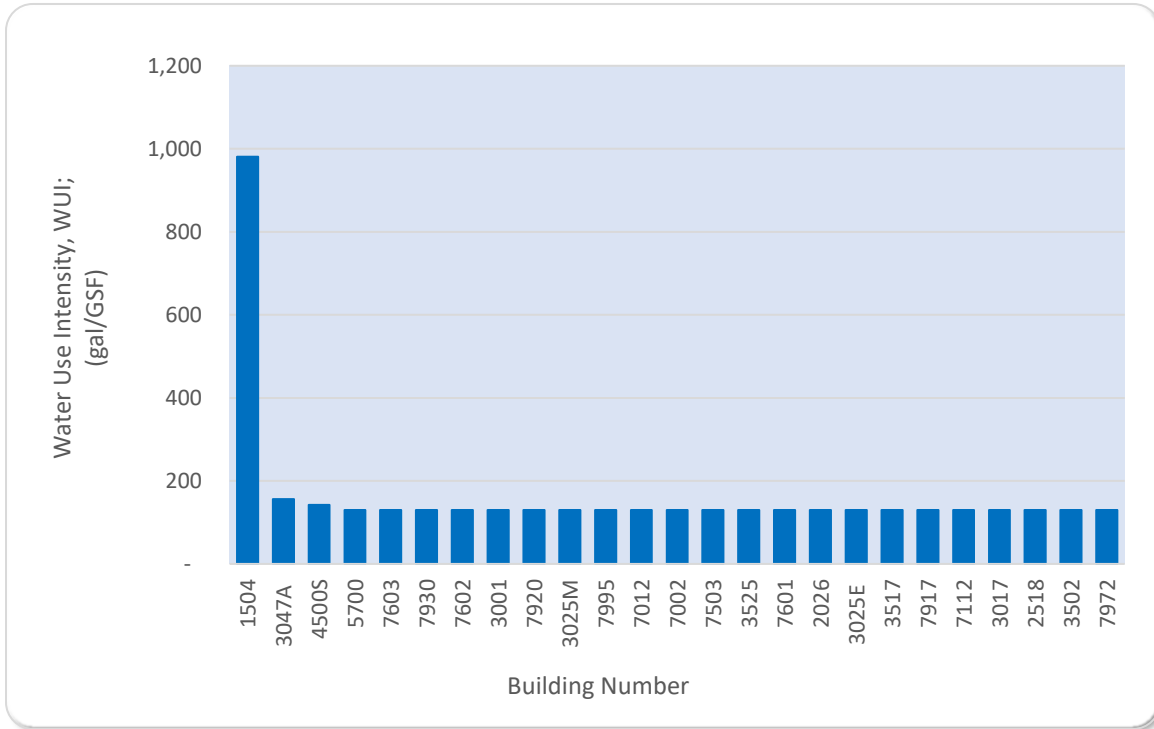


Figure 20. ORNL facilities with the highest WUIs in FY 2023.

Forty-two facilities are responsible for 80% of ORNL’s total water consumption. Again, chilled water and steam production, HFIR, and SNS are the largest consumers of water. Twenty-five of the largest water consumers are shown in Figure 21.

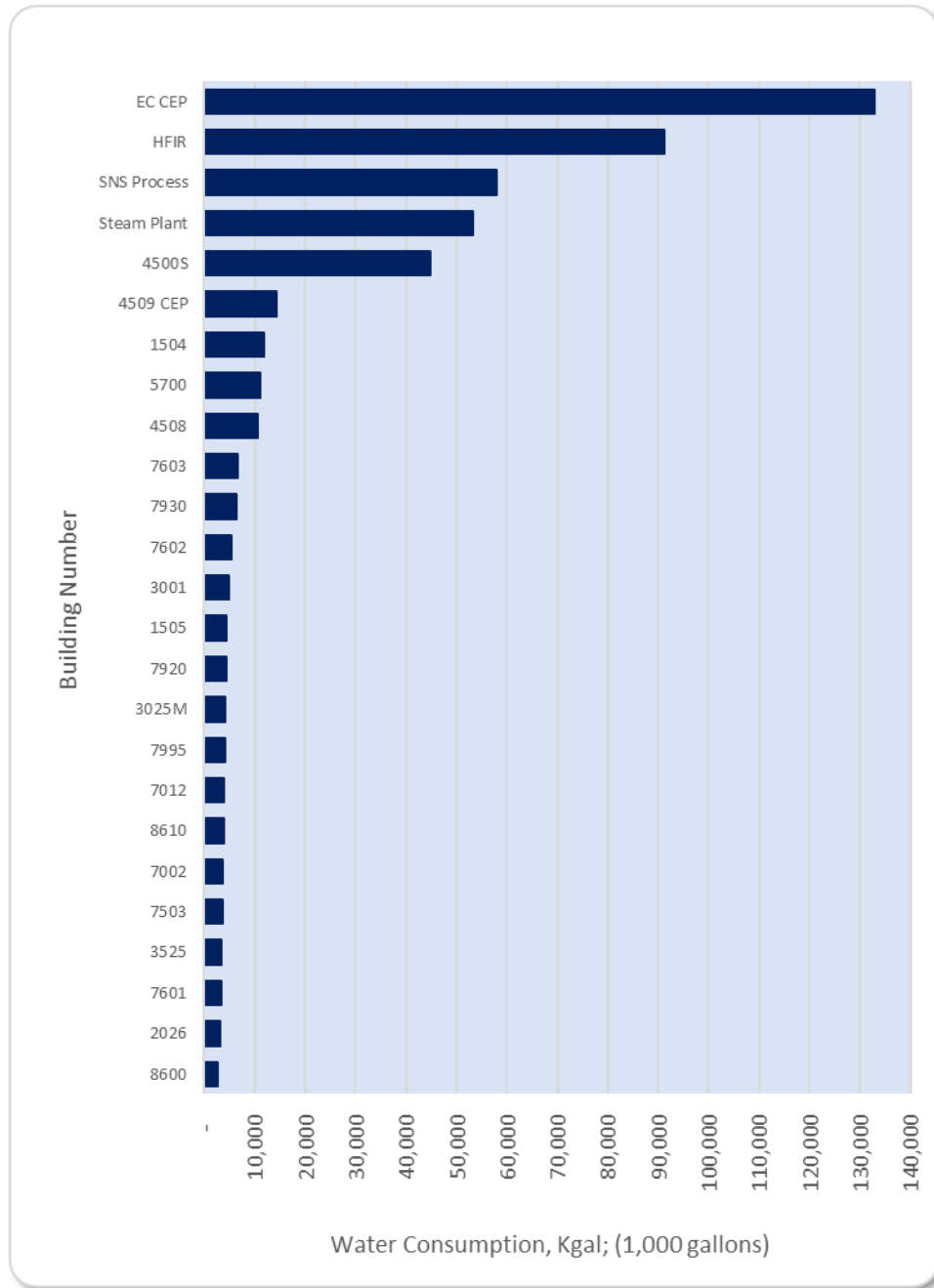


Figure 21. Largest water consuming facilities at ORNL in FY 2023.

6. FLEET MANAGEMENT

6.1 PERFORMANCE STATUS

ORNL has continued to increase the number of AFVs, hybrid vehicles, and plug-in hybrid electric vehicles (PHEVs) when options are available. Currently, 80% of all ORNL fleet vehicles are AFVs. Since FY 2020, ORNL has replaced 350 vehicles, of which 309, or 88%, have been AFVs, hybrid vehicles, or PHEVs.

Fleet managers continued coordination with vehicle custodians during FY 2023 acquisitions to ensure vehicle rightsizing while also meeting mission-critical needs. This effort also allows the fleet manager to place custodians in more fuel-efficient vehicles such as AFVs and EVs when applicable, lowering the emissions impact and overall GHG produced by ORNL.

ORNL uses internal operating procedures, including home-to-work, and follows all applicable Code of Federal Regulations that govern procurement, utilization, disposition, and mission support while working closely with federal oversight.

ORNL uses an in-house-developed fleet management information system. This system is called Facility Services Center (FSC), and Fleet Management uses it for internal tracking, recordkeeping, and work orders generated on vehicles. Agency-owned vehicles' annual maintenance is also tracked in FSC. However, General Services Administration (GSA)-leased vehicles' annual maintenance is tracked through GSA Drive-thru.

The fleet office has grown by one employee to support the electrification requirements into the future. The ORNL fleet management organization structure is shown in Figure 22.

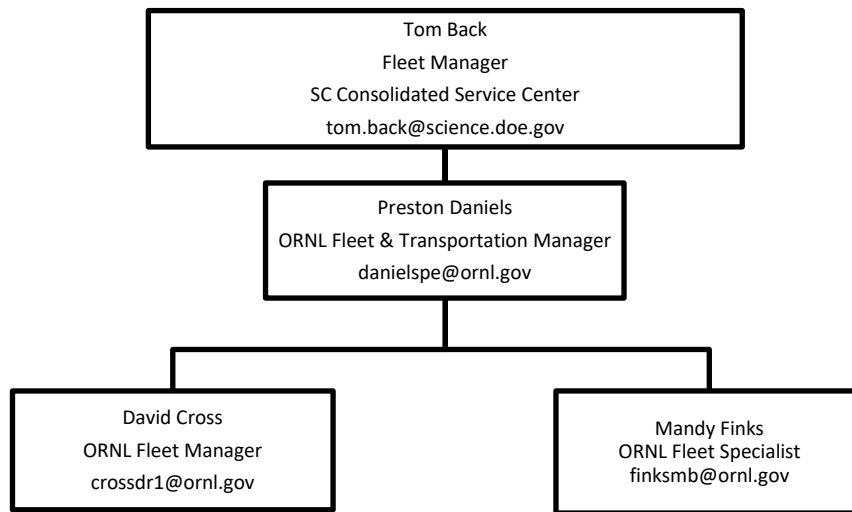


Figure 22. ORNL Fleet Management organizational structure.

6.1.1 Alternative Fuel Use and Infrastructure

In accordance with DOE guidance, ORNL Fleet Management continues to stress the use of alternative fuels. The alternative fuel available on-site is E-85. Fleet Management continues to examine available technologies to upgrade ORNL's on-site fueling station.

6.2 PLANS AND PROJECTED PERFORMANCE

The fleet office is coordinating with the ORNL Laboratory Modernization Division to locate optimal locations for future vehicle charging stations and include them in the pooling program project. Zero-emissions vehicle (ZEV) charging infrastructure will not be provided for home-to-work.

6.3 ZEV CURRENT AND PROJECTED PERFORMANCE

ORNL fleet currently has five PHEVs that are utilized as gas vehicles because ORNL does not yet have the infrastructure to charge them. The plan is to pursue the following tasks in ORNL's ongoing efforts to increase the fuel efficiency of its fleet, to maximize utilization, and to move toward a net-zero fleet:

- The expansion of projects at ORNL has led to an increase in fleet size since FY 2021. As the laboratory continues to explore options of teleworking and the launch of a passenger-carrying vehicle pool, the ORNL fleet size could be redistributed or reduced to meet current and future missions.
- The ORNL Fleet Office has procured hardware and software that will allow the launch of a passenger-carrying vehicle pooling program in FY 2024. By pooling ORNL's passenger-carrying fleet, ORNL seeks to do the following:
 - Optimize vehicle utilization.
 - Expand vehicle options and accessibility for ORNL staff.
 - Right-size the ORNL fleet.
 - Align government-owned vehicle parking spaces for future EV charging station deployment.
- As ORNL moves toward the passenger-carrying vehicle pooling program, vehicle keys will be secured, and vehicle users will be tracked using technology associated with the pooling project. ORNL will utilize the capabilities of the telematics systems that ORNL deployed in vehicles in FY 2022. ORNL will use data from telematics for reporting and analysis functions within the pooling program. This addition to the software will allow ORNL to track utilization in real-time, ensuring that vehicles are used appropriately. The pooling locations should also be able to align the parking structure needed to align EV chargers for government spaces.
- When no AFV/EV models are available as a replacement option, ORNL will select vehicles with the best possible fuel economy.
- ORNL will continue to invest in improved technology and updated management practices to reduce fuel consumption.
- ORNL continues to structure a solid foundation for ZEV and electric vehicle supply equipment (EVSE). Goals are based on the progress toward DOE EO 14057 and implementing Order 436.1A.
 - ORNL anticipates delivery for the first ZEV in FY 2024. Most vehicles should be delivered around FY 2026.
 - In FY 2024, ORNL plans to establish the first five EVSE on-site. This installation will accommodate up to 10 ZEVs.
- As ORNL looks to deploy future EVSE around the site, site-specific challenges have affected implementation, such as having sufficient space to accommodate EVSE infrastructure. During FY 2024, ORNL will be able to establish parking lots to find the most suitable locations. Upon receiving ZEVs and/or EVSE, employees will receive training and communication on operations.
- ORNL will continue to investigate and be proactive in addressing the challenges of adding PHEVs and EVs to the ORNL fleet in greater numbers. This would require a study of electric plug-in capacity and the placement/location of charging stations.
- ORNL will investigate the tools that are available to improve EVSE and ZEV deployment.

7. CLEAN & RENEWABLE ENERGY

7.1 PERFORMANCE STATUS

In FY 2023, ORNL purchased RECs to supplement on-site renewable energy generation, representing 8.63% of the laboratory’s electrical energy consumption shown in Figure 23. ORNL on-site renewable energy and REC purchases resulted in a calculated renewable electricity usage of 48,572 MWh for the year. The result is a total renewable offset performance of 8.66%, including RECS and on-site generation, exceeding DOE’s 7.5% target as identified in EAct of 2005.

ORNL has identified multiple sources of renewable energy to offset the site’s total electrical consumption of 561,051 MWh, including the following:

- The 86 MWh of electricity produced on-site by five solar arrays accounted for 0.015% of ORNL electricity, which includes the double bonus allowed for on-site generation at federal facilities. Associated RECs are retained for use by the site.
- ORNL continued participation in TVA’s Green Flex program by purchasing 14,400 MWh of renewable energy in FY 2023.
- Via a competitive procurement, ORNL purchased 34,000 MWh of RECs from wind resources on the open market in FY 2023.
- ORNL’s FY 2023 REC procurement activity included the statement “Preference to Tribal Majority-Owned Business” in the request for proposal. Unfortunately, ORNL did not receive any bids for RECs generated on tribal lands.
- ORNL maintains an inventory of RECs that can be dedicated to specific buildings or projects to meet renewable energy goals for GP renewable energy criteria.

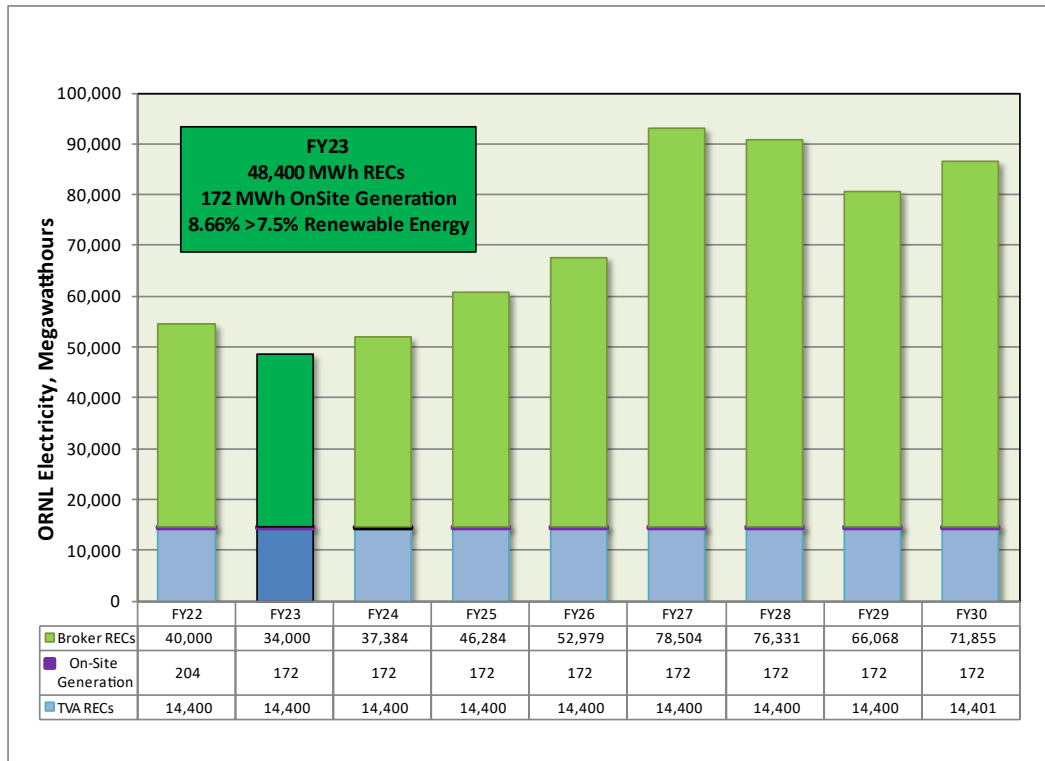


Figure 23. FY 2023 ORNL REC purchase details and projections.

7.2 PLANS AND PROJECTED PERFORMANCE

In the near term, ORNL will continue with recent strategies to purchase sufficient RECs to meet the renewable energy goal of EPC Act 2005 of 7.5% electrical energy, which will also temporarily count as CFE until suitable CFE or EACs are available for purchase. ORNL will continue to investigate on-site economically feasible renewable energy projects to minimize annual REC purchases. Strategies used to meet the renewable energy goals will also result in progress toward GHG emissions reduction. Specific plans include the following:

- Sustainable ORNL will take the lead in the continued investigation for a potential large-scale solar project at the main campus or a remote campus location. ORNL would like to encourage a project development plan that would combine research opportunities, such as microgrid research, with large solar installations for renewable credit. ORNL will continue to evaluate project concepts that include financial benefits such as investment tax credits and research grant opportunities.
- Life cycle cost analysis and project payback are critical when investing public funds; sustainable solutions must include financial considerations. Until renewable projects are identified and implemented to meet on-site renewable objectives, RECs and EACs, when available, will be the primary cost-effective means to meet DOE goals. ORNL will prioritize a strategy to develop on-site capabilities, ideally incorporating research possibilities, before considering other options.

ORNL REC purchase strategy options include the following:

- Looking into bundled RECs and EACs to count as credit for both CFE and EPC Act of 2005
- Periodically monitoring the REC and EAC open-market and considering purchasing opportunities as they arise
- Monitoring changes in renewable goals and striving to purchase the quantity of RECs needed to meet or exceed renewable targets as they change while maintaining good stewardship of government funding
- Planning for multiple strategic purchases throughout the year based on energy consumption projections and REC pricing to best fit the identified annual targets
- Seeking options to engage in a multiyear purchasing agreement that will provide a more streamlined and flexible procurement process
- Considering increasing participation with TVA's Green Flex Program to purchase additional RECs through the utility if cost/benefit analysis is favorable
- Developing specific REC strategic purchasing guidance to help incorporate these strategies into a viable document to help determine the best value for the long term; guidance should encourage brokers to provide better tribal options, include dedication of RECs to specific buildings for LEED (Leadership in Energy and Environmental Design) certification or GP certification for consideration for premium REC cost from tribal land resources, and other goals.
- Further evaluating opportunities to partner with the Defense Logistics Agency or the Western Area Power Administration to identify tribal RECs for purchase

7.3 CARBON POLLUTION-FREE ELECTRICITY

7.3.1 Performance Status

Per the defined methods for calculated percentage of CFE shown in Figure 24, ORNL had a 41.3% CFE in FY 2022 based on eGRID data. The 41.3% CFE is largely due to the grid supplied CFE from ORNL's supplied electricity region, or eGRID Subregion SRTV (SERC Tennessee Valley).

Figure 24 shows the specific numbers used to calculate ORNL’s percentage of CFE. Less than 1% of the current percentage of CFE comes from onsite generation.

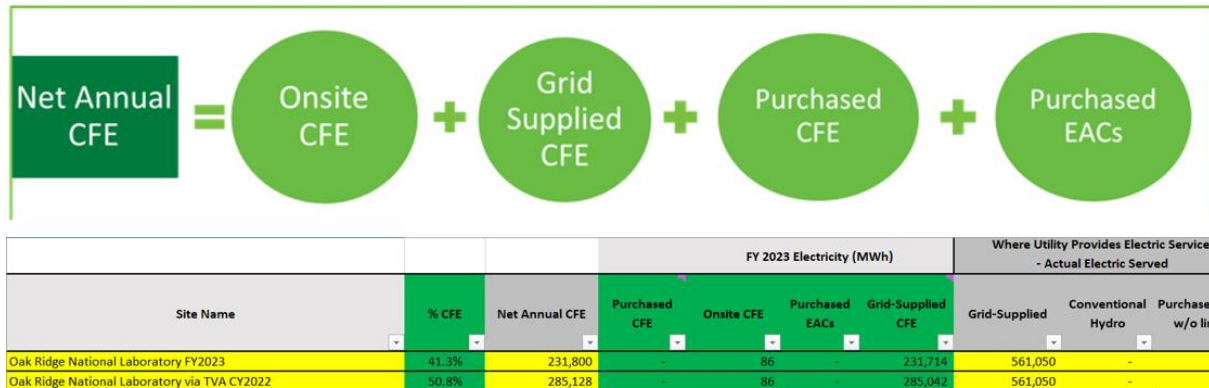


Figure 24. ORNL CFE calculation.

DOE is still refining the mechanics and methods of calculating and reporting meaningful CFE values at the site level. TVA provided their specific generation resource mix for calendar year 2022 (the most recent data), resulting in a TVA-dedicated 50.8% CFE. This value can be used to provide a more robust percentage of CFE provided from the electrical grid for ORNL’s consumption. More robust SPO supporting documentation should be available next year.

The SRTV region includes the TVA, which is ORNL’s direct electricity provider. It is estimated that TVA’s percentage of CFE, approximately 50.98% CFE, is currently higher than the eGRID subregion’s percentage of CFE production. Figure 25 outlines the net annual CFE calculation from 2005, with projections into future years for TVA’s decarbonization journey.

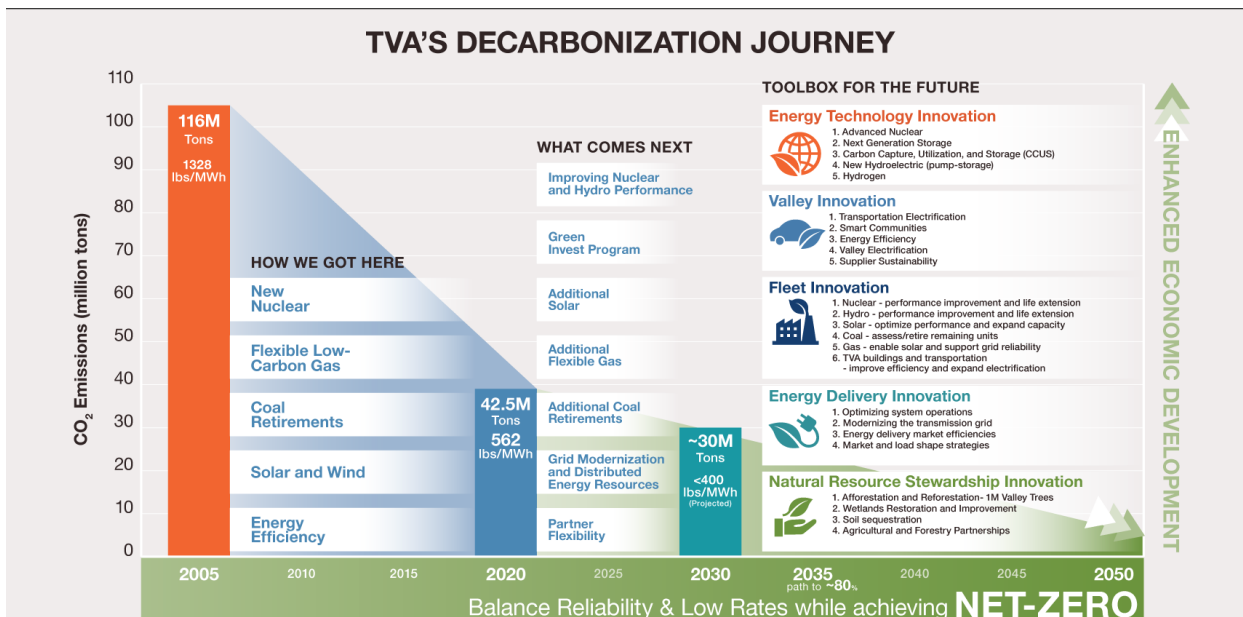


Figure 25. TVA’s CFE and net-zero projections (Tennessee Valley Authority 2021).

<https://www.tva.com/environment/environmental-stewardship/sustainability/carbon-report>

7.3.2 Plans and Projected Performance

ORNL’s annual projections or targets for percentage of CFE through FY 2030 are listed in Table 8. The baseline year is FY 2022, reported last year, when SPO provided the eGRID region data and specific CFE percentage for ORNL. For FY 2023, TVA’s CFE was used because ORNL is directly supplied by TVA. The TVA generation mix data were reported for the calendar year 2022 but were used for FY 2023 CFE percent reporting with an additional 7.5% CFE credit from the EPAct 2005 7.5% renewable electric energy requirement, resulting in an 58.3% CFE for FY 2023.

Table 8. ORNL’s baseline CFE and annual CFE performance targets

Fiscal year	Program office baseline and annual CFE performance target (%)
2022 ^a	44 ^b
2023	58.3 ^c
2024	60
2025	62
2026	64
2027	66
2028	68
2029	70
2030	100

^a baseline

^b eGRID (51% CFE for TVA)

^c assuming estimated TVA percentage of CFE

ORNL projects 100% CFE by FY 2030 to meet the federal goal. However, some caveats were identified before ORNL can achieve 100% CFE.

- In 2023, ORNL used the calendar year 2022 TVA generation mix to achieve 50.8% CFE supplied from the electrical grid. ORNL will use TVA’s percentage of CFE instead of the eGRID SRTV subregion’s percentage from 2023 to 2030 because ORNL’s electricity is provided directly from TVA.
- An additional 7.5% will be considered as CFE as the maximum allowable credit for REC purchases as a temporary allowance as CFE and EACs are in development.
- Most of ORNL’s annual CFE target increase relies upon TVA’s commitment to CFE increases through FY 2030 (Figure 25). TVA has projected that it will reach approximately 70% CFE by 2030. Because ORNL is a direct feed from TVA, the lab forecasts 70% CFE by FY 2029.
- The large jump between FY 2029 and FY 2030 is possible because of anticipated clean energy projects/applications, such as any potential future solar project or power purchasing agreements that are being investigated. ORNL will also consider EAC purchases if supply is available in the coming years, specifically if they are available between FY 2029 and FY 2030. The purchased EAC strategy to meet CFE goals will be accomplished on an as-needed basis and reevaluated annually. Due to the risk of the developing energy attribute markets, supply chain risk exists concerning EAC supply availability that cannot be foreseen. TVA will likely have established some EAC availability as FY 2030 approaches. Because of the many unknowns, ORNL may not be able to purchase enough EACs to supplement annual targets.

The action items between FY 2029 and FY 2030 depend on further investigation, identification of the most effective strategy, verified project efficiencies, leadership approval, and capital funding. ORNL will continuously investigate changing technologies and aim for capital projects with the best probabilities of reaching and maintaining energy-efficient performance over time. ORNL must balance progress toward

100% CFE for existing electricity consumption and predicted electricity consumption growth due to mission needs. Electricity consumption is expected to increase because of the SNS Second Target Station and the next high-performance supercomputer launch in the coming years.

ORNL is already investigating various projects, equipment, processes, and buildings that could be electrified. ORNL is looking into the potential for an electrification study or scope 1 emissions mitigation study in the future.

8. ACQUISITION & PROCUREMENT

8.1 PERFORMANCE STATUS

All applicable contracts in FY 2023 contained terms and conditions that invoke requirements for sustainable acquisitions as defined in the UT-Battelle prime contract as flow-down requirements. Standard contract terms and conditions, which are made part of all procurement actions for commercial items and services, invoke the pertinent FAR subcontract sustainability requirements:

- 52.223-2 Affirmative Procurement of Biobased Products under Service and Construction Contracts
- 52.223-13 Acquisition of EPEAT®-Registered Imaging Equipment
- 52.223-14 Acquisition of EPEAT®-Registered Televisions
- 52.223-15 Energy Efficiency in Energy-Consuming Products
- 52.223-16 Acquisition of EPEAT-Registered Personal Computer Products
- 52.223-17 Affirmative Procurement of EPA-designated Items in Service and Construction Contracts

Neither FAR 52.223-4 nor 52.223-9 as referenced in the SSP guidance definition table is included in the prime contract as a flow-down requirement. As ORNL includes all of these in each subcontract or purchase order, the required information can be found in the multi-statutory column of Table 9.

Table 9. Types of sustainable acquisition (SA) clauses in contracts

	Recycled	Energy efficient	Biobased	Multi-statutory	Environmentally preferable	Statutory+
Number of contract actions with SA clauses	—	—	—	6,875	—	—
Total contract dollars with SA clauses (\$)	—	—	—	2,169,448,272.97	—	—

Each of the ORNL Marketplace catalog/punchout vendors’ basic ordering agreements (BOA) require the submission of a quarterly “Environmental Preferable Procurement Report” that highlights commodities that fall into the environmentally preferable, recycled, postconsumer, waste prevention, pollution prevention, and biobased categories. The vendor sends four reports per year to recycle@ornl.gov highlighting all efforts. These reports are analyzed by the pollution prevention program coordinator. Any efforts to track data for the new initiative “Phasing Out Single-Use Plastics” as mentioned in the current SSP guidance document will be undertaken through a similar process.

No new janitorial contracts were issued in FY 2023. Kelsan, ORNL’s janitor contract vendor, recognizes the lab’s interest in sustainability and has made sustainable acquisition products a point of emphasis in its product line for ORNL, including biobased products. Kelsan offers more than 100 items that are sustainable including bio-preferred, post-consumer recycled content, and Green Seal-certified items. These items include janitorial products such as paper, hand care, and cleaning products. This product line provided by Kelsan helps support ORNL’s sustainability goals. In FY 2023, \$227,928.54 of \$763,003.32, or 29.87%, of Kelsan’s contract spend was for bio-preferred products alone. Additionally, ORNL strives to buy bio-preferred dielectric fluids when technically feasible and synthetic ester-based dielectric fluids

in other appropriate applications because both are biodegradable and more environmentally friendly than conventional mineral oil-based dielectric fluids.

Office supply vendor A&W offers remanufactured ink cartridges and provides a rebate to ORNL on printer cartridges that are recycled back to A&W through central receiving. In addition, they offer a variety of recycled-content office supplies like paper, binders, notebooks, planners, etc.

ORNL IT Operations administers the IT managed hardware program, which pushes administrative controls for all requisitions for IT equipment. Both IT Operations and the Subcontract Division are responsible for 100% compliance for all eligible equipment.

Waste Management supports procurement of the biobased preferred product tracking and sustainable disposition of federal property, including electronics.

The Contracts Division uses subcontract language in communications with key commodity suppliers, requiring that the vendors provide detailed reports on the purchases of electronics products designated as ENERGY STAR and listed as EPEAT (Electronic Product Environmental Assessment Tool).

8.2 PLANS AND PROJECTED PERFORMANCE

The ORNL Contracts Division includes several working groups aimed at sustainable acquisition. The Contracts Compliance Division is responsible for policies, procedures, records, reports, and compliance with all prime contract terms and conditions. Advances and improvements in these processes to promote sustainable acquisitions and procurement are among the division's highest priorities, as the division remains committed to maintaining 100% compliance with DOE Order 436.1 SSP goals. FY 2024 initiatives include:

- Per Section 3b of DOE's *Climate Adaptation and Resilience Plan*, sites are to complete supply chain risk assessments to determine the reliability and vulnerability of critical supply chains. SPO is currently developing the guidance for this assessment and will work with programs to set the due date. SC will work with the science laboratories to issue this guidance, including due dates, when available.
- ORNL is open to attending training sessions that will address the requirements and logistics needed to access and report laboratory procurement data, the Federal Procurement Data System – Next Generation (FPDS) as a preferred data reporting system. ORNL is hopeful the training will be available in FY 2024.
- Work with the Environmental Protection Services Division toward progress on minimizing products that contain perfluoroalkyl and polyfluoroalkyl substances.
- Coordinate with the ORNL Pollution Prevention program to determine whether the Procurement Organization can play a meaningful role in ORNL efforts toward phasing out single-use plastics.

9. INVESTMENTS: IMPROVEMENT MEASURES, WORKFORCE, & COMMUNITY

9.1 PERFORMANCE STATUS

9.1.1 Energy Act of 2020

ORNL develops an annual ECM list from the following two primary conduits of information sources throughout the year:

- The EE&S program meets early each new fiscal year with FMD managers and facility engineers to identify ECM and funding requests. The majority of ORNL's annual ECMs are identified through this process.
- EISA building audits also provide ECMs. ECMs can be identified through a walk down of the facility and/or directly from the facility representative who is interviewed during their respective audits.

In the past, ORNL has found that building facility engineers and supervisors are the most knowledgeable about facility conditions and can provide valuable information and suggestions concerning ECMs. ECM project identification, evaluation, funding, and execution are mutually beneficial for those requesting the funds and for the EE&S program to properly document and track information. The facility owners are provided with funds and made responsible for performing the projects on schedule and within budget. The facilities are turned over with new energy-efficient and reliable systems and/or equipment, and the EE&S program benefits from being able to report the energy savings that are realized. In the past few years, the ORNL EE&S program on average has funded over \$500,000/year toward ECMs. The EE&S program analyzes the preliminary list and funds the ones that provide the shortest payback periods and best benefits for the building owners and occupants while still working within the limitations of the program budget.

In FY 2023, the ORNL EE&S program funded \$565,000 toward projects for ECMs or energy-efficient equipment such as LEDs (not including metering and FDD). EE&S representatives met with facility engineers and managers from across the various ORNL complexes and brainstormed ECM ideas. Facility engineers formally submitted their top ideas to the EE&S program, a comprehensive prioritized list was developed, and then ECM projects were funded accordingly. Life cycle cost analysis, annual energy savings, or a combination of both was used to rank ECMs. Life cycle cost analysis uses building, system, or equipment data; engineering principles; and employee expertise to perform the calculations and validate efficiency measures.

The following eight energy reduction projects were funded in FY 2023:

- Building 1059 LED conversion
- Building 2661 LED conversion
- Building 4007 LED conversion
- Building 6011 LED conversion (phase II)
- Building 7601 LED conversion
- Building 7603 LED conversion
- Building 7962 LED conversion
- Building 8640 LED conversion

As part of the total ECM funds, ORNL also purchased more than \$66,000 of LEDs at the end of FY 2023 for FY 2024's LED ECMs. ORNL also supported other smaller LED room installations that were not part

of a large ECM. The EE&S program also received an additional \$300,000 from ORNL leadership to complete more of these projects midway through the year to support funding for EAct 20.

The ORNL EE&S program recognized that the passing of EAct 20 would mean more substantive reporting and funding changes to the EISA auditing process, especially because ORNL averages more than 20 building audits per year to meet the requirements. The passing of EAct 20 strongly emphasized the importance of finding ECM projects via the EISA auditing process that will increase operational and organizational performance while reducing energy and water consumption.

As EAct 20 requirements are implemented, ORNL has a limited list of past ECM ideas that were not funded. New FY 2023 ECMs will be added to the ECM list moving forward. The revised list will then be evaluated to determine whether the ECMs are life cycle cost-effective, and if they are found to be so, ORNL will determine the funding process and begin installation to the maximum level of funding available.

ORNL’s current understanding of life cycle cost effectiveness is as follows:

- The ECMs that prove to have simple paybacks of 10 years or less should be funded internally.
- ECMs with paybacks between 10 and 25 years should be funded internally, or performance contracting should be considered/pursued.

Because ORNL has many buildings to audit each year (approximately 20 to 25 meet the one-fourth annual EISA requirement), ORNL plans to investigate a reasonably acceptable number of ECMs per audited building. The number of EMCs for a given building is heavily reliant on building design and size, so the number of ECMs per building will vary across a diverse portfolio like ORNL. With this approach, ORNL anticipates that an ample number of ECMs will be identified. After the audit cycle has been executed for several 4-year iterations, ORNL expects that the list will shorten as most of the ECMs are addressed through the cyclical process.

ORNL has developed an ECM project tool as a sub-application to the newly developed building energy audit tool (see Figure 26 for an example). This app will allow the auditing team to record required information for potential ECMs as a part of building audits. Additionally, the tool will aid in the funding decision process by presenting the required information in one easy-to-interpret format.

Add Building Energy ECM Project		EIC	EIA	ESC
Building/Complex:	1061 / WF			
Identified Year:	<input type="text"/>			
Description:	<input type="text"/>			
Site Assigned Project ID:	<input type="text"/>			
WBS Element:	[Select] ▼			
WBS Breakdown:	[Select] ▼			
Equipment Asset Number:	<input type="text"/>			
Location Description:	<input type="text"/>			
Quantity:	<input type="text"/>			
Unit of Measure:	[Select] ▼			
Notes:	<input type="text"/>			
Estimated Implementation Cost (\$):	<input type="text"/>			
Anticipated Completion Year:	<input type="text"/>			
Estimated Service Life (Year):	<input type="text"/>			
Simple Payback with O&M (Years):	<input type="text"/>			
Simple Payback without O&M (Years):	<input type="text"/>			
Estimated Annual Energy Cost Savings (\$):	<input type="text"/>			
Estimated Annual O&M Cost Savings (\$):	<input type="text"/>			
Estimated Annual Electricity Savings (Kwh/Yr):	<input type="text"/>			
Estimated Annual Other Savings (BTU/Yr):	<input type="text"/>			
Estimated Annual Potable Water Savings (Gall/Yr):	<input type="text"/>			
ECM Status:	[Select] ▼			
		Save Cancel		

Figure 26. ECM input screen.

9.1.2 Energy Savings Performance Contracts

ORNL's ESPC with JCI was the primary mechanism for achieving the goals established to meet EAct of 2005 directives. A delivery order with JCI was awarded in July 2008 and was accepted in July 2012. This ESPC is creating opportunities for ORNL to improve its depth of experience in performance contracting and to develop an understanding of the most effective use of this funding mechanism. The ESPC is currently in the middle of year 12 of the 21-year contract term. As a result of the ESPC, year 11 contract realized savings of \$12,419,000: which includes \$10,520,000 (762 million Btu) of electricity, natural gas, and fuel oil savings; \$376,000 (170 million gal) of water savings; and \$1,898,000 of operations and maintenance savings.

A dual-fuel natural gas/fuel oil boiler replaced the biomass gasification system, which had experienced operational difficulties. The new boiler has been in operation since FY 2016, and natural gas and fuel oil consumption have been reduced, complementing two similar dual-fuel natural gas/fuel oil boilers that replaced a vintage boiler installed under a separate activity. Steam distribution decentralization, including the new Melton Valley steam plant and steam production efficiency improvements, further increase ORNL's steam service and reliability.

Other ESPC improvements include lighting upgrades and water conservation measures. Equipment upgrades, a building management system, and modernized HVAC control systems provide the means to significantly reduce or eliminate energy-intensive simultaneous heating and cooling in several large air-handling units.

M&V of the ECMs completed under the ORNL ESPC is ongoing per the contract between JCI and DOE. JCI employs an on-site performance assurance engineer who leads the M&V effort. M&V activities are reviewed by the ORNL DOE Site Office contracting officer's representative with the engagement of UT-Battelle's EE&S program and Utilities Division staff. Monthly ESPC performance reviews are held by JCI with ORNL DOE Site Office personnel and ORNL personnel. An annual M&V report review and comment resolution process is conducted with the same group.

ORNL is not currently pursuing any other performance contract options. Further discussion and planning are underway for how to proceed with the EAct 20 performance contracting requirements and carbon net-zero initiatives. ORNL will be better informed to develop funding plans, whether via performance contracting or internal funding, after implementing and integrating the new approaches to ECM identification and life cycle cost-effective funding strategies per EAct 20.

9.1.3 Funding

ORNL assesses the environmental, economic, and social benefits of proposed activities on an individual, project-specific basis. Through the mission readiness process, ORNL gauges the abilities of its facilities and infrastructure to accomplish mission objectives now and in the future. Projects are identified to meet the safe, compliant, efficient accomplishment of mission objectives, including sustainable operations. Funding sources for projects are evaluated and established by considering all available and appropriate funding venues, including private sector financing, cost sharing, institutional investment, and programmatic appropriations. Allocation of funds is based on multiple considerations, including mission impact, sustainability, and return on investment (Table 10).

Table 10. FY 2023 budget and future funding for sustainability funding categories

ORNL sustainability funding categories (\$ × 1,000)	FY 2023 actual (\$ × 1,000)	FY 2024 planned/ requested (\$ × 1,000)	FY 2025 projected (\$ × 1,000)
Sustainability projects (including ECMs and metering)	805	810	820
Sustainability activities other than projects	442	445	450
Sustainability program division-funded projects (SPO funding portion only)	0	0	0
SLI GPP ECM funding	0	0	0
Site contribution to sustainability funded projects	630	0	0
ESPC	12,168	12,568	12,981
REC purchase costs	134	156	193
Total	14,179	13,979	14,444

In FY 2023, ORNL EE&S program spent most of its budget on sustainability projects (including ECMs, metering, FDD, audits, etc.) Our program received an additional \$330,000 from ORNL senior leadership in NZEB projects investigation and development at ORNL and an extra \$300,000 from leadership to support the EAct 20 ECMs.

The remaining sustainability activities support the overall Sustainable ORNL function. The Sustainable ORNL program invests in sustainability activities (other than projects and research, ECMs, and so on) in support of the 15 roadmaps that correlate with the main reporting and implementation needs of the SSP requirements and goals. Funding for sustainable activities also included the three funded NZEB Sustainable ORNL showcase projects (because these are research focused objectives that help ORNL’s overall net zero goal).

9.1.4 Training and Education

At least 10 F&O ORNL personnel hold and maintain the Association of Energy Engineers’ Certified Energy Manager (CEM) credentials across various positions and fields throughout the campus. ORNL plans to send two engineers in FY 2024 to the CEM training and certification process.

The ORNL EE&S program has members that have been involved with the local chapter of the Association of Energy Engineers. The local chapter has held two local CEM trainings in the past. In FY 2017, ORNL EE&S program members participated in the planning committee for the local certification training, which allowed 4 out of the 10 CEMs at ORNL to receive their certifications. ORNL was working with the local Association of Energy Engineers chapter prior to 2020 to plan another in-person training, but the training was cancelled because of COVID-19 precautions.

ORNL EE&S engineers take opportunities to participate in facility and operations training that is offered to facility and utility engineers at ORNL. In FY 2023, two EE&S engineers participated in ASHRAE HVAC Training Levels I and II. One engineer also virtually attended the I2SL Conference as an intro to SmartLab program training in FY 2023. When possible, ORNL used facility and maintenance training to glean more energy-efficient methods for operations and improved system performance. ORNL’s EE&S program personnel also participated in periodically scheduled webinars in FY 2023 for the Energy Facility Contractors Group Sustainability and Environmental Subgroup.

9.1.5 Environmental Justice, Workforce, and Community

9.1.5.1 Environmental justice

In FY 2023, ORNL prepared a National Environmental Policy Act (NEPA) environmental assessment for the construction and operation of the Radiochemical Processing Facility (RPF). The RPF project is a planned 40,000–60,000 ft² new nuclear hot cell processing facility at ORNL that will be capable of processing multiple radioisotopes of interest and will expand processing capabilities for irradiated reactor targets from HFIR at ORNL. As required by NEPA regulations, the environmental justice impacts of the construction and operation of RPF were evaluated in the environmental assessment. Because the RPF will be constructed and operated within the established ORNL site, no adverse environmental justice impacts for communities outside of the Oak Ridge Reservation were identified.

In FY 2023, ORNL evaluated and documented the impacts of its significant environmental aspects on the disadvantaged community that is closest to the lab. Based on this evaluation, no disproportionately high impacts were identified.

9.1.5.2 Workforce, community, and stakeholder engagement initiatives

Each year in September, DOE publishes an annual site environmental report (ASER) for the Oak Ridge Reservation. The ASER contains detailed information on ORNL's environmental performance in the areas of compliance and sustainability. The ASER is accessible to ORNL stakeholders through an external DOE website. DOE solicits stakeholder comments on the ASER through the DOE ASER website.

Sustainable ORNL hosts an annual Earth Day celebration with engagement activities for staff and community. FY 2023's Earth Day was titled "Sustainable ORNL 2023 Earth Day – Invest in our Planet." Earth Day 2023 was an extension of Earth Day 2022 and carried the same name. This was the first year since the COVID-19 pandemic that ORNL was able to hold this event in person. The event was a huge success with 3 seminars (described in the following paragraphs), 28 vendors on Main Street, an EV/hybrid car show on the quad, and an EV ride-and-drive event.³

"Growing Greener Communities through Tennessee Smart Yards" was held on April 17, 2023, and was presented by the University of Tennessee's Professor Dr. Andrea Ludwig. The abstract for this presentation is as follows:

In the face of dramatic biodiversity loss globally, a changing climate, land use pressures across Tennessee, and inadequate protection policies for natural capital, the role of voluntary land stewardship practices has never been more important. *Tennessee Smart Yards* is a university-led education and yard certification program for residents and their private property. Through the program, participants first learn about ecologically-sound landscaping principles, then adopt a tailored set of stewardship practices in their landscape that meets their unique needs and environmental conditions. After a level of stewardship is reached, they report back their actions as they certify their yards as Tennessee Smart Yards, protecting water and natural resources one yard at a time. This presentation provided both an overview and update on the statewide program and future trajectories for outreach efforts in sustainable landscapes.

³ Recordings of the three 2023 Earth Week seminars and of other sustainability and Earth Week seminars are provided at <https://www.ornl.gov/sustainable-ornl/sustainability-seminars>.

“Science and Society: Working Together for a Nature-Inclusive Energy Transition” was held on April 20, 2023, and was presented by ORNL Senior R&D Staff Dr. David McCollum. The abstract for this presentation is as follows:

International agreements and domestic policies call for deep decarbonization of the global energy system while ensuring that broader objectives for sustainability (social, economic, and environmental) are simultaneously achieved. Analysis of such futures demands integrated modeling tools that bridge sectors, scales, and disciplines. This presentation provided examples of such analyses, with a particular eye toward the social, technical, and investment pathways for achieving a nature-inclusive energy transition.

“The State of Sustainability in Tennessee” was held on April 21, 2023, and was presented by the Tennessee Department of Environment & Conservation (TDEC) Office of Sustainable Practices Program Manager Chris Pianta. The abstract for this presentation is as follows:

The Tennessee Department of Environment and Conservation (TDEC) exists to enhance the quality of life for citizens of Tennessee and to be stewards of our natural environment by protecting and improving the quality of Tennessee’s air, land, and water through a responsible regulatory system. This is done through both regulatory enforcement and stakeholder engagement. TDEC’s Division of Stakeholder Engagement (DSE) engages and empowers stakeholders through clear communication with a focus on customers, sustainability, resourceful problem solving, and leading by example. Within DSE, the Office of Sustainable Practices works with businesses, communities, and governments and institutions to provide programming, resources, and technical assistance that promote environmental sustainability and resilience throughout Tennessee.

The announcements of the seminars during Earth Week are shown in Figure 27.

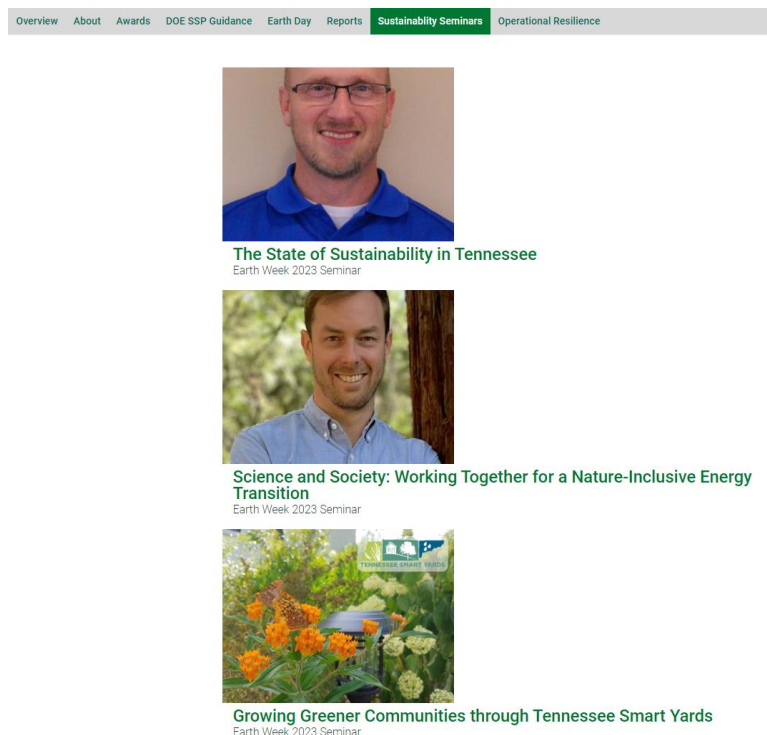


Figure 27. Public-facing Sustainable ORNL website presenting three 2023 Earth Day seminars.

9.1.5.3 2023 Annual Sustainability Report

ORNL has published the 2023 *Annual Sustainability Report*, which is released for public use as shown in Figure 28. 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.



Figure 28. Example of the content in the public-facing 2023 *Annual Sustainability Report*.

9.1.5.4 University of Tennessee/Pellissippi State Community College/ORNL transportation route

In August 2015, ORNL and the University of Tennessee partnered on a new bus route that connected the University of Tennessee, Knoxville campus; Pellissippi State Community College in west Knox County; and ORNL, providing transportation to staff, students, and faculty. This bus offered three round-trip routes each day to all three sites based on the University of Tennessee’s semester schedules. The transportation route has grown with stops at ORNL’s National Transportation Research Center and SNS campuses and has expanded to year-round service with the exception of federal holidays and the week of Christmas. Ridership grew in the summer months with the influx of ORNL summer interns (June riders, 1,230; July riders, 974). With this ongoing initiative, ORNL and the University of Tennessee continue to support alternative commuting.

9.2 PLANS AND PROJECTED PERFORMANCE

ORNL will continue to develop and define the plans and action items necessary to meet EAct 20 requirements, including funding strategies. ORNL will continue developing the new ECM project tool to better document and track the status of projects identified by audit evaluations and to align this process with the projects identified via the FCAs.

ORNL will continue life-of-contract activities associated with its current ESPC. This includes participation in monthly project performance review meetings, review of the annual M&V report, and other support as requested by DOE. All funding paths for ECMs, including performance contracting, will be considered as ORNL works to meet sustainability goals.

ORNL's EE&S program plans to continue promoting CEM credentials. ORNL hopes to further collaborate with the local chapter of the Association of Energy Engineers to support any future local trainings.

ORNL employees from several research and operations divisions plan to attend the 2024 Energy Exchange.

In FY 2024, DOE will publish an ASER, which will be accessible to ORNL stakeholders, and stakeholder comments will be solicited.

ORNL will continue to promote Sustainable ORNL showcase projects (as outlined in the Energy: Net Zero Energy Buildings Section 4.6) and engage the workforce with Earth Day FY 2024 activities to promote environmental justice, resiliency, and net-zero efforts with ORNL and within the community.

10. FUGITIVE EMISSIONS AND REFRIGERANTS

10.1 PERFORMANCE STATUS

Fugitive emissions (unintentional releases such as leaks) from refrigerants and industrial gases are included in federal GHG inventories to track and reduce scope 1 GHG emissions. Commonly used materials in this category contain substances that can disproportionately influence the climate because of exceptionally high GWP values. Fugitive emissions from refrigerants and laboratory gases contain substances that have GWPs that are hundreds to several thousand times more potent than released CO₂. A common but very potent gas used for industrial process is SF₆, which is estimated to be 22,800 times more threatening to the climate than CO₂.

Direct emissions from purchased industrial gases for standard processes such as testing and laboratory applications are included and tracked by DOE in this category to help identify the need for alternative substances. In FY 2023, ORNL's environmental management systems tracking system resulted in GHG emissions of 2,624 MTCO_{2e}, approximated 1%, down from 4% last year, of all emissions from lab operations. Releases are measured using complex materials-handling procedures, balances, and resultant calculations using the individual GWP of each type and volume of gas released. Since the final decommissioning of a large SF₆ process in 2018, this category has remained less than 5% of total emissions at ORNL and is expected to remain at a minimum over the coming years.

Fugitive emissions decreased for this category in 2023 because of a site-wide effort to reduce GHG emissions based on the directives in EO 14057 and the facility's sustainability roadmap. In 2023, ORNL expanded the site's refrigerant management program to address DOE's GHG reduction goals as well as the comprehensive changes to the refrigeration industry due to the future phasedown of HFCs. ORNL hired two new employees to facilitate improved communication among the sustainability, F&O, and environmental compliance groups to address refrigerant management. This greatly improved the systematic approach to the upcoming changes. During the year, ORNL's F&O Division created a list of existing refrigeration appliances to assess both short-term and long-term replacement strategies. The HFC phasedown will be factored into asset replacement decisions. The facility also successfully obtained and operated a refrigerant recovery device capable of recovering SF₆ from on-site research applications, including microscopes. Compliance specialists, researchers, and other SMEs track inventories and ensure proper storage by utilizing a complex materials management system. Special leak detection equipment is generally available for deployment when needed to monitor large quantities of refrigerants. Environmental staff also encourage researchers to consider refrigerants with lower GWPs when conducting investigations, referencing the SNAP (Significant New Alternatives Policy) list. Compliance with NEPA reviews will also reveal whether new materials or large quantities of material are defined as high GWPs. Processes and procedures within science research projects are also reviewed any time there is a new circumstance. Compliance specialists will work with F&O moving forward to identify aging equipment with high GWPs to be considered for replacement as well as to follow new projects through to completion, ensuring that requests during the NEPA phase are properly implemented.

New federal regulations have begun to limit the amounts of high-GWP refrigerants being produced by manufacturers. Laboratory staff will naturally decrease use of these materials in favor of lower GWP refrigerants.

10.2 PLANS AND PROJECTED PERFORMANCE

No on-site process at ORNL utilized SF₆ in FY 2023, and no process use of SF₆ is expected in the future.

Site-wide fugitive emissions should continue to decline as research scientists are made aware of less potent alternatives for tracer gases and are introduced to more compelling gases for use in experiments and research projects. Project costs will also favor less potent (and less expensive) gases.

Site-wide fugitives and refrigerant GHG emissions will continue to have a minor impact on the GHG emission estimates across ORNL.

11. ADAPTATION & RESILIENCE

11.1 PERFORMANCE STATUS

Following the release of DOE's VARP guidance and associated timelines, ORNL added operational resilience to the Sustainable ORNL roadmap structure and established a core team to develop a site-specific plan to meet VARP requirements. At ORNL, the VARP is centered on mission-essential facilities and utility infrastructure to ensure that the physical assets will be prepared to exhibit a high degree of resilience in response to extreme weather events. Operations stakeholders including building engineers, utility engineers, and their management are included in the broader VARP team. Division- and directorate-level leadership in operations continue to provide support for VARP team activities. A portfolio of solutions to address resiliency projects was created and uploaded to the DOE Sustainability Dashboard in 2022. Portfolio solutions included newly developed project ideas resulting from VARP discussions and evaluations as well as projects from other lab infrastructure enhancement efforts, such as SLI-funded projects and reliability improvements.

In FY 2023, EESP energy engineers coordinated with facility stakeholders to update the project status of identified portfolio solutions. ORNL continues to measure implementation milestones against the resilience plan and gather feedback from various site organizations implementing the resilience solutions. EESP takes the lead on periodic communications with asset owners, including reporting on project costs.

ORNL continues to coordinate VARP solutions with other priorities to reach a number of agency objectives. Throughout the ORNL campus, projects are evaluated on several sustainability priorities, including energy and water savings (and cost savings) from ECMs, net-zero initiatives, and operational resilience.

11.2 PLANS AND PROJECTED PERFORMANCE

The implementation status of ORNL's resilience solutions will continue to be updated each year during the annual SSP process. Additional resilience solutions will be identified and added to the DOE Sustainability Dashboard for tracking as appropriate. In recognition of the important goal of addressing operational and climate resiliency solution for critical missions and operations, ORNL will 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. VARP goals in FY 2024 include a plan to better document resilience solutions during implementation and completion, including lessons learned. Meetings are being planned to work with stakeholders to develop cost estimates and life cycle cost-effectiveness analyses.

12. REFERENCES

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