



OAK RIDGE NATIONAL LABORATORY

FY 2018 SITE SUSTAINABILITY PLAN

With FY 2017 Performance Data



U.S. Department of Energy
Sustainability Performance Office

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Executive Summary

ORNL's Sustainable Campus Initiative (SCI) achievements to highlight include the following:

- Teresa Nichols, co-lead of the ORNL Sustainable Campus Initiative (SCI), led a DOE, Sustainability Performance Office (SPO) project to create a Telework Guide for DOE facilities to use. The project involved working with five partner labs—Brookhaven National Laboratory (BNL), Idaho National Laboratory (INL), the National Energy Technology Laboratory (NETL), the National Renewable Energy Laboratory (NREL), and Pacific Northwest National Laboratory (PNNL). The project was completed in May 2017, and the final report, *Enabling a Mobile Workforce: How to Implement Effective Teleworking at U.S. Department of Energy National Laboratories—A Guidebook and Toolkit* (ORNL/TM-2017/257), was distributed by the SPO through its June *SPOtlight* newsletter and was posted on the SPO homepage: (<https://us14.campaign-archive.com/?u=6d5983d55ea04b3e7cdaad75c&id=ebfb3f60e2>).
- ORNL SCI compiled the *Annual Sustainability Report for FY 2017*, which was electronically distributed to all ORNL staff and guests. The report was also distributed to 104 recipients in cities, counties, municipalities, chambers, colleges, and high schools in the counties neighboring ORNL. By distributing the report, ORNL informed its neighbors of its sustainable best practices. The complete report may be viewed at: <http://sustainability-ornl.org/Documents/2017ASRv15.pdf>.
- ORNL distributed a commuter survey in June 2017 to all ORNL staff and received a 33% response rate. Analysis and further focus on some key areas are scheduled for FY 2018.
- ORNL applied new approaches to energy consumption awareness using data visualization and reporting during FY 2017. One such approach was the development of utility consumption dashboards and reports populated with interval data, which helped to identify energy conservation opportunities in FY 2017. Building data analytics, including fault detection and diagnostics (FDD), are also being added to ORNL's energy conservation tools. To bolster this effort, ORNL has elected to participate in the Better Buildings Smart Energy Analytics Campaign. Going forward, ORNL will implement a new energy data analytics module for more robust dashboard development and sharing. FDD implementation will also be scaled up to include additional buildings, and a work flow will be established to successfully address faults and to achieve energy and operational improvements.
- ORNL employee participation in commuting options/programs in FY 2017 include:
 - 170 employees participated in carpools and vanpools. Of these, 76 entered data into the Smart Trips™ system, a regional transportation project.
 - 140 employees completed a formal telework agreement, at an increase of more than 300% from the prior year.
 - 114 employees participated in alternative work schedules via 9/80 and 4/10 shift designs.
 - ORNL distributed a commuter survey to all staff during the summer and received a 33% response rate.
 - Bus Transit continued operations during the academic year (August 2016–May 2017, round-trips per day between the University of Tennessee (UT), Knoxville; Pellissippi State Community College; and ORNL) with an average daily ridership of 30. SCI was able to provide funding to support a summer bus route (2 round-trips per day), and a larger (48- passenger) bus had to be used during the summer months (May–August

2017), with an average daily ridership of 48. SCI is working with UT to continue bus operations in the new academic year (August 2017–May 2018), with 3 round-trips per day.

- ORNL Fleet received an Honorable Mention from 100 Best Fleets in May 2017.
- ORNL’s fleet received the 2017 Government Green Fleet Award. The award honors federal, state and local government fleets in North America that have achieved success in “greening” their fleet by using alternative fuel and hybrid vehicles, emissions reduction, long-range planning, and staff education and involvement. The top 50 green fleets are recognized annually. This year, ORNL ranked number 29th on the list and was the only fleet from the State of Tennessee to win the award. Furthermore, ORNL was the only DOE facility to be recognized. There are 38,000 government fleets in North America. The 2017 awards were presented at the Sustainable Fleet Technology Conference held in Raleigh, NC. (http://www.the100bestfleets.com/gf_winners_2017.htm).
- SCI hosted the first Regional Composting Meeting on February 1, 2017, with stakeholders from the Tennessee Department of Environment and Conservation; the Y-12 National Security Complex; The Center for Nanophase Materials Sciences Pollution Prevention; Roane County Schools; Roane County Solid Waste; and Sevier Solid Waste, Inc.
- SCI coordinated “Seeds of Progress,” the ORNL Earth Day Celebration, on April 19, 2017, during lunch. Activities included a presentation, “The Gatlinburg Firestorm—Can It Happen Here?” opportunities to meet with visiting experts, and events such as the planting and recycling relays.
- Two SCI team members (Teresa Nichols and ORNL Fleet Manager Ernie Ford), represented ORNL at the Tennessee Sustainable Transportation Awards and Forum, held in Nashville, Tennessee, on May 23-24, 2017.
- Teresa Nichols; Ernie Ford; and Amy Albaugh, Glenn Cross, and Rob Crowell (engineers in the Facilities and Operations Directorate) attended the Energy Exchange Conference sponsored by the US Department of Energy (DOE) Federal Energy Management Program (FEMP), held in Tampa, Florida. ORNL SCI arranged a meeting with this team and with sustainability program managers from INL and NREL to meet with Kevin Carroll, the newly appointed director for the DOE Sustainability Performance Office (SPO). The meeting was used to provide brief lab sustainability program overviews for Director Carroll and to ask questions regarding his plans for the SPO and FY 2018 forecasts. The Energy Exchange Conference, FEMP’s flagship event, brings together subject matter experts from a wide range of technical disciplines to share their knowledge of government best practices with the federal energy management community.
- SCI leadership gave more than 15 SCI overview presentations during FY 2017, including one to the Battelle – Research Facilities Benchmarking Best Practices Meeting and one to External ISO Auditors, a Battelle Environmental Subgroup Peer Review Team.

Executive Summary: Plan Goal Table

ORNL Site Sustainability Plan Goal Table: FY 2017 Performance Data

The following table provides a summary of the performance status of Oak Ridge National Laboratory's (ORNL) Fiscal Year (FY) 2017 US Department of Energy (DOE) sustainability goals and future plans and projected performance.

DOE Goal	Current Performance Status	Performance & Plans
GHG Emission Reductions: Multiple Categories		
50% Scope 1 & 2 GHG emissions reduction by FY 2025 from a FY 2008 baseline.	Scope 1 and 2 combined GHG emissions estimate is 345,400 MTCO ₂ e, an increase of 2% from the baseline year of FY 2008 due to increased electricity usage. Scope 2 reductions represent a substantial challenge due to growth in electricity demands for high-energy mission-critical facilities.	REC purchases, TVA partnerships, and innovative technologies will be used to meet the Scope 1 and 2 combined goal by the target year 2025.
25% Scope 3 GHG emissions reduction by FY 2025 from a FY 2008 baseline.	Scope 3 estimate is 40,560 MTCO ₂ e, a 1% decrease. A 12% increase in T&D losses impacts the overall performance.	Further examine transportation options based on commuter survey results. In addition, REC purchases will produce credits to offset T&D emissions by the target year.
Energy Management		
25% energy intensity (Btu per gross square foot) reduction in goal-subject buildings by FY 2025 from a FY 2015 baseline.	ORNL achieved a 7.4% reduction in energy use intensity in FY 2017, exceeding the 5% cumulative goal.	ORNL will continue to drive energy intensity reduction with emphasis on data-driven insights and lifecycle cost-effective ECMs.
EISA Section 432 continuous (4-year cycle) energy and water evaluations.	ORNL began a new, 4-year cycle by evaluating seven covered buildings for a total of 920,700 GSF. ORNL will leverage knowledge from previous cycles to conduct focused evaluations.	The remaining covered facilities will be evaluated using a graded approach to complete the 4-year cycle. Primary focus will be given to laboratory buildings.
Meter all individual buildings for electricity, natural gas, steam and water, where cost-effective and appropriate.	Eighteen new advanced utility meters were installed in FY 2017. ORNL periodically updates a metering plan to guide ongoing implementation efforts.	Continued implementation of metering plan will allow progress toward building-level metering of all commodities for buildings greater than 5,000 GSF.
Water Management		
36% potable water intensity (Gal per gross square foot) reduction by FY 2025 from a FY 2007 baseline.	Water use intensity measured 134 Gal/GSF, a reduction of 24% to date, exceeding the interim goal of 20%.	ORNL plans to continue to identify water conservation opportunities to achieve a reduced site water use intensity.
30% water consumption (Gal) reduction of industrial, landscaping, and agricultural (ILA) water by FY 2025 from a FY 2010 baseline.	NA	NA

Waste Management		
Divert at least 50% of non-hazardous solid waste, excluding construction and demolition debris.	ORNL achieved a 44% diversion rate in FY 2017.	ORNL plans to continue mitigation measures and process improvements to close the gap for this goal.
Divert at least 50% of construction and demolition materials and debris.	ORNL's diversion rate for construction and demolition debris for FY 2017 is 76%, exceeding the target by 26%.	ORNL plans to continue process improvements and to place additional focus on segregation of waste.
Fleet Management		
30% reduction in fleet-wide per-mile GHG emissions reduction by FY 2025 from a FY 2014 baseline.	The ORNL Fleet per-mile GHG emissions baseline of 527 g/mile saw a 3% decrease in FY 2017, and is expected to stabilize with updated FAST data.	ORNL plans to support the per-mile GHG emission initiative through purchasing PHEV passenger vehicles whenever possible. Plans call for the replacement of light-duty vehicles with AFVs and to acquire more efficient models when new vehicle purchases are required.
20% reduction in annual petroleum consumption by FY 2015 relative to a FY 2005 baseline; maintain 20% reduction thereafter.	In FY 2017 ORNL achieved a 32% reduction in cumulative petroleum consumption relative to the baseline.	ORNL plans to continue to use alternative fuel and to continue to educate drivers about the importance of using alternative fuels in flex fuel vehicles to meet requirements.
10% increase in annual alternative fuel consumption by FY 2015 relative to a FY 2005 baseline; maintain 10% increase thereafter.	ORNL achieved a 70% increase in cumulative alternative fuel consumption relative to the FY 2005 baseline, exceeding the DOE target.	ORNL plans to continue to use alternative fuel and to continue to ensure that the quality of biodiesel is maintained.
75% of light duty vehicle acquisitions must consist of alternative fuel vehicles (AFV).	100% of light-duty vehicles purchased by ORNL are AFVs.	ORNL plans to continue to purchase only AFVs when light-duty vehicles are replaced.
50% of passenger vehicle acquisitions consist of zero emission or plug-in hybrid electric vehicles by FY 2025.	ORNL has a total of five PHEVs in the fleet. EV charging infrastructure has been developed to support this goal. In addition, ORNL purchased three Telematics devices, which have advanced capabilities such as energy use by fuel/EV type and including capabilities to automatically transfer data to the Network Fleet web portal, where ORNL fleet management and ORNL researchers can access the data.	ORNL is preparing for new FY 2025 targets while remaining attuned to other directives related to vehicle acquisitions. Data from the Telematics devices will be used in making decisions of where to best utilize PHEV and charging infrastructure as more PHEVs are added to the ORNL fleet.
Clean & Renewable Energy		
"Clean Energy" requires that the percentage of an agency's total electric and thermal energy accounted for by renewable and alternative energy shall be not less than 25% by FY 2025 and each year thereafter.	The purchase of RECs for the Renewable Energy Target resulted in 14% of the Clean Energy Target, exceeding the FY 2017 interim goal of 10% and is progressing toward the FY 2025 goal.	ORNL plans to purchase additional RECs beyond the Renewable Energy Target to meet or exceed Clean Energy goals, until sufficient renewable/clean energy generation is achieved on site.

“Renewable Electric Energy” requires that renewable electric energy account for not less than 30% of a total agency electric consumption by FY 2025 and each year thereafter.	ORNL has purchased RECs to supplement on-site renewable energy generation, representing 19% of electrical energy consumption, exceeding the FY2017 interim goal of 10%, and is progressing toward the FY 2025 goal.	ORNL plans to purchase sufficient RECs to meet or exceed the renewable energy goal. ORNL continues its review of a report from an external expert to determine the financial feasibility of locating a large solar photovoltaic to minimize the REC purchases each year.
Green Buildings		
At least 17% (by building count) of existing buildings greater than 5,000 gross square feet to be compliant with the revised Guiding Principles for HPSB by FY 2025, with progress to 100% thereafter.	ORNL has established an HPSB inventory of 19 buildings or 14% of total applicable building portfolio.	Efforts will continue toward expanding the existing HPSB inventory to 17% and beyond.
Net Zero Buildings: 1% of the site’s existing buildings above 5,000 gross square feet intended to be energy, waste, or water net-zero buildings by FY 2025.	ORNL is assessing technical and financial feasibility and is formulating a strategy.	ORNL will define an implementation strategy prior to the target date.
Net Zero Buildings: All new buildings (>5,000 GSF) entering the planning process designed to achieve energy net-zero beginning in FY 2020.	ORNL is assessing technical and financial feasibility, defining barriers, and formulating solutions.	ORNL will define an implementation strategy prior to the target date.
Increase regional and local planning coordination and involvement.	ORNL’s staff members were active in participation in local and regional organizations, including service on the Board of Directors of the East Tennessee Clean Fuels Coalition and Southeast Sustainability Group.	ORNL will examine the feasibility of implementing recommendations from the ORNL employee commuting survey. In addition, participation is continuing in local and regional transportation and sustainability organizations.
Acquisition & Procurement		
Promote sustainable acquisition and procurement to the maximum extent practicable, ensuring BioPreferred and biobased provisions and clauses are included in 95% of applicable contracts.	In FY 2017, 100% of the applicable ORNL contracts contained terms and conditions that invoke requirements for sustainable acquisitions.	ORNL plans to continue being proactive in procurement of sustainable items.
Measures, Funding, & Training		
Annual targets for performance contracting to be implemented in FY 2017 and annually thereafter as part of the planning of section 14 of E.O. 13693.	The current ESPC at ORNL is in Performance Period 6. A total of nine staff completed the Certified Energy Manager® credentials through the Association of Energy Engineers.	ORNL has an existing ESPC in place with Johnson Controls, Inc. through FY 2032. ORNL continues looking for cost effective on-site solar projects.
Electronic Stewardship		
Purchases – 95% of eligible acquisitions each year are EPEAT-registered products.	ORNL exceeded the 95% goal of purchasing EPEAT-registered products in FY 2017.	ORNL plans to continue with guided procurement to acquire EPEAT-registered products and to closely monitor nonstandard requests for electronic requisitions.
Power management – 100% of eligible PCs, laptops, and monitors have power management enabled.	100% of eligible computers, monitors, and laptops actively power-managed.	ORNL plans to continue to actively ensure that all eligible computing equipment is power-managed.

Automatic duplexing – 100% of eligible computers and imaging equipment have automatic duplexing enabled.	Shared print services include replacing multiple local printers with a single shared printer where possible, setting automatic duplexing as the default, and managing power use for the printers.	ORNL plans to continue the use of managed print services with default duplexing and power management and to remove printers as they reach end of life.
End of Life – 100% of used electronics are reused or recycled using environmentally sound disposition options each year.	100% of dispositioned electronic equipment is being reused or recycled through CFL and R2 certified reuse/recycle practices.	ORNL plans to continue to dispose of electronic equipment using CFL and R2 certified reuse/recycle practices.
Data Center Efficiency. Establish a power usage effectiveness target in the range of 1.2-1.4 for new data centers and less than 1.5 for existing data centers.	In FY 2017 ORNL data centers experienced a portfolio power utilization effectiveness of 1.3, less than the goal of 1.5.	ORNL plans to continue to optimize data center systems to meet or exceed goals. Engineering staff have identified several areas in which to pursue additional energy savings.

Organizational Resilience		
Discuss overall integration of climate resilience in emergency response, workforce, and operations procedures and protocols.	<p>ORNL’s Organizational Resilience Team held its annual work session during FY 2017 the year to review climate risk elements and event categories and their potential impacts to critical missions and operations, while considering specific geographic location and associated potential risk for extreme events.</p> <p>A second meeting was held during the year with key staff from ORNL’s Fire Department, Environmental Department, Lab Protection, Facilities and Operations Directorate, and SCI to review wildfire preparedness.</p>	The ORNL Organizational Resilience Team roadmap owners continue to facilitate reviews, updates, and implementation of policies that are applicable to organizational resilience, including facility resilience, emergency preparedness, better communications systems, engagement with local partners, and health and human safety systems are among the systems under review.

AFV	alternative fuel vehicle	HPSB	high-performance sustainable building
CFL	Computers for Learning	ILA	Industrial, Landscaping, and Agricultural
C&D	construction and demolition	LED	light emitting diode
CEDS	Central Energy Data System	MGy	million gallons per year
DOE	US Department of Energy	MSW	municipal solid waste
E.O.	executive order	MTCO _{2e}	metric ton carbon dioxide equivalent
ECM	energy conservation measure	NA	not applicable
EGCR	Experimental Gas Cooling Reactor	NEPA	National Environmental Policy Act
EISA	Energy Independence and Security Act	ORNL	Oak Ridge National Laboratory
EPA	US Environmental Protection Agency	ORO	Oak Ridge Office
EPEAT	Electronic Product Environmental Assessment Tool	ORR	Oak Ridge Reservation
ESPC	energy savings performance contract	OTC	once-through cooling
EV	electric vehicle	PC	personal computer
FAST	Federal Automotive Statistical Tool	PHEV	plug-in hybrid electric vehicle
FEMP	Federal Energy Management Program	PUE	power utilization effectiveness
FY	fiscal year	R2	Responsible Recycling
g	gram	REC	renewable energy certificate
Gal	gallon	SCI	Sustainable Campus Initiative
GHG	greenhouse gas	T&D	transportation and distribution
GSF	gross square foot	TVA	Tennessee Valley Authority
HEMSF	high-energy mission-specific facility	WUI	Water Use Intensity

Energy Management

Energy Management: GHG Scope 1, 2, 3 related to Energy Savings

Performance Status

In FY 2017, ORNL was again resolute in its commitment to sustainable operations and the reduction of GHG emissions wherever possible while remaining diligent to the DOE mission to provide valuable solutions to the nation's energy and security challenges. GHG emission goals are not normalized to mission or employee growth. Since the FY 2008 baseline, the energy consumption of critical operations has grown by 70%. A 50% reduction in emissions is more difficult to obtain in locations that have undergone significant growth such as that experienced at ORNL.

Significant redesign of the reporting logistics for DOE Site Sustainability Plans places greater emphasis on roadmaps and projects that result in reduced emissions. It is recognized that GHG emission goals will be achieved when advances are made in multiple SSP categories, including Energy Management, Green Buildings, Fleet Management, Clean and Renewable Energy, and Fugitive Emissions. The strategies, projects, and activities resulting in Scope 1 & 2 GHG emissions are provided in the category narratives in the SPO Dashboard. In an inclusive commitment, ORNL leadership, sustainability experts, and facility professionals have continued to focus on effective strategies for efficient operations during FY 2017. The reduction of GHG is not a standalone goal, but rather the result of sustainable practices implemented by the organization.

As the largest science and energy laboratory in the DOE system, ORNL remains committed to the unique and innovative high-energy mission-specific facilities (HEMSFs) that allow it to contribute to the primary missions of ORNL and DOE. The HEMSFs are critical to ORNL's success, and they often require greater energy resources than a traditional laboratory or office environment. Thus, because energy efficiency at all facilities remains the goal, the unique equipment and design of the HEMSFs require a specialized approach. In FY 2017, HEMSF operations consumed 72% of ORNL's electrical energy and 51% of all the water used. Current projections to support growth in these critical research areas indicate increases in all utility resource areas by FY 2025, especially electricity and water. Details of HEMSF growth may be found in the Supplemental SSP narrative in the SPO Dashboard repository.

The FY 2017 Scope 3 GHG emissions estimate is 40,560 MTCO₂e. Overall, the Scope 3 inventory experienced a 1% decrease from the FY 2008 baseline. Scope 3 performance indicators demonstrate that while the employee commutes, business air travel, and business ground travel categories have all improved, the 12% growth in T&D losses limits the overall performance.

Plans and Projected Performance

ORNL is committed to the DOE GHG Scope 1 and 2 reduction targets and has developed reduction estimates indicating that ORNL is on target to meet the FY 2025 target reduction goal of 50%. This projected success is based on a number of key projects and initiatives detailed in the SPO Dashboard narrative sections for Energy Management, Green Buildings, Fleet Management, Clean and Renewable Energy, and Fugitive Emissions. Additional HEMSf details may be found in the Supplemental SSP narrative in the SPO repository.

In addition, REC purchases to meet clean and renewable energy goals will help offset the growth in T&D emissions due to the increased use of electricity at the site. The use of REC procurements will produce credits to offset T&D emissions by the target year.

Energy Management: Energy Use Intensity (EUI)

Performance Status

Executive Order 13693 established a new baseline for energy intensity in FY 2015. The latest reduction goal targets a reduction in energy intensity for subject facilities of 25% by FY 2025 relative to the FY 2015 baseline.

Based on FY 2017 data, energy use in the buildings category at ORNL is 1,278 billion Btu, not including ORNL's excluded facilities as defined by the Energy Policy Act of 1992. Given an area of 5,265,623 GSF of energy-consuming buildings, trailers, and other structures and facilities identified in the Facilities Information Management System, the FY 2017 calculated energy use intensity is 242,632 Btu/GSF. This results in a reduction of 7.4%, exceeding the interim goal.

To maintain steady progress toward this goal, ORNL focuses on energy-efficient and sustainable design in new construction projects as well as smart repurposing of existing facilities and a drive for continuous improvement in facility and utility operations. ORNL continues to modernize by demolishing old, energy-inefficient buildings such as building 7001 and 6025, which were brought down in FY 2017. This activity makes way for the construction of new, high-performance buildings that better serve the ORNL mission. An example is building 6010, which was repurposed in FY 2017 to fulfill established needs and refurbished to bring its energy performance up to current standards.

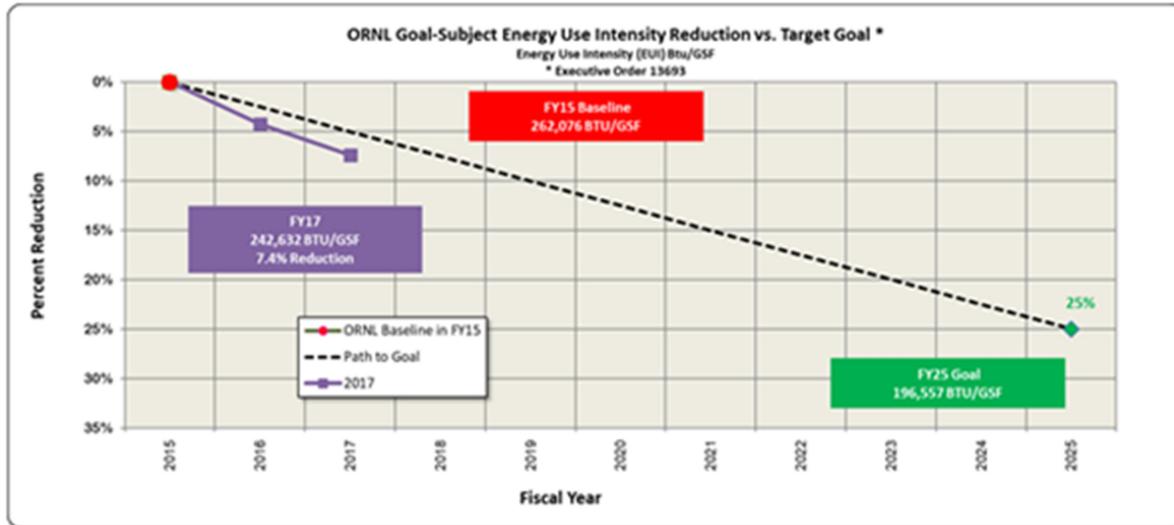
Energy intensity reduction in existing ORNL facilities is data-driven, and ORNL makes efforts to quantify and bring awareness to building energy performance so that operations staff can make informed decisions. Initiatives in FY 2017 included new approaches to energy consumption awareness using data visualization and reporting. Building data analytics, including fault detection and diagnostics, are also being added to ORNL's energy conservation tools. To bolster this effort, ORNL has elected to participate in the Better Buildings Smart Energy Analytics Campaign. New and innovative methods were accompanied by time-tested approaches to energy conservation, including LED lighting upgrades, existing building commissioning, and HVAC control system improvements.

Improvements in utilities services have reduced energy/fuel cost, reduced maintenance costs, and increased reliability in the delivery of steam, chilled water, and potable water.

Steam system improvements include replacing insulation and repair of condensate leaks to save fuel, water, and chemical treatment costs. Installation of independent hot water boilers increases efficiency and reduces chemical treatment and water use. Chemical cleaning of the ORNL heating water system has enhanced heat transfer in heating coils and has improved zone temperature control.

Chilled Water System improvements include replacement of a chiller with a high-efficiency unit, a chiller refurbishment, and a new filter system for enhanced water quality for better heat transfer in cooling coils and improved chiller performance. Various cooling tower upgrades include splash plates to reduce fouling and to increase efficiency. A new medium-temperature water-cooling system has been commissioned to save energy and water by increasing cooling via cooling towers rather entirely by chillers for selected processes.

Energy Use Intensity Reduction vs Target Goal



Plans and Projected Performance

ORNL’s effort toward energy intensity reduction has resulted in significant progress by targeting readily applied energy conservation measures (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 is continuing to build a foundation of awareness to make energy efficiency increasingly part of daily operations. A goal has been established to make energy implications part of consideration for specific ECMs in addition to being the daily operation, maintenance, and update of buildings and their systems. 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 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 on 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 Utility Division will continue to evaluate utility systems for improving operations, improving reliability, and reducing maintenance costs. Future projections include additional upgrades to insulation on steam distribution lines, a new magnetic-drive chiller with a variable primary pump system, enhanced chilled water controls, and replacement of the condenser pump impeller.

Energy Management: EISA 432 Continuous Evaluations

Performance Status

In FY 2017, ORNL began a new 4-year energy audit cycle using a graded approach that incorporates American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) level audits, as well as laboratory-specific evaluations. The graded approach also leverages technology in the form of fault detection diagnostics (FDDs) and meter data analytics, in addition to facility walkdowns.

Laboratories comprise a very significant portion of ORNL's building portfolio in terms of gross square footage (GSF) and energy consumption. Due to the high energy intensity of these facilities, ORNL chose to focus FY 2017 efforts on evaluating the opportunity for energy efficiency improvements in laboratories. ORNL commissioned assistance from Exposure Control Technologies (ECT) to conduct a rapid energy and laboratory safety assessment (RELSA) of seven buildings for a total of 920,700 GSF. This assessment incorporated input and historical energy data provided by Energy Management, along with building walkdowns and operational knowledge gleaned from facility managers. The output of this assessment was a ranked order of buildings according to their potential for energy reduction, complexity of the optimization project, and potential return on investment. This output was supported by an assessment methodology that began at the individual laboratory level and expanded to building mechanicals. The assessment process accounted for a laboratory's primary objective: to safely and effectively enable research. Only after safety and productivity considerations are addressed can energy efficiency measures be considered. Using the prioritization established in this assessment as a guide, ORNL will look for opportunities to implement the recommended ECMs in conjunction with laboratory renovation projects and other modernization and operational improvement initiatives.

ORNL continues to use the EPA ENERGY STAR Portfolio Manager as the primary tool for building energy performance benchmarking. The portfolio of buildings continues to grow as additional metering goes online, and benchmarking history improves as existing meter data sets accumulate over time. ENERGY STAR data have become more robust with the implementation of ORNL's Central Energy Data System (CEDs), continuing to grow in historical data capacity and through the addition of new smart steam and water meters.

Plans and Projected Performance

In FY 2018 ORNL will continue application of this graded approach to energy auditing, with an ongoing focus directed to laboratories. In addition, ORNL plans to leverage energy data analytics in combination with inhouse facility engineering insight to conduct streamlined evaluation and to identify valuable energy conservation opportunities. These opportunities will likely be in the form of incremental operational changes that can be prioritized in the near term, with larger scale equipment efficiency improvement projects to be prioritized for future funding as it becomes available.

Continued focus will be placed on improving the breadth and depth of ORNL's benchmarked building portfolio. The EPA's ENERGY STAR Portfolio Manager currently contains many meter datasets for ORNL buildings, but efforts to improve the continuity of data and consistency of building profiles are under way. Capabilities within CEDs will be integral to streamlining and automating data flow to the ENERGY STAR Portfolio Manager.

Energy Management: Metering Status

Performance Status

As part of the FY 2015 SSP, ORNL created an extensive site-wide metering plan that included the status and plans for all metered utilities on campus. The metering plan is a comprehensive document that charts a course for ORNL's continued advanced metering deployment which is consistent with the *November 2014 Update to the Federal Building Metering Guidance* and with current DOE directives focused on adding electricity, natural gas, steam, and water meters where cost-effective and appropriate. The metering plan is updated at least annually to document progress that has been made and to note any shifting in priorities.

In FY 2017 ORNL installed 18 new advanced utility meters across all utilities, including electrical, steam, chilled water, natural gas, and potable water. The meters were connected to ORNL's Central Energy Data System (CEDS) for data archiving and analysis. CEDS can log multiple parameters from each meter on a standard 15-minute interval. This system also enables meter data trend analysis, report generation, and energy awareness dashboard deployment as well as data export for use in other analyses.

In FY 2017 ORNL began deploying a new module for the CEDS system called "Resource Advisor." It provides more robust dash boarding and energy-analysis capabilities that align with ORNL's continued maturation in energy data utilization. ORNL has also leveraged the integration capabilities of its industrial control systems network to share data from the building automation system to the CEDS in a secure way. This capability has enabled the consolidation of metering sources, creating a one-stop shop for energy consumption data.

As with any project undertaking 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 technical challenges.

Plans and Projected Performance

ORNL will follow its metering plan to continue installing additional advanced utility meters, where cost-effective and appropriate, on all utilities. All of these meters will be connected to ORNL's CEDS for data analysis and archiving. ORNL will continue the deployment of the new Resource Advisor module with plans to go live in FY 2018. Resource Advisor will be used to expand energy awareness with more robust dashboards and analyses for facility managers, facility engineers, and eventually the greater lab population. Energy data threshold alerts will be deployed, and continued efforts will be made to leverage meter data for facility and utilities operational awareness and improvement.

Energy Management: Non-Fleet Vehicles and Equipment

Performance Status

GHG emissions from Non-Fleet Fuels (Facility Vehicles and Equipment) are a comparatively minor source of emissions at ORNL. Utility Division engineers remain in compliance with reporting and tracking the use of these fuels (gasoline and oils) for GHG performance goals. The ORNL FY 2017 Comprehensive Scorecard demonstrates that GHG emissions for this category has shown a 35% reduction compared to the FY 2008 baseline.



Greenhouse Gas Inventory



Scope 1 & 2 Greenhouse Gas Emissions

Goal: Reduce direct GHG emissions by 50 percent by FY 2025 relative to FY 2008 baseline. Interim Target (FY 2017): -25.0 %

Current Performance: 2%

	FY 2008	FY 2017	% Change
Facility Energy	299,434.6	397,707.2	32.8%
Non-Fleet V&E Fuel	245.4	159.5	-35.0%

Plans and Projected Performance

Continued reporting and tracking of these fuels for GHG performance goals will be ongoing in FY 2018.

Water Management

Performance Status

EO 13693 continues the federal commitments established by prior directives, with an FY 2025 target goal to reduce water use intensity (WUI) by 36% from an FY 2007 baseline. ORNL has long been aware of the benefits of effective water management, and by FY 2007, ORNL had already experienced a 57.2% reduction in water use compared with its highest level of water use experienced in FY1985.

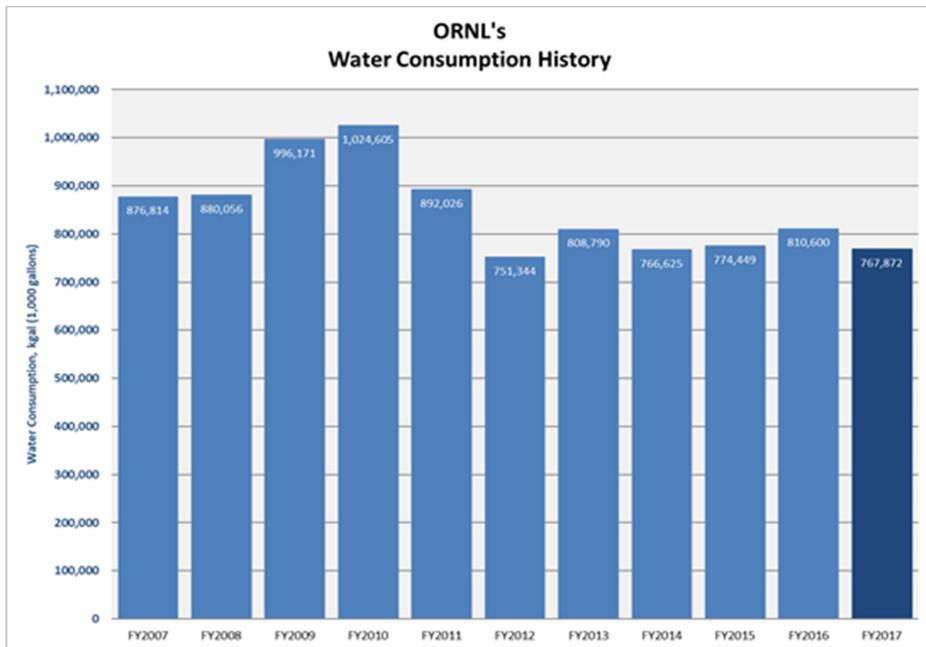
ORNL's aggressive plan to reduce water consumption includes repairing leaks, replacing old lines in the site water distribution system, and eliminating once-through cooling (OTC) where possible. The cumulative result of these efforts is a WUI of 134 G/GSF in FY 2017, which is a reduction of 24% from FY 2007, exceeding the interim goal of 20%.

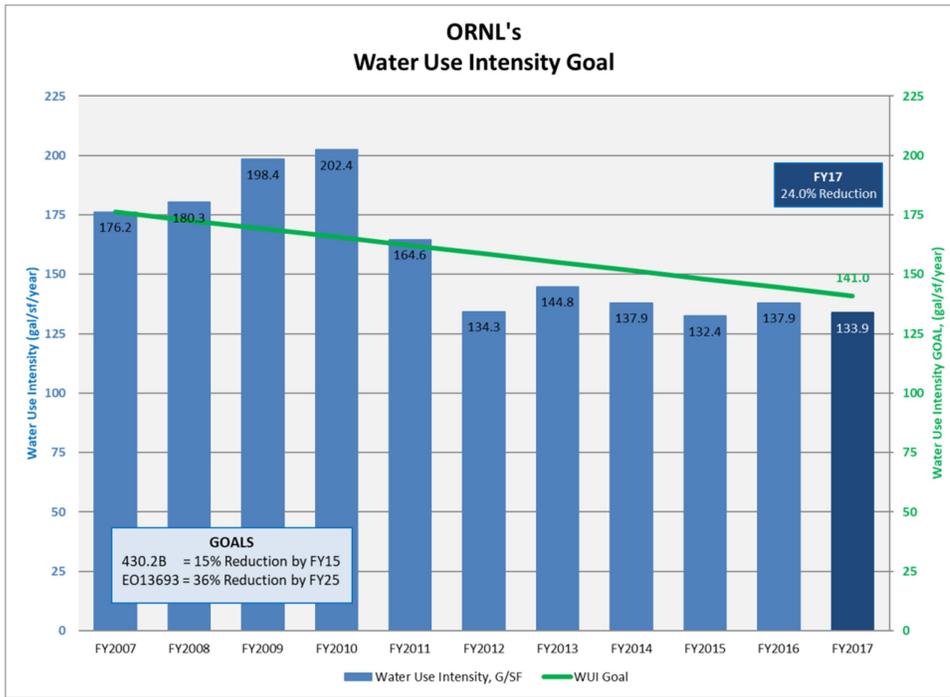
ORNL uses potable water from the City of Oak Ridge for domestic use (handwashing, flushing), cooling (cooling towers, chillers), heating (steam generation, hot water generation), limited landscape irrigation, laboratories, and special research processes. ORNL does not utilize gray water or industrial,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

- The system infrastructure buildout phase has been completed on a project to eliminate an estimated 80–100 million gallons per year (MGY) in Building 4508. A closed-loop process cooling water system was installed to replace the OTC method. Final connections to research equipment are in progress.
- ORNL works to maintain the WUI-improving measures initiated in FY 2008 upon the award of an Energy Savings Performance Contract (ESPC) and will continue to save an estimated 170 MGY.
- The ORNL Utilities Division has worked with two different leak detection companies to identify and repair leaks in the site's water distribution system. In addition, the Utilities Division has replaced the identified sections of piping and has repaired leaks found while replacing lines.

- Research and development organizations have installed stand-alone coolers or flow reducers where OTC could not be eliminated.
- Piping to Building 4509 and the associated cooling towers were replaced to reduce multiple leaks in the system.
- Installation of an independent hot water boiler at Building 5100 eliminated leaks in the hot water distribution system.
- Installation of an automatic flushing system for potable water service to EGCR reduced the water flushed out to maintain water quality by approximately 50,000 gallons per year.
- Replacement of seven safety showers and their associated piping eliminated leaks in the original outdoor showers.
- New closed-loop cooling ozone generators for potable water disinfection eliminated the OTC requirement, saving 8 gallons per minute in operations.

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 have been updated with advanced meters that are connected to ORNL's Central Energy Data System (CEDS) and are collecting interval data. These data are used to understand water end uses, consumption patterns, and potential opportunities for WUI reduction.





Plans and Projected Performance

With continued modernization activities that include elimination of old facilities and the addition of new facilities, ORNL must consider more water-efficient systems and must maintain a focus on water management best practices to meet future WUI reduction goals:

- Planned growth to support ORNL’s high performance computing (HPC) mission is projected to result in additional water consumption for cooling towers. Water consumption for this additional capacity is expected to increase by 40 MGY in FY 2018.
- New building-specific locations and strategic points on the site’s water distribution system will be evaluated for installation of advanced metering. Deep analysis of accumulated water meter interval data will be an increased focus area.
- An upgrade for one of ORNL’s reservoirs is underway.
- An enhanced site-wide water balance is being developed to better account for specific water end uses and to prioritize additional advanced water meters. This effort will also serve to identify new water conservation opportunities.
- Manual flushing methodology has been used to maintain water quality in reservoirs and long runs of distribution piping with small demand. This flushing methodology is a large consumer of water, but it is being replaced by an automated system to optimize the flushing process for more efficient water use and the respective chemical treatment of the water system.
- ORNL is working with the DOE Fire Protection Plan to identify/predict valve failures to develop a plan for replacing the vintage valves.

Current performance and future projections indicate that ORNL’s WUI is subject to rise due to increased demands for cooling tower makeup water to support growth of HPC systems. Therefore, ORNL must aggressively pursue additional water-savings opportunities to offset mission-specific demands to align with the FY 2025 goal established by EO 13693.

Waste Management

Waste Management (MSW and C&D)

Performance Status

The ORNL Pollution Prevention Program and Plan

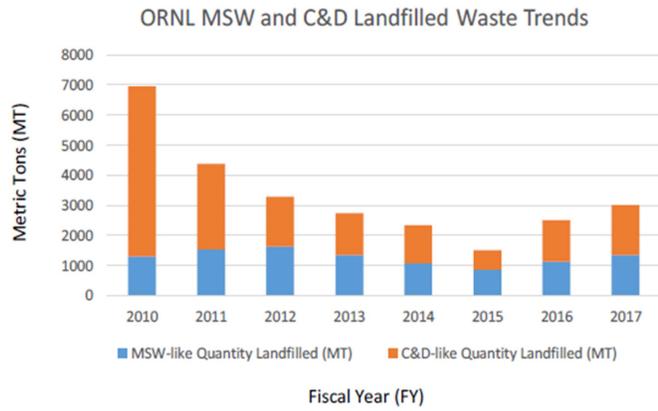
ORNL's pollution prevention (P2) program and plan embody the commitment of ORNL management and staff to embrace sustainability, including reducing waste generation and toxicity. Accomplishment of the ORNL goals requires the merger of administrative and cultural changes with new technologies and procedures. Specifically, the generation of waste and pollutants is minimized first through source reduction and then by reuse and recycling if a waste must be generated. The P2 focus has been to reduce the amount of material going to the landfill. Efforts to support this goal include the following:

- Significant amounts of material are being diverted from the landfill as a result of development and use of contract language requiring construction contractors to recycle as much construction debris as possible and to report the recycled amounts.
- Additional recycling containers were distributed to offices and breakrooms, and large recycling bins are provided in many areas, encouraging common recycle materials from inadvertently being placed in the trash.
- Assessments of specific operations and their pollution prevention practices were performed.
- Recycle/reuse is maximized for both municipal solid waste (MSW) and construction and demolition (C&D) waste, including off-site recycling of scrap metal, pallets, broken furniture, and wood.

The quantities of landfilled waste and diverted waste are highly dependent on the types of projects funded and can fluctuate. ORNL has, however, emphasized source reduction efforts such as the use of paperless systems as its preferred pollution prevention technique. These source reduction efforts along with other factors, such as diversion, have contributed to the overall downward trend observed in the combined amount of MSW and C&D waste sent to on-site landfills by ORNL (see charts below).

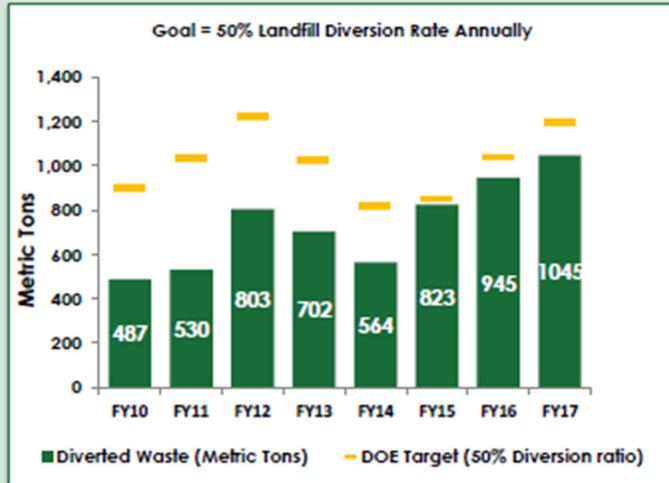
ORNL's diversion rate for MSW reached 44% in FY 2017 by continuing its initiatives and best management practices to reduce the amount of material going to the landfill, including monitoring materials going into trash cans and dumpsters; undertaking special initiatives; and examining operations to determine whether there are additional materials that have the potential for source reduction, recycling, or resale. In FY 2017, recycling scrap wood was piloted and expanded. As a result, more than 20 MT of wood waste was diverted from the landfill.

In FY 2017, ORNL achieved a 76% diversion rate for C&D waste materials and debris due to materials from several ORNL activities being reused and recycled, including 689 MT of scrap metal sent for recycle and 951 yd³ of soil as clean cover at the Oak Ridge Operations (ORO) landfill. Additionally, specific efforts to extensively characterize wastes from demolition activities prevented costly disposal as low-level radioactive waste and reduced costs by managing it as C&D waste instead. The presence of certain regulated materials (e.g., asbestos) prevented the recycling of some demolition waste and thus prevented the Laboratory diversion rate from being even higher.

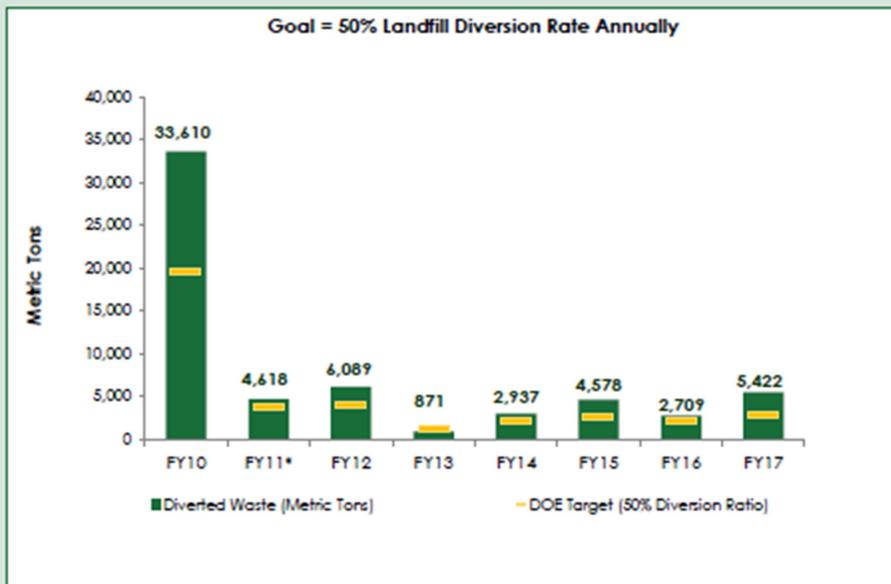


C&D – Construction and Demolition
 MSW – Municipal Solid Waste

Municipal Waste Diversion Graph



Construction and Demolition Waste Diversion



FY 2017 Wood Recycling



FY 2017 Surplus Reuse



Plans and Projected Performance

The ORNL Pollution Prevention Program and Plan

ORNL will continue its initiatives and best management practices to reduce the amount of material going to the landfill.

The following actions will continue to be implemented as a means to improve the diversion rate:

- monitoring of materials placed into trash cans and dumpsters;
- presenting findings of missed recycling opportunities to personnel to reinforce the mission of P2;
- enhancing communications with divisions and facility managers concerning which materials are acceptable in the recycling streams;
- reevaluating opportunities for composting by the ORNL cafeteria operator and continuing discussions with neighboring organizations and the City of Oak Ridge, researching the feasibility for a regional composting pilot;
- evaluating and implementing recycling of any new material streams identified;

- using effective contract language that requires construction contractors to recycle as much C&D debris as possible and to report the recycled amounts;
- using internal NEPA reviews conducted for most projects performed at ORNL to promote the reuse of soils, concrete, asphalt, and other C&D materials; and
- including recycling opportunities in the project planning process, thus ensuring cost-effective diversion results.

Waste Management: Non-toxic Chemical Management, Pest Management, and Landscape Management

Performance Status

Variables, Less-Toxic Chemical Alternatives, Integrated Pest Management, and Landscape Management

Waste generation can fluctuate with the number of people on the site, funding levels, types of work performed, and changes in research and development missions. As it continues to experience an increase in retirees due to incentive programs, ORNL strives to maximize the recycling of old files and papers.

ORNL increases the use of acceptable nontoxic or less-toxic alternative chemicals and processes while minimizing the acquisition of hazardous chemicals and materials through material substitution; operational assessments; and inventory management, including using the ORNL Chemical Management Center (CMC). Also, ORNL does not currently have waste-to-energy system and does not plan to obtain one.

ORNL implemented the Integrated Pest Management (IPM) program, which includes both interior and exterior strategies for the entire Oak Ridge Reservation (ORR). Practices include environmental controls such as ensuring that all cracks and holes are sealed to minimize pathways for pests to enter a building and educating building occupants as to the importance of good housekeeping regarding food storage, waste collection, and plant maintenance. The goal is to reduce the exposure of building occupants and maintenance personnel to potentially hazardous chemical, biological, and particulate

contaminants that adversely affect air quality, human health, building finishes, building systems, and the environment while controlling potential infestations of insects, rodents, fungi, and invasive plant species.

FY 2017 accomplishments include the following:

- Transfers of 240 chemical items were tracked through CMC efforts.
- At least 74 ash trees were removed from the campus and surroundings, along with approximately 36 to 40 in the Tower Shielding Area, in response to infestation by the emerald ash borer. The trees were dying and were removed to address safety concerns and to prevent potential damage to infrastructure.
- Sixty nuisance animals that were presenting employee safety concerns and/or damaging infrastructure were removed from the ORNL campus.
- Bird exclusion practices (mesh netting and sheet metal) were utilized.
- Control of invasive plants (e.g., kudzu) was conducted in a number of areas in and around the ORNL campus, including along Bethel Valley Road and Melton Valley Drive, in the First Creek riparian zone, in the landscaped area in front of Building 4515, and in surrounding natural areas.

ORR IPM includes removal of invasive plants, nuisance wildlife, and hazardous trees along roads and monitoring forest pests (emerald ash borer, walnut twig beetle, hemlock woolly adelgid, gypsy moth, pine beetle).

Plans and Projected Performance

ORNL continues to demonstrate commitments to programs that enhance the physical environment through its landscape management practices, to name a few include:

- planning based on sustainable principles in the *Sustainable Landscapes Initiative 2020*,
- increasing and improving pollinator habitats.

Fleet Management

Performance Status

FY2017 ORNL Fleet Performance:

- **Fleet-Wide per Mile GHG Emissions:** The ORNL fleet per-mile GHG emissions baseline of 527 grams/mile reports a 3% decrease in FY 2017, and is expected to stabilize with updated data from FAST.
- **Reduction in Fleet Petroleum Consumption:** Fuel data for FY 2017 reflects that ORNL has exceeded the cumulative target of a 20% decrease in petroleum consumption by achieving a cumulative decrease of 32% compared to the 2005 baseline, exceeding the DOE Target. To ensure that this level of progress is maintained, ORNL will continue to increase use of alternative fuels, increase the fuel economy of fleet vehicles, and reduce the number of vehicle miles driven. The DOE Oak Ridge Office (ORO) local utilization mileage goal of 94% has been exceeded, with 99% utilization for FY2017.
- **Fleet Alternative Fuel Consumption:** Fuel data for FY 2017 reflect that ORNL alternative fuel use has increased from the 2005 baseline by 70%, exceeding the DOE goal. Currently, the ORNL fleet consists of 315 flexible fuel vehicles (FFVs), or 63% of the fleet. Overall, 72% of the fleet can use alternative fuel.
- **Light Duty Vehicle Acquisitions:** ORNL continues to support the AFV acquisition requirement by purchasing available FFVs from the GSA. ORNL's ability to make additional purchases will continue to depend upon

available funding and approval. In FY 2017 all new vehicle purchased (five light-duty trucks) use alternative fuels.

- Zero Emissions or Plug-in Hybrid Electric Vehicles: ORNL began purchasing plug-in hybrid electric vehicles (PHEVs) in FY 2013 and now has a total of five PHEVs in the fleet. As funding becomes available and as appropriations are made for purchasing passenger-carrying vehicles, ORNL will continue to acquire these types of vehicles. Due to lack of funding, no PHEVs were purchased in FY 2017.

Awards

- ORNL Fleet received an *Honorable Mention* from 100 Best Fleets in May 2017.
- **Green Fleet Award Winner** – ORNL’s fleet received the 2017 Government Green Fleet Award. The award honors federal, state and local government fleets in North America that have achieved success in “greening” their fleet by using alternative fuel and hybrid vehicles, emissions reduction, long-range planning, and staff education and involvement. The top 50 green fleets are recognized annually. This year, ORNL ranked number 29th on the list and was the only fleet from the State of Tennessee to win the award. Furthermore, ORNL was the only DOE facility to be recognized. There are 38,000 government fleets in North America. The 2017 awards were presented at the Sustainable Fleet Technology Conference held in Raleigh, NC. (http://www.the100bestfleets.com/gf_winners_2017.htm).

Telematics installed in one of ORNL’s Fleet PHEV (installation by Beau Galyon, ORNL fleet mechanic)



2017 Green Fleet Award pictured L-R: Preston Daniels (Supervisor, ORNL Garage Services) and Ernie Ford (ORNL Fleet Manager)



Plans and Projected Performance

Increased Use of Telematics in Vehicles – Future plans call for continued installation of telematics in fleet vehicles. Telematics devices collect data on vehicle use, battery charging, and fuel economy. These devices record data for each trip and cumulative data for distance, energy use by type (gasoline engine + electricity), and driver behavior, including hard accelerations, the number of idle events, and the amount of fuel consumed during idling. In addition to collecting data on driving and driver behavior, information is also recorded on charging, including the type of charger used and a summary of the time of day that charging occurred.

In FY2017, an additional three Verizon network fleet telematics devices were purchased. These devices have advanced capabilities, including automatically transferring data to the network fleet web portal, where ORNL fleet management and researchers can access the data. The data will be used when deciding where to best utilize PHEVs and the charging infrastructure as more PHEVs are added to the ORNL fleet.

Reduction of Diesel Work Trucks – Future plans call for the replacement of light duty diesel trucks with more efficient models that use alternative fuels. Diesel vehicles develop problems when they are used for short trips, are driven at low speeds, and are driven in stop-and-go circumstances. In FY2017, five diesel-fueled light duty trucks with numerous engine issues were replaced with E85 fueled light duty trucks. The continued practice of obtaining replacements will improve all aspects of the ORNL fleet's performance.

Clean & Renewable Energy

Performance Status

Clean Energy Performance Status

EO 13693 expanded energy goals to include clean alternative energy sources in addition to the previous goals for renewable electrical energy. Goals include using thermal energy from renewable and alternative sources. Pursuing clean sources of energy will improve energy and water security while ensuring that federal facilities continue to meet mission requirements and lead by example.

Alternative energy projects for clean energy and the purchase of cost-effective RECs will be implemented to meet clean energy goals. ORNL's onsite renewable energy and REC purchases resulted in calculated clean energy usage of 374,521 MMBtu in FY 2017. The result is a performance of 14%, exceeding the 10% interim target set by DOE.

Renewable Energy Performance Status

In FY 2017, ORNL purchased RECs to supplement onsite renewable energy generation, representing 19% of the lab's electrical energy consumption. ORNL onsite renewable energy and REC purchases resulted in calculated renewable electricity usage of 109,766 MWh in FY 2017. The result is a performance of 19%, exceeding DOE's 10% interim target.

ORNL has identified multiple sources of renewable energy to offset the site's total electrical consumption of 593,954 MWh, including the following:

- 183 MWh of electricity produced onsite by the five solar arrays account for approximately 0.031% of ORNL electricity, which includes the double bonus allowed for onsite generation at federal facilities. Associated RECs are retained for use by the site.
- ORNL participated in the TVA Southeastern REC pilot by purchasing 14,400 MWh of renewable energy in FY 2017.
- ORNL purchased 95,000 MWh of RECs from wind resources in 2017.
- ORNL's bid request included opportunity to offer RECs for purchase from Indian Lands. Brokers did not provide RECs from Tribal Lands.

Plans and Projected Performance

ORNL plans to purchase sufficient RECs to meet the renewable energy goal, as well as the clean energy goal, and will continue to invest in economically feasible renewable energy projects on site to minimize annual REC purchases. See the following section on combined strategy for more information.

A combined strategy to meet both the clean energy and renewable energy goals will also result in progress toward GHG reduction goals.

ORNL has revisited the prospect of a large-scale solar array project. While this option is becoming more economically feasible, additional project evaluation is needed to move forward.

Along with Guiding Principles, incorporation of energy efficiency and renewable energy features will be considered in new building design conceptualization.

Until new renewable projects are identified, RECs will be the primary cost-effective means to meet DOE goals.

- ORNL will periodically monitor the REC open market and will consider purchases as they become available. The purchase quantity of RECs will include the amount to meet or exceed both the renewable target and the clean energy target.
- ORNL will make multiple strategic purchases throughout the year based on energy consumption projections and REC pricing to best fit the interim annual incremental targets to achieve the 25% goal for FY 2025.
- RECs are likely to be considered in the short term until a cost-effective, feasible solution for onsite electrical generation can be developed and implemented. ORNL's primary strategy is to develop onsite capabilities before considering other options.
- ORNL will develop specific REC strategic purchasing guidance to help incorporate these strategies into a living document to help determine the best value. Guidance will also include dedication of RECs to specific buildings for LEED certification, consideration for premium REC cost from Tribal Land resources, or other goals.

Green Buildings

Green Buildings: New Building Design

Performance Status

ORNL continues to assess opportunities and challenges of new building construction to identify designs with the highest potential to reach net-zero energy for waste and/or water. This facilitates long-term well-grounded building planning and implementation of activities enabling development of new net-zero buildings on ORNL's campus, as well as compliance with EO 13693 directives.

Plans and Projected Performance

To improve building efficiency, performance, and management in accordance with the new EO 13693, all new ORNL buildings with a gross square footage (GSF) of over 5,000 that enter planning in FY 2020 and thereafter will be designed to attain net-zero energy status, as well as net-zero water and waste when feasible by FY 2030. ORNL will provide further internal procedures and define an implementation strategy prior to FY 2020 for net-zero energy design in new construction. FY 2018 new construction projects in planning (>5,000 GSF) are being designed to be in compliance with EO 13693.

Green Buildings: Guiding Principles

Performance Status

In FY 2017, ORNL's high performance sustainable building (HPSB) inventory included a total of 20 buildings, or 15% (which meets the 2017 interim target) of the total applicable site buildings according to the *Guiding Principles (GPs) for Federal Leadership in Sustainable Buildings*.

In prior reports, ORNL included third party and joint institute facilities in the HPSB total because they are operated and maintained by ORNL, and they were previously grandfathered. The revised HPSB GPs stipulate that contractor-leased facilities should not be included in HPSB accounting. ORNL's third party and joint institute facilities are categorized in the Facility Information Management System (FIMS) as contractor leased; therefore, they will no longer be included as applicable site buildings or in the total HPSB count.

Employing a systematic approach to identifying HPSB candidates and applying the GPs has been an effective way to ensure continued progress. HPSB candidates have been identified based on building space use, existing metering infrastructure, and known energy conservation opportunities. Action plans for achieving building-specific GPs are developed and executed, while laboratory-wide standards are used to fulfill HPSB applicable policies and procedures. Engagement of facility managers, facility engineers, and other technical personnel has been essential to acquiring quality benchmarking data, performing commissioning activities, and implementing energy conservation measures.

As experience with the GPs has grown, the focus of ORNL's HPSB efforts has begun to shift from office buildings to include laboratory and mixed-use buildings. The existing building commissioning process has proven very beneficial in identifying opportunities to optimize existing equipment and systems to better align with current space use. With the evolution of research programs and projects, buildings are often used in a manner that is different from their original

designs. Therefore, identifying, evaluating, and adjusting HVAC airflow volumes, set points, control sequences, and related actions have provided the best return on investment.

Achieving HPSB status is only the beginning of an ongoing cycle of “plan, do, check, act.” Advanced metering and building automation system data are leveraged to monitor ongoing performance. This ensures the persistence of savings and may even help to increase them over time.

Plans and Projected Performance

ORNL will continue to work on evaluating applicable site buildings to achieve greater compliance with GPs to meet the year 2025 target and then to work toward 100% compliance. ORNL will focus on leveraging energy data and performance analytics whenever possible to make progress towards fulfilling GPs. Partial GP compliance will be documented to better track the status and progress of each applicable building. As it becomes increasingly more challenging to apply 100% of the GPs to ORNL’s most complex buildings, intensive effort and often capital investment will be required to make significant changes to reduce energy consumption. Additional time will also be required to measure performance and verify savings. Efforts will continue toward expanding the existing HPSB inventory at a pace that does not compromise the ability to effectively manage the buildings that have already achieved HPSB status.

Green Buildings: Net Zero Buildings-Existing Building

Performance Status

ORNL has begun the process to assess its existing building portfolio and to identify candidate buildings with the greatest net zero energy, waste, and/or water potential. Continued focus on the GPs for sustainable buildings, retrocommissioning, ECM implementation, and operational best practices will be used to drive building performance to approach net zero. On-site renewables that are grid cost competitive will be required to complete the task of full net zero conversion. Significant barriers to attainment will also be identified so that they may be discussed internally in agency working groups and in other appropriate forums.

In FY 2017, ORNL applied the principles to improve the existing roof of Building 4508 to be a cool roof, installing a closed loop cooling system to eliminate the once-through process water cooling. Additionally, Building 6010 underwent a renovation (<5,000 GSF) that complied with EO 13693 principles. As systems (chilled water units, overhead cranes, etc.) and utilities (water treatment systems) are improved or upgraded, energy efficient components are specified.

Plans and Projected Performance

ORNL is assessing technical and financial feasibility and formulating a strategy to accomplish the DOE goal. ORNL will define an implementation strategy for existing buildings prior to the target date.

Green Buildings: Regional & Local Planning Coordination and Involvement

Performance Status

Transportation Efforts

During FY 2017, ORNL and the leaders of the Sustainable Campus Transportation Roadmap continued to actively engage in regional and local planning for sustainable transportation, as well as outreach activities for the enhancement of

sustainable transportation across the entire southeast region. ORNL is a leader in the region not only in the science and technology behind sustainable commuting, but ORNL also employs an array of best practices for employee commuting.

In 2017, SCI coordinated with state and regional transportation programs to help create more effective, efficient, affordable regional transportation and commuting options. Staff members from ORNL actively participated in local and regional organizations, including service on the Board of Directors of the East Tennessee Clean Fuels Coalition and use of regional sustainable transportation options. These meetings are important interactions with regional stakeholders, including Knox Area Transit (KAT), City of Knoxville, Smart Trips™, and others. ORNL remains committed to coordinating with local, state, and federal telecommute and rideshare initiatives. Use of the route linking ORNL to Pellissippi State Community College (PSCC) continues to be a success, and ORNL remains committed to its partnership with the University of Tennessee (UT) and PSCC. The Sustainable Campus Initiative team recognizes regular bus riders for using the UT/ORNL/PSCC daily transit.

Specific outreach efforts included the following:

- ORNL participated in the Tennessee Electric Vehicle Advisory Council (TEVAC).
- A draft paper, “Evaluation of Alternative Employee Commuting Strategies to Reduce Scope 3 GHG Emissions at the Oak Ridge National Laboratory” and was submitted for publication.
- ORNL continued engaging UT and PSCC regarding the bus route, with a trial expansion to the Hardin Valley Campus.
- ORNL conducted a new employee commute survey, and the associated draft analysis has been completed.
- ORNL employees were encouraged to participate in Smart Trips™.
- ORNL collaborated with the local DOE Clean Cities coalition and regional stakeholders, including board service and active participation in quarterly meetings.

ORNL is a leader in the region in promoting electric vehicle use and has been actively participating in regional workplace charging efforts, including installation of 47 electric vehicle supply equipment (EVSE) charging stations at ORNL’s main and Hardin Valley campuses. An ongoing electric vehicle club allows ORNL employees access to charging stations.

Regional Outreach

During FY 2017, the Southeast Sustainability Group (SSG) continued to review project opportunities based on its four key charter areas: sustainable transportation, low-carbon power generation, energy efficiency, and water and waste management. The primary project under consideration is installation of solar capacity at a college campus location, with active grid management as a potential pattern for other similar settings. This would offer potential cost savings, time-of-day grid management, and the advancement of renewable power. SSG is composed of research, academic, and industry partners throughout the southeastern United States with a shared vision to advance sustainability in the region (EPA Region IV).

Other Regional and Local Sustainability Planning Activities

ORNL continues to be a leader in the region in promoting electric vehicle use and has been actively participating in regional workplace charging efforts as noted above.

Plans and Projected Performance

ORNL will continue to pursue existing and new activities in support of sustainable transportation, complete the employee commuting report now in progress, and review the feasibility for implementing the following recommendations:

- examine transportation options based on the new commuting survey,
- continue active participation in SSG,
- prepare further for new EO goals and multimodal access planning for commuters,
- further develop the regional transportation planning partnerships with Smart Trips™ and KAT,
- report on the Southeast Alternative Fuels Conference with a focus on regional transportation planning,
- continue to participate in the Knoxville Regional Transit Development Plan to promote and to coordinate ORNL's commute/transit needs into the long-range transportation strategy for the region, and
- continue to participate in the PlanET regional consortium, sharing sustainability lessons learned with regional leadership.

Acquisition & Procurement

Performance Status

All applicable contracts in FY 2017 contained terms and conditions that invoke requirements for sustainable acquisitions. As directed in EO 13693, three Federal Acquisition Regulation (FAR) clauses were added to the standard commercial items in terms and conditions contracts beginning in January 2016.

Standard contract terms and conditions, which are made part of all procurement actions for commercial items and services, invoke the pertinent FAR contractual requirements for energy efficiency and sustainability. Those clauses were included in 100% of the following FY 2016 subcontract actions:

- ORNL issued 23 new construction contracts in FY 2017, 100% of which were reviewed and verified to contain the sustainability contractual requirements. No new janitorial contracts were issued in this period; however, Kel-San (janitor contract Vendor) recognizes ORNL's interest in sustainability and have made Environmentally Preferred Products (EPP) a point of emphasis in their product line for ORNL. They have 100+ items that are either EPP or Green Seal certified. This includes all of the paper, hand care, and cleaning chemicals that they provide for our janitorial staff. They have done a good job in helping us support our sustainability goals.
- In FY 2017, all unique subcontracts, purchase orders, and task orders met the DOE procurement requirements for sustainable acquisitions.
- All purchase orders issued against blanket ordering agreements met the requirements.
- Terms and conditions issued with blanket ordering agreements not only contain all FAR provisions, but they also include additional requirements for promoting and providing environmentally preferable products. The Acquisition Management Services Division includes subcontract language for key commodity suppliers, requiring that the vendors provide detailed reports on the purchases of electronics products designated as ENERGY STAR and the Electronic Product Environmental Assessment Tool (EPEAT).

Plans and Projected Performance

The ORNL Acquisition Management Services Division includes various purchasing groups and a group responsible for policies, procedures, records, reports, and compliance. Advances and improvements in these processes to promote sustainable acquisitions and procurement are among the highest priorities, as the division remains committed to maintain 100% compliance with SSP/EO goals.

Measures, Funding, & Training

Performance Status

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.

ORNL's Sustainable Campus Initiative (SCI) managed 25 dynamic roadmaps in FY 2017, all at varying stages of implementation. Each roadmap has specific fiscal year deliverables that are kept on schedule by holding regular review meetings with individual roadmap owners and SCI leadership. In addition, the Facilities and Operations (F&O) director, an SCI sponsor, has made success on these roadmaps a part of the directorate's performance plan. Furthermore, all roadmaps are reviewed quarterly with SCI sponsors from ORNL's SCI Leadership Team. This scheduled review also provides a forum for ORNL staff members to present new roadmap proposals.

FY 2017 values and future funding for Sustainability Budget Categories is covered in the table below.

Category	FY17 Actual	FY18 Planned/ Request	FY19 Projected
Sustainability Projects*	1,651	1,300	1,300
Sustainability Activities other than projects	701	578	800
Sustainability Program Office (SPO) Funded Projects (SPO funding portion only)	53	49	0
Site Contribution to SPO Funded Project	49	0	0
ESPC /Utility Energy Service Contract (UESC) Contract Payments (if applicable)	10,021	10,351	10,691
Renewable Energy Credits (RECs) Purchase Costs (if applicable)	53	132	155
Total	12,528	12,410	12,946

Energy Performance Contracts

ORNL's Energy Savings Performance Contract (ESPC) with Johnson Controls, Inc. (JCI) was the primary mechanism for achieving the goals established to meet Energy Policy Act (EPACT) 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 utilization of this funding mechanism.

A dual-fuel natural gas/fuel oil boiler replaced the Biomass Gasification System that experienced operational difficulties. The new boiler has been in operation since FY 2016, and reductions in natural gas and fuel oil consumption have been achieved, 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 and a building management system modernized HVAC control systems and provide the means to significantly reduce or eliminate energy intensive simultaneous heating and cooling in several large air-handling units.

Training

In FY 2017, six facilities and operations engineers and three research personnel received the training and examinations required to achieve the Certified Energy Manager (CEM) credential from the Association of Energy Engineers (AEE). ORNL’s Energy Efficiency and Sustainability Program coordinated with the local East Tennessee chapter of AEE to plan and schedule the week-long review course and exam session locally. This arrangement provided the group from ORNL and other local energy professionals with the opportunity to achieve this valuable credential without the expense and inconvenience of travel.

Plans and Projected Performance

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 measurement and verification report, and other support as requested by DOE. All funding paths for energy conservation measures, including performance contracting, will be considered as ORNL works to meet sustainability goals.

When considering financing mechanisms for performance contracting, ORNL identifies challenges such as the potential for savings interactions between existing and new projects, as well as the impact of mission and facility changes inherent to ORNL’s operating environment.

ORNL continues its review of a large solar photovoltaic project to minimize the REC purchases each year.

Travel & Commute

Performance Status

ORNL continues its overall commitment to communications to employees that encourage their engagement in GHG reduction. Influencing the actions of employees and their awareness of how those actions affect the carbon footprint of the organization is one of the foundational methods to achieve a more sustainable future. Employee outreach interactions are designed to focus efforts on the reduction of direct and indirect emissions in all actions. Communication is designed to reach management personnel, employees, and contractors to encourage sustainable practices in the workplace, at home, and in the community. Details of employee commute projects can be found in the Regional and Local Planning SSP Dashboard narrative.

Activities described in detail in previous ORNL SSP submittals include projects that promote sustainable employee commuting options. Employees are educated in the benefits of using carpools, alternative work schedules, proper use of EV charging stations, and more efficient transportation options. Projects such as improved videoconferencing tools in lieu of expensive business travel continue to yield results in Scope 3 GHG performance. In FY 2017, ORNL SCI Teresa Nichols led a DOE/Sustainability Performance Office project to create a Telework Guide for DOE facilities to use. Details can be found in the Executive Summary Highlights.

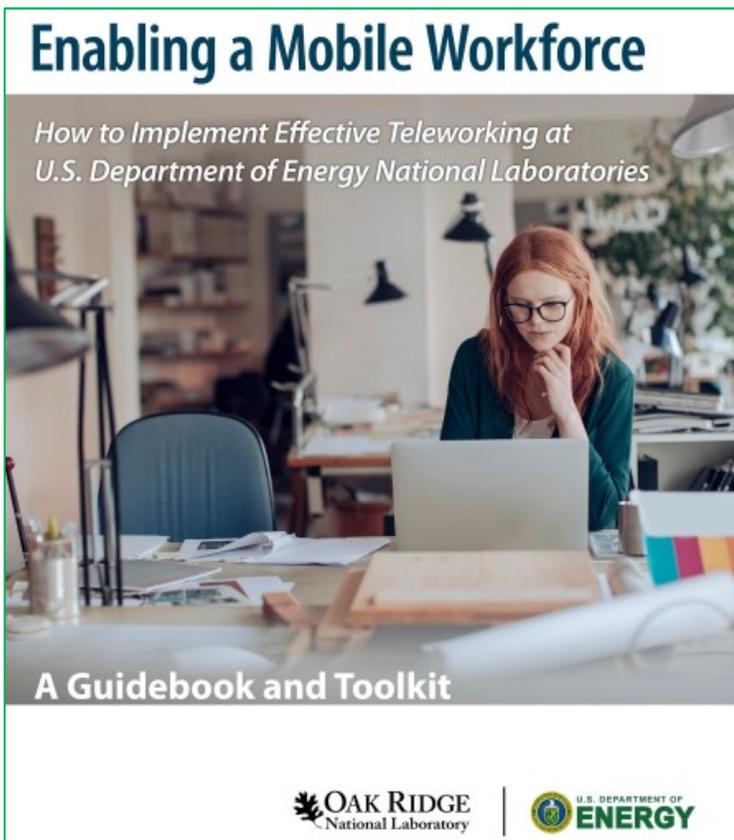
ORNL employee participation in commuting options/programs in FY 2017 include:

- 170 employees participated in carpools and vanpools. Of these, 76 entered data into the Smart Trips™ system, a regional transportation project.
- 140 employees completed a formal telework agreement, an increase of more than 300% increase from the prior year (see Executive Summary and telework report embedded below).
- Staff continue to use ORNL teleconferencing capabilities (BlueJeans) to reduce business travel as well as onsite travel across campus. Teresa Nichols and Bryce Hudey (ORNL SCI) avoided two business travels by using BlueJeans to participate in meetings being held in Ohio as well as being able to participate in the monthly DOE SAN/SESG webinars.
- Bus transit experienced increases in ridership and frequency of service for the dedicated ORNL/UT/PSCC route (see Executive Summary and photo slide embedded below).
- 114 employees participated in alternative work schedules via 9/80 and 4/10 shift designs.

Additional Information

1) **Telework Guidebook and Toolkit** (*Enabling a Mobile Workforce: How to Implement Effective Teleworking at US Department of Energy National Laboratories*) was published by ORNL and DOE.

https://powerpedia.energy.gov/w/images/9/9f/Telework_Report_FINAL_May_18_2017_ORNL.pdf



2) Sustainable Campus Initiative co-sponsors with the University of Tennessee to provide FREE Bus Transit. The bus operates during the UT academic year providing three-round trips each day between three campuses (including Pellissippi State Community College) and two round-trips during the summer months. Summer 2017 ridership averaged 48 riders each day.



Plans and Projected Performance

Projects and activities to promote Scope 3 GHG reductions include the following:

- ORNL distributed a commuter survey to all staff members in 2017 and received a 33% response rate. Plans for FY 2018 include further examination of employee commuting transportation options based on commuter results.
- The incremental improvement and availability of videoconferencing tools will continue to have a positive effect on reducing business travel.
- ORNL will continue to encourage and monitor the progression of alternative work schedules, telework participation, and sustainable commuting options.

Fugitives & Refrigerants

Performance Status

In Fiscal Year (FY) 2017 Oak Ridge National Laboratory (ORNL) was again resolute in its commitment to sustainable operations and the reduction of GHG emissions wherever possible while remaining diligent to the (DOE) mission of providing valuable solutions to the nation's energy and security challenges. ORNL continued to look for methods that would advance the goals and targets of Executive Order 13693 and DOE sustainability initiatives.

Sulfur hexafluoride (SF₆) is a key contributor to ORNL's Scope 1 GHG emissions inventory. Active management of SF₆ emissions is necessary to meet DOE's overall reduction goal of 50% for Scope 1 GHG emissions. An overall awareness of the global-warming potential of SF₆ has resulted in a more cautious approach to the requisition and purchase of this

potent GHG. ORNL is committed to evaluating processes and purchasing improvements with the potential to reduce SF₆ emissions.

Furthermore, the Holifield Radioactive Ion Beam Facility (HRIBF), located in Building 6000, was a national user facility for research with radioactive ion beams that is now being decommissioned. SF₆ insulating gas was required for operation of the tandem accelerator to prevent electrical discharge from the high-voltage terminal and accelerating column to the pressure vessel. The HRIBF tandem accelerator SF₆ inventory at the end of FY 2017 was approximately 74,000 lb. Losses during the year, which totaled 2,560 lb, resulted from normal process losses and unavoidable losses during on-site operations associated with the transfer of SF₆ to a private company.

At the end of FY 2017, a total of 126,480 lb of SF₆ was transferred off-site to a private company that purchased the gas from the DOE Office of Science. SF₆ process losses are down by 2% in FY 2017, and we expect zero GHG emission from SF₆ by FY 2019.

Other GHG emissions from misc. fugitive gases (such as lab and testing gases) have decreased by 74% from the baseline year.

Scope 1 GHG Emissions (MTCO ₂ e)	FY 2008	FY 2017	Decrease	(% +/-)
SF ₆ Process Losses	27,102	26,475	(627)	-2%
Fugitive Gases	10,660	2,813	(7,847)	-74%

ORNL				Emissions (lbs)												Projected			Total - FY18 to FY20
Applications/Processes/Facilities/Systems Using SF ₆	Identify Key Facilities by FIMS Asset #	Current SF ₆ Inventory (lbs)	SF ₆ Device Inventory (lbs)	FY10	FY11	FY12	FY13	FY14	FY15	FY16	Total - FY10 to FY-16	FY17 Actual	FY18	FY19	FY20	Total - FY18 to FY20			
Holifield Radioactive Ion Beam Facility*	97322	74,000	0	2,500	10,400	1,700	1,326	2,008	1,766	1,660	21,360	2,560	2,500	0	0	2,500			
Balance of Site	NA	4,538	NA	450	247	235	3	24	20	33	1,012	181	100	100	100	300			
Total		78,538		2,950	10,647	1,935	1,329	2,032	1,786		20,679	2,741	2,600	100	100	2,800			

*Note that during FY17, 126,480 lb of SF₆ was transferred off-site to a private company that purchased the gas from the DOE Office of Science.

Instructions:

- (1) Please identify specific applications/processes/facilities/systems that account for at least 80% of the site's SF₆ inventory starting with largest down to smallest. The remaining 20% may be grouped as "Balance of Site"
- (2) Please enter documented emissions for FY 2010 thru FY 2016, as available. Total by year should align with SF₆ emissions identified in Site Sustainability Plans

Plans and Projected Performance

Scope 1 GHG emission reduction estimates indicate that ORNL is on target to meet the FY 2025 target reduction goal of 50%. This projected success specifically is based on a number of key projects and initiatives:

- The HRIBF SF₆ inventory has been sold and is currently being transferred off site over a period of about four months spanning the end of FY 2017 and the beginning of FY 2018. Until the SF₆ inventory has been fully transferred, the remaining SF₆ will continue to be carefully maintained, managed, and monitored as it has been for more than 30 years. The entire SF₆ inventory will be transferred off site by the end of FY 2018.

- Site-wide fugitive emissions should continue to decline as research scientists are made aware of less potent alternatives for tracer gases and for gases used in research. Overall, the site-wide fugitives and refrigerant GHG emissions have a minor impact on the overall production of GHG emissions across ORNL.

Additional Documentation in the Technical Process of SF₆ GHG Inventory Verification, submitted by Alan Tatum and William McCarter.

FY17 Green House Gas Inventory Verification Team Documentation For Industrial Process Emissions, Sulfur Hexafluoride (SF₆)

Points of Contact:

Alan Tatum, Accelerator Systems & Stable Isotopes, (865) 574-4759

William McCarter, Environmental Protection Services Division, (865) 576-1172

Process Description

The Holifield Radioactive Ion Beam Facility (HRIBF), located in Building 6000 at the Oak Ridge National Laboratory (ORNL), was a national user facility for research with radioactive ion beams that is now being decommissioned. Sulfur hexafluoride (SF₆) insulating gas was required for operation of the tandem accelerator to prevent electrical discharge from the high-voltage terminal and accelerating column to the pressure vessel. The SF₆ inventory has been sold and is currently being transferred offsite over a period of about four months spanning the end of FY17 and the beginning of FY18. Until the SF₆ inventory has been fully transferred, the remaining SF₆ will continue to be carefully maintained, managed, and monitored as it has been for over thirty years. The entire SF₆ inventory will be transferred offsite by the end of FY18. The pressure vessel for the tandem accelerator contains the high-voltage terminal and accelerating column structure, and was filled with SF₆ insulating gas during accelerator operations. Three large pressure vessels located on the second floor of Building 6005 are used to store the SF₆ in liquid form when it is removed from the tandem accelerator pressure vessel. In addition to transferring the SF₆ gas to and from storage, the gas-handling system was used to circulate the SF₆ gas during accelerator operations for heat transfer and the removal of moisture and breakdown products; that portion of the system was demolished in FY17.

Only trained and certified HRIBF Gas Handling System Operators perform gas transfers. These individuals are responsible for the safe operation of the system, and for ensuring that SF₆ losses are minimized, thus limiting Greenhouse Gas emissions.

Industrial Process Emissions Calculation Methodology

The SF₆ inventory at HRIBF is determined by a load-cell-type weighing system located in the gas storage building, Building 6005. In order to determine the current gas inventory at the facility, all of the gas is put into storage, and distributed between three storage tanks for measurement. The weight of each of the three storage tanks, and thus their contents, are recorded immediately after a gas transfer to storage and again immediately before transfer back into the tandem pressure vessel. This weight is checked at the end of each FY to provide the annual process data in order to estimate via a simple material balance the amount of SF₆ emitted over the FY.

A basic material balance is used to make this determination as shown in the table below:

Table 1 – Example Material Balance for SF6 Industrial Process Emissions

Industrial Process Emission Source	Fiscal Year	Beginning FY SF6 Storage Inventory (lb)	Final FY SF6 Storage Inventory (lb)	FY Emissions as Reported in Dashboard (lb)
Holifield Radioactive Ion Beam Facility	2015	206,466	204,700	1,766
Holifield Radioactive Ion Beam Facility	2016	204,700	203,040	1,660
Holifield Radioactive Ion Beam Facility	2017	203,040	74,000	2,560

Note: The fiscal year (FY) weights are calculated using a simple material balance. The difference in the initial and final fiscal year weights for SF6 in storage inventory is conservatively assumed to be emitted as GHG.

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Note: The fiscal year (FY) weights are calculated using a simple material balance. The difference in the initial and final fiscal year weights for SF6 in storage inventory is conservatively assumed to be emitted as GHG.

Weights are affected by temperature variations and are measured to the nearest 20 pounds. However, the weighing system is reliable and accurate for providing a conservative SF6 emission loss value. Note that, in addition to the emissions reported in Table 1, 126,480 lb of SF6 was transferred offsite in FY17 to a private company that purchased the gas from DOE.



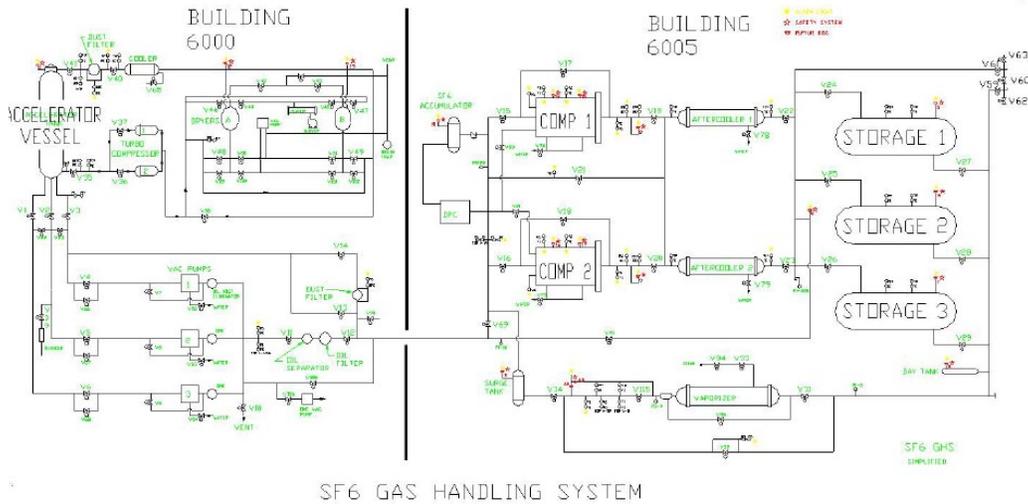


Figure 1 – Simplified Schematic of the Holyfield SF6 Gas Handling System

Electronic Stewardship

Electronic Stewardship: Acquisition

Performance Status

ORNL continues to exceed 95% compliance with EPEAT standards for purchases of computers, monitors, and laptops. All desktop and laptop computers and monitors are Energy Star qualified. In FY 2017, multiple workstations that were not compliant with EPEAT criteria were replaced with new standard EPEAT workstations that are certified for computer-aided design and that meet researchers' requirements. ORNL continues to meet the requirements for electronics purchases with respect to EPEAT, Energy Star, and FEMP via the use of a guided procurement system to route staff to the approved electronic devices. The ORNL Managed Hardware Program provides a listing of approved standard hardware (i.e., desktops, laptops, and tablets) that may be purchased without further approvals. All electronic devices meet EPEAT, Energy Star, and FEMP requirements. Established automated procurement governance ensures that all nonstandard requests are reviewed to determine whether the devices comply with cyber security, configuration management, EPEAT, Energy Star, and FEMP requirements.

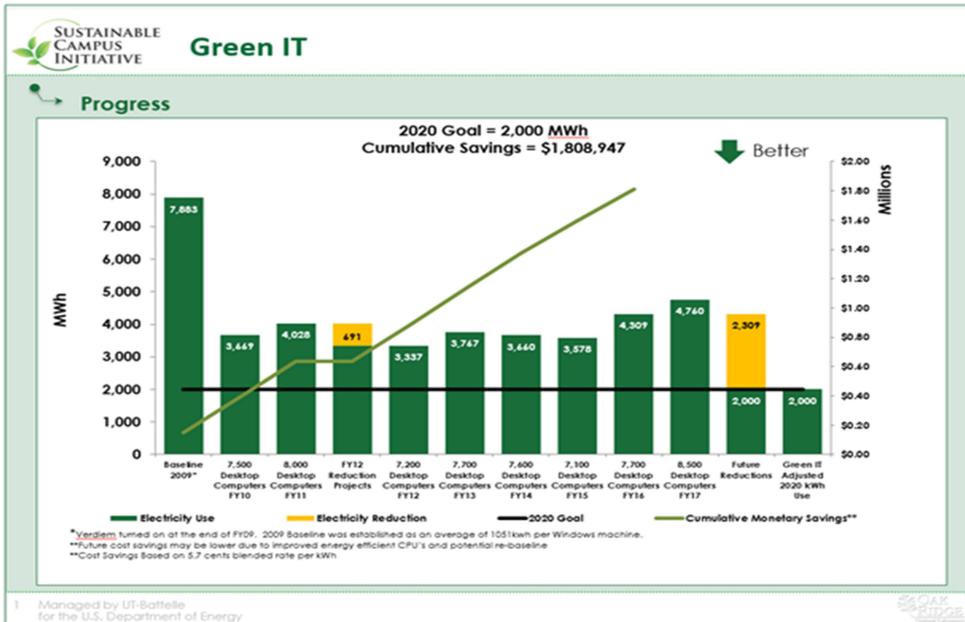
Plans and Projected Performance

ORNL will continue to focus on minimizing the number of print devices that are purchased and will guide staff toward a standard set of shared network printers. All requests for nonstandard (i.e., non-EPEAT) computers, monitors, and laptops will be closely monitored by the Green Information Technology Team and Procurement.

Electronic Stewardship: Operations: Power Management

Performance Status

As shown in the figure below, ORNL has successfully met the electronic stewardship goal of power-managing 100% of the eligible personal computers, laptop computers, and monitors in use by ORNL staff since 2009. The progression of estimated power management electricity savings is shown. The chart includes estimates that are generated from collected data.



All ORNL Windows computers, including servers, desktops, and laptops, are required to be power-managed and to have a secure screen saver with a timeout setting between 1 to 15 minutes. Windows screen saver configuration settings are enforced by the System Center Configuration Manager, which is managed by the Information Technology Services Division.

All ORNL Macintosh systems are required to have a password-protected screen saver with an inactivity timeout (unless a system has an exception). Settings are checked and changed, if necessary, every 12 hours by automated systems.

Linux screen saver settings vary based on the operating system version and the desktop environment. Because of the large number of configurations and the lack of centrally configurable policies for some desktop environments, screen savers on the Linux platform are managed on a best-effort basis.

Plans and Projected Performance

ORNL plans to continue power management using the Verdiem Surveyor software. The Green IT roadmap for FY 2018 includes continued operation of the computer power management and monitoring system in a manner that will enable the power management of the latest versions of Windows and MacOS systems.

Electronic Stewardship: Operations: Policies/Procedures (Automatic Duplexing)

Performance Status

ORNL has successfully implemented a shared print services program to update existing multifunction print devices (print/scan/copy/fax devices) and to provide for other shared print devices. All new print services include automatic

duplexing set as the default. An individual can override duplexing for a print job that requires single-side printing. In addition, locked print is an option for all new shared printers, so users can release an individual print job by entering a personal identification number at the printer as needed to limit others' access to a print job prior to retrieving the printout from the shared printer. Existing printers without duplexing capability are being replaced with printers that require duplexing capability.

The shared network printer services model is helping to standardize equipment, reduce energy consumption, reduce landfill waste, reduce the cost of operations, improve printing services in general, and provide more efficient use of consumable products. Over time, ORNL plans to shrink the printer equipment footprint and to save essential overhead costs by reducing toner purchases, support costs, and power demands.

Plans and Projected Performance

ORNL plans to continue to (1) implement shared network print devices with automatic duplexing set as the default and (2) reduce the number of local print devices by providing additional shared network printers.

Electronic Stewardship: End of Life

Performance Status

In FY 2017, ORNL met this goal with 100% of used electronics being reused or recycled using environmentally sound disposition options. Options include transfer to other DOE contractors, nonprofits, and schools by means of programs such as the Computers-For-Learning (CFL) Program. Electronics that have reached end of life are recycled through a Responsible Recycling Practices (R2)-certified recycler.

ORNL has supported transfer of specific electronic components to other DOE contractors, nonprofits, and the CFL Program for decades. Since May 2012, ORNL has exclusively used an R2-certified recycler to recycle its electronics that have reached end of life. ORNL has had processes in place to reuse and recycle electronics in an environmentally sound manner even before certifications were available by doing on-site assessments of the recycling facilities. ORNL also reviews procedures and certifications to ensure that recyclers are in compliance with all regulations, are using best practices, and are in good standing with professional recycling associations.

Plans and Projected Performance

ORNL plans to continue to (1) use the CFL Program to reuse viable electronics and (2) use an R2-certified recycler to recycle its electronics that have reached end of life.

Electronic Stewardship: Data Centers

Performance Status

ORNL is pleased to report that this year's power utilization effectiveness (PUE) has been steady at ~1.3. FY 2017 brought the construction of a new 9,400SF data center to substantial completion. The anticipated PUE of this data center is less than 1.15, a substantial improvement to the data center portfolio's overall PUE. The new center (*Exhibits 1 and 2*) will house a new high-performance computing (HPC) system (debuted as SUMMIT) to leverage dynamic liquid cooling for the ambient space and the compute nodes, using a water side economizer when outdoor conditions allow. Fans in the IT equipment and the rack-level cooling system (*Exhibit 3*) are used to control the data

center's ambient conditions rather than facility fans. Cooling controls will be integrated with the HPC system and cooling pumps (*Exhibit 4*) which will receive real-time feedback on the amount of cooling required.



The controls will also exchange information regarding future changes in demand and cooling availability. A water-sourced variable refrigerant flow (VRF) system is available to condition the space if the HPC system is offline. This VRF system's air handlers filter the air and provide dehumidification only when needed while the HPC system is in operation. The data center air is filtered using MERV 13 nano-fiber filters for enhanced filtration. These filters have a lower pressure drop than standard MERV 13 filters, reducing fan horse power requirements, thus improving energy efficiency. The primary water source for the VRF system is the same water side economizer loop (*Exhibit 5*) used by the HPC System. On the hardware side of this HPC system, computational performance should use one-sixth of the energy as its predecessor, producing more than 12 billion floating point calculations per watt. The system's data buffer will absorb data one hundred times faster than its predecessor, and when combined with NVLINK, jobs will finish quicker, minimizing compute time and overall energy consumption.

Over the past three years, a ten-year overhaul was performed on three 1,200-ton chillers. The efficiency of each chiller was improved by up to 10%, saving energy and water due to the reduced load on the cooling towers.

Continuing migration of IT equipment from an older data center to a newer one has led to less energy usage in the older center, while the newer center is becoming more efficient as the cooling systems load up more toward their design point. As new programs come online, virtualization continues to be the first choice. The migration has also resulted in replacement of older, less efficient servers with new, more efficient ones. When old equipment is removed, hard drives are recycled, and when batteries were replaced in an uninterruptible power supply (UPS), the old batteries were recycled.

Exhibit 1. Computational Facilities Overview

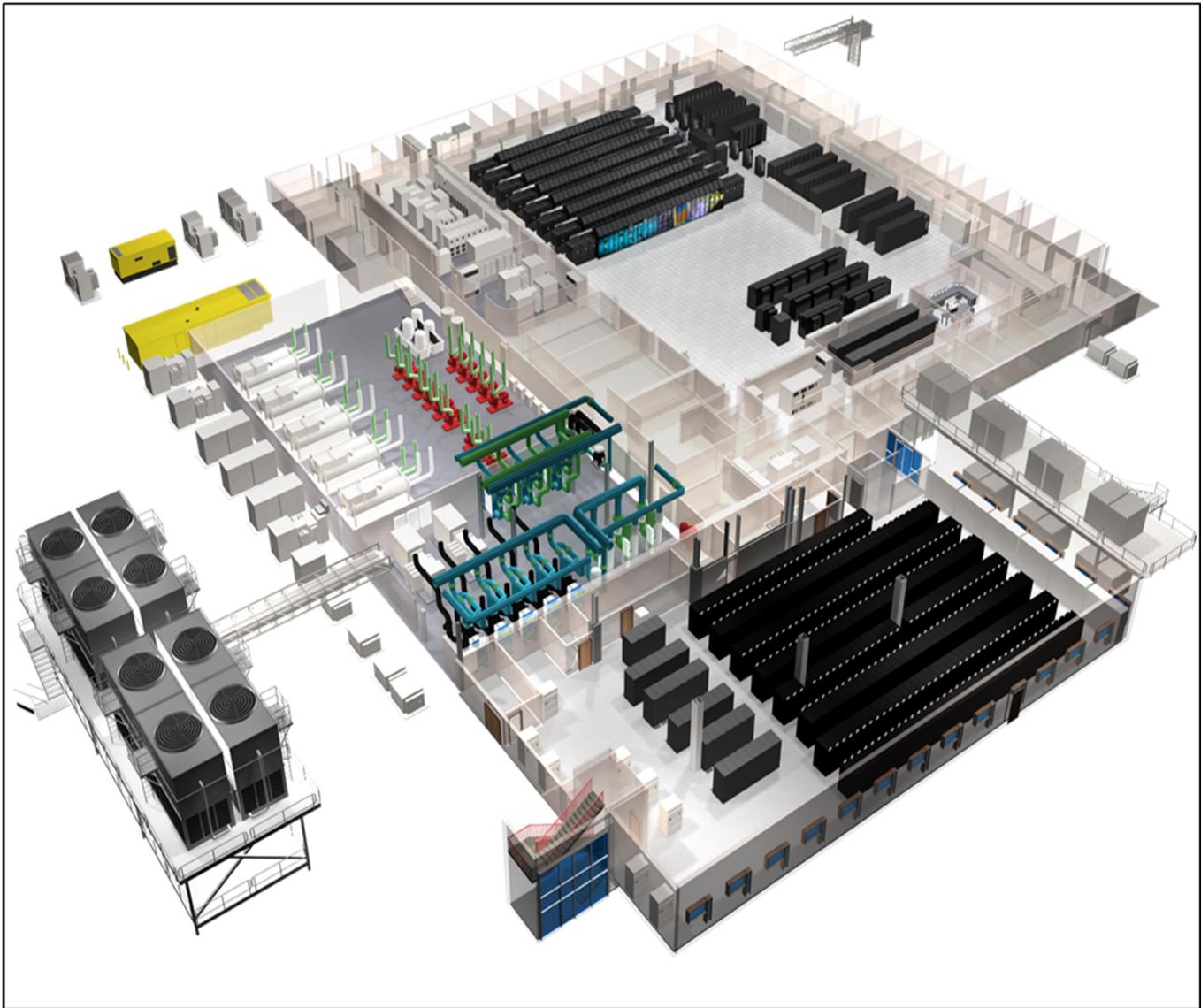


Exhibit 2. HPC Cooling System Methods

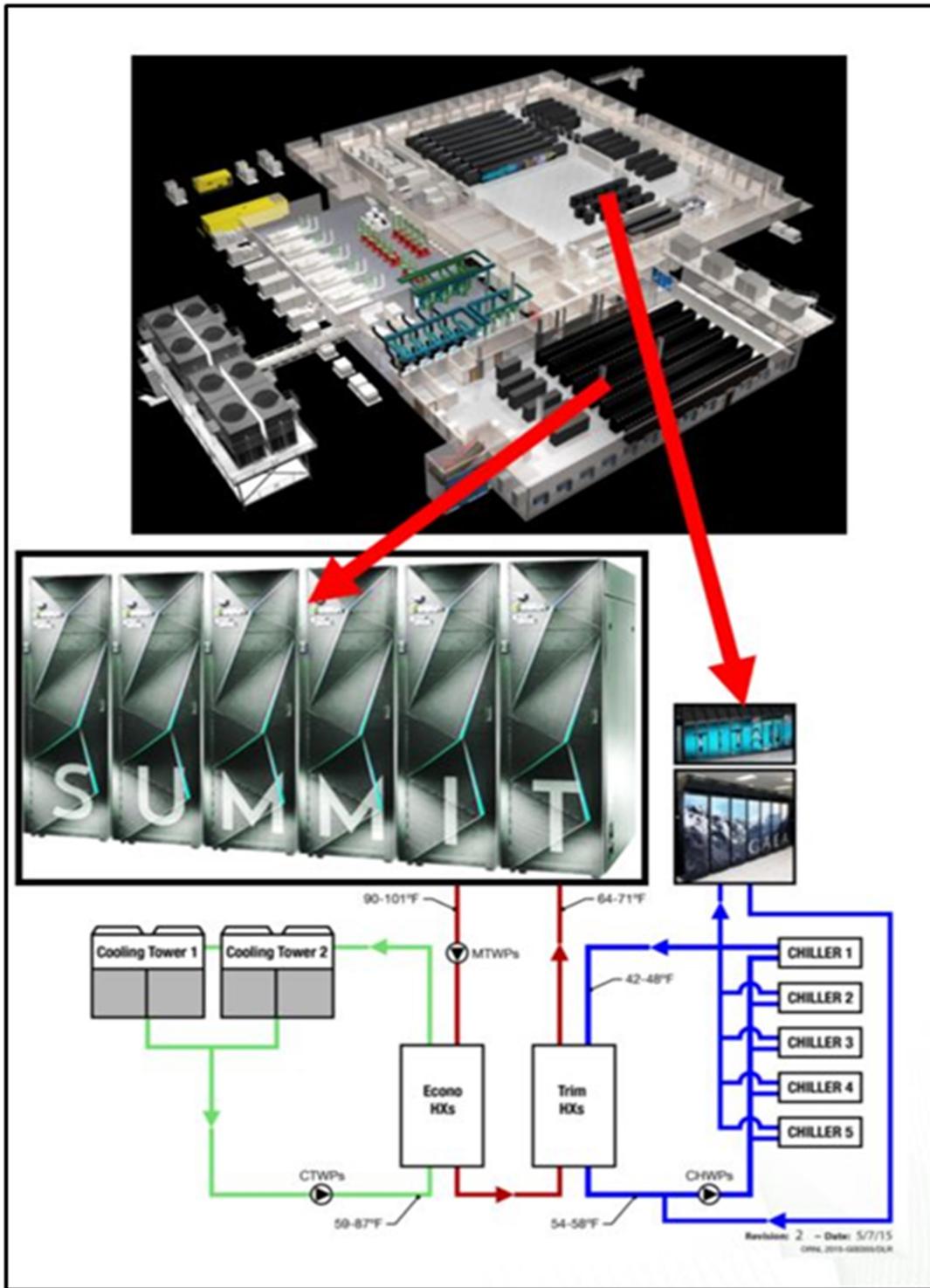


Exhibit 3. Summit's Cabinet



Exhibit 4. Summit's Cooling Pumps



Plans and Projected Performance

In future systems, electrical loads will be distributed as evenly as possible across multiple main feeders that arrive on campus. Minimizing the transmission losses associated with those electrical feeders will save a significant amount of energy. Control sequences in the new HPC data center will be closely observed and optimized in the coming years to ensure that they perform as designed and to identify more opportunities for improvement. Overall performance of the infrastructure systems will also be carefully monitored to ensure the desired equipment reliability and to confirm that system architecture meets intended design expectations. Necessary piping and valves have been made available so that future designs can increase usage of water side economized assisted warm water cooling for future IT equipment. Necessary changes will be made to the primary chiller plant to use a VFD-driven chiller in order to base load constant speed chillers and trim (Exhibit 6) with the VFD chiller, thus maximizing the efficiency of chiller operation. The advantages of resetting the supply temperature setpoint of the chiller plant will also be investigated, which may provide considerable savings.

Organizational Resilience

Performance Status

Organizational Planning:

To better clarify program priorities, the ORNL SCI Roadmap name was changed to the Organizational Resilience Team (ORT) late in FY 2017. ORNL is taking an integrated and proactive approach to including sustainability efforts and organizational resilience into the operational planning process. ORT members representatives are from F&O senior management, SCI, site strategic planning, environmental management, natural resources, and Climate Change Science Institute (CCSI). ORNL is committed to the incorporation of climate-resilient design and management elements into the planning process and to determine the specific risks and level of resiliency required. Planning steps for future activities include the following:

- focus on resilience strategies and procedures that identify and respond to events with the potential to disrupt, strain, compromise, or eliminate DOE activities or facilities;
- apply this knowledge to missions and operations;
- develop and prioritize actions based on site-specific risks and threats;
- build awareness and improve skills to respond to potential events*; and
- apply organizational resilience best practices into the facilities-planning process and the design of new agency buildings.

Emergency Response:

ORNL has engaged with state, local, and regional entities to address emergency response and preparedness. The entities include the Tennessee Department of Environment and Conservation; the City of Oak Ridge; and the Roane County fire departments, emergency medical services, and first responders. The primary functions of the ORNL Emergency Management System include

- protecting workers, the public, the environment, and national security;
- serving as a resource to line management for emergency preparedness activities;

*** Organizational Resilience: Emergency Response in action:** *On November 28, 2016, ORNL the state of Tennessee experienced the most deadly and destructive wildfire in state history. ORNL received a request from DOE's Oak Ridge Office for an ambulance to support the medical branch of the Sevier County incident responders following the outbreak of the massive fire. The ORNL Fire Department sent personnel and emergency equipment to the LeConte Medical Center.*

Three ORNL fire fighters were dispatched to Sevier County immediately following the fire to relieve exhausted responders. According to chief Mike Masters, "They worked inside of four geographic divisions deploying fire resources to perform fire suppression efforts, conduct search and rescue operations in cooperation with the National Guard, and recon operations. The team also got a visit from Gov. Haslam at the command post." Recovery operations also included managing weather-related situations, including flash flooding, in the rains that followed the fire, and assisting a heart attack victim in an evacuation center.

- coordinating with other first-response entities to mitigate risk in extreme events
- furnishing first responders with support in emergency situations*; and
- planning for and respond to emergency situations that can be attributed to extreme weather events.

The emergency management process is accomplished through training, counseling, oversight, policy and procedural development, guidance, and successful event resolution. Through these methods, it provides for the coordination and direction of planning, preparedness, and response to emergency conditions and/or abnormal events where the potential exists for personal injury; damage to facilities or equipment; release of toxic, radioactive, or hazardous materials; release of chemical or biological toxins; and/or impact to projects or programs, including extreme weather impacts.

Workforce Health and Safety:

ORNL has several communication protocols in place for staff to receive more timely and precise communications about Lab conditions, which allow them to make safe choices to either telework from home or travel to their on-site office:

- Staff can check the ORNL Weather Line and *ORNL Today* for current conditions.
- Upgrades of internal notification system features allow messages concerning extreme weather events (and other emergency concerns) to better reflect current technology. Messages are broadly disseminated through a variety of methods, including alerts sent via email, text message, and cell phones.
- The Standards-Based Management System contains the on-line procedure, "Handle Absences Related to Weather, Adverse Events, and the Laboratory's Operational Status."
- ORNL has instituted a more formalized system of identifying priority areas for snow removal.

Weather Extremes at ORNL: Hot and Cold:

One area of concern and key focus for ORNL is staff safety during inclement weather events for both hot and cold weather extremes. Workforce health and safety concerns are elevated when there is an extended period of days in which high temperatures reach more than 90 degrees and heat and humidity indexes are heightened. During these times the

Worker Safety Toolbox, a weekly newsletter for workers and supervisors, provided information on heat issues continually. In winter months, extreme cold weather conditions can occasionally make travel to ORNL hazardous. In addition, ORNL continues to promote various arrangements to accommodate staff members who had to determine what would be best, given their particular circumstances, whether to travel to work or stay at home. As winter approaches this year, the snow-ice priority removal policy will be communicated to road crews and to all staff who can safely travel to ORNL and its off-site facilities during times of icy weather and snowfall. In addition, staff and supervisors will be reminded of the importance of making safe choices, including telework.

Management Commitment:

ORNL has a strong commitment to adaptation efforts and to communicating existing and new policies to the staff. The mission of the ORNL ORT team is integrated into all aspects of F&O senior managers; utilities managers; and staff in site strategic planning, environmental management, and natural resources. Additionally, Laboratory Director monthly messages contain updates on a multitude of current topics. Always included are a safety message, answers to staff concerns, explanations for decisions made such as why ORNL remained opened during inclement weather, and updates that keep the staff informed.

Facilities and Operations Management: Enabling and Sustaining ORNL's World-Leading Science

At ORNL, F&O management has articulated its criteria for sustainable operation:

- Work will be done safely, securely, and in compliance.
- We are here to serve our customers.
- We value our staff.
- We manage our business well.
- We understand the importance of integrated operations.
- We strive for continuous improvement.
- We have personal accountability.
- We are committed to environmental sustainability.

Science Integration:

ORNL works to ensure that climate adaptation and organizational resilience policies and programs reflect the best available current science. The ORT team includes representatives from F&O and research programs to ensure continued collaboration and focus on the organizational resilience topic between operations and scientific research divisions.

ORNL is proud to house the CCSI, a unique, dedicated institution within the national laboratory system and in the country, composed of approximately 130 scientists and co-located in a single modern, open office space. During FY 2017, CCSI's Director served as a member of ORT providing regional projections ranging from number of days the region will experience max temperatures exceeding 95°, number of days and temperatures falling below 32° and given the persistent nature of these temperatures, human productivity, energy costs, materials, pests are all impacted. CCSI's priorities are to create the science, experiments, data, and community capacity needed to

- strengthen the predictive capabilities and effectiveness of climate and biogeochemical models,

- identify and understand how extreme events and climate tipping points affect the resiliency of human and natural land-energy-water systems,
- participate in national and international climate assessments and response option analysis, and
- develop useful climate adaptation and mitigation tools and information in collaboration with land-energy-water system stakeholders.

ORNL's science research staff on the Impacts, Adaptation, and Vulnerability (IAV) Team develop analysis tools and methods for assessing adaptation strategies for stakeholders who must prepare people and infrastructure for the risks associated with climate change. Many of the methods span multiple scales, from local to global, and rely on advanced computer models and diverse data sets that include social, political, economic, and environmental, assessments. The IAV group works with local governments at home and abroad on climate change assessments, analyzes the resilience of the nation's energy infrastructures to climate risks, and aids in the development of regional climate models needed by local decision makers.

Two ORNL institutes, the Urban Dynamics Institute and the CCSI, have joined forces to address one of the most pressing problems facing midsize cities today: how best to allocate scarce resources to deal with extreme weather events due to climate change. The solution they have devised, the Urban Climate Adaptation Tool (Urban-CAT), is a unique web-based decision support tool that can be customized for unique risks such as location, population, local economy, and available resources. The Urban-CAT platform addresses the risks by coupling climate projections with socioeconomic and infrastructure data at scales useful for urban planning. The platform also provides connectivity to multiple data sources for comparison and assessment of local project scenarios under different climate conditions. The project team has developed a set of urban resilience indicators to be used in assessing resilience and in monitoring and evaluating the effectiveness of selected adaptation actions in reducing risk.

EARTH DAY SEMINAR announced in ORNL Today employee newsletter (see additional details in footnote above in Emergency Response Section)

Foresters discuss Gatlinburg fire Wednesday

The Sustainable Campus Initiative is sponsoring a seminar, "The Gatlinburg Firestorm: Can it Happen Here?" at 10 a.m., Wednesday, April 19, in Bldg. 4500-North, Wigner Auditorium.

The November 2016 Gatlinburg firestorm has been called a "perfect storm," but will similar events recur in East Tennessee soon? Could it happen here on the Oak Ridge Reservation? What can homeowners do to reduce the risk of devastating loss of life or property to wildfire? What is the difference between prescribed fires and wildfires? How do we use prescribed fires on the Oak Ridge Reservation to reduce wildfire risk while also helping native plants and wildfire to thrive?

Bruce Miller is a veteran wildland fire specialist with the Tennessee Division of Forestry and has 34 years of experience in fire suppression, structure protection, and incident command. He was among the early responders as the Chimney Top 2 Fire overran Gatlinburg in November 2016. He will share his observations of the event and will discuss the principles of the Firewise Program.

Greg Byrd is program manager for the Forest Stewardship and Wildland Fire Management Programs for the ORNL Natural Resources Program. He has more than 25 years of service as a forester on the 33,000-acre Oak Ridge Reservation. Chief among his duties are publishing wildland fire preplanning documents and monitoring fire use and wildfire occurrence on the reservation. He will provide a description of the reservation, its forest, and its fire history.



Bruce Miller (left) and Greg Byrd at a recent ORR prescribed burn.

Oak Ridge National Laboratory: Organizational Resilience Risk Table, Updated in FY 2017

Climate Hazard	Operations			Personnel			Productivity		
	Consequence	Risk	Actions	Consequence	Risk	Actions	Consequence	Risk	Actions
Average Temperature	<ul style="list-style-type: none"> No impacts anticipated from Average Temperature scenarios 	L	<ul style="list-style-type: none"> Low risk, NA Stay abreast of environmental permit and compliance issues 		L			L	
High Temperatures	<ul style="list-style-type: none"> Increased cooling costs for buildings and equipment Increased demand on equipment (e.g. chillers/substations) Peak demand could exceed TVA contract limits TVA could ask for voluntary curtailments or force blackouts 	M	<ul style="list-style-type: none"> Review and analyze design standard changes Engineering study to Identify impacts of discharged heat in creeks and waterways Continuous engagement with TVA to ensure power reliability Blackouts are not likely 	<ul style="list-style-type: none"> Increased heat-related illness (outdoor/field work) Reduced building thermal comfort 	L		<ul style="list-style-type: none"> Increased heat-related illness (outdoor/field work) Loss of productive working hours 	L	<ul style="list-style-type: none"> Improve remote work procedures for applicable positions Adjust outside work schedules to avoid heat of the day Ensure notifications when remote worker options are advised due to extreme temperatures
Average Rainfall	<ul style="list-style-type: none"> No Average Rainfall impacts anticipated 	L	<ul style="list-style-type: none"> Low risk, NA Stay abreast of environmental permit and compliance issues 		L			L	
Heavy Rainfall	<ul style="list-style-type: none"> Potential flooding from White Oak Creek Increased water damage to buildings, equipment, utilities Operational delays due to weather Unintended remobilization of unearthed hazardous materials Sewage and Wastewater treatment plants impacts Adverse effects on Natural Resources assets 	M	<ul style="list-style-type: none"> Modify flow restrictions in White Oak Creek PM added to work schedule to clean storm drains on a frequency of every six months. Ensure pumps are in place and maintained Run sensitivity analysis on all land use and planning variables Review designs Trees and other vegetation can be planted to improve resilience to floods 	<ul style="list-style-type: none"> Increased potential of flood-related injury/death Reduced site access; longer commuting times 	L	<ul style="list-style-type: none"> Rework emergency employee communications plans to include handling "flooding situations" 	<ul style="list-style-type: none"> Reduced site access; longer commuting times Loss of productive working hours 	L	<ul style="list-style-type: none"> Improve remote work procedures for applicable positions Ensure notifications when remote work options are advised due to area flooding and localized incidents
Severe Weather (Droughts, Thunderstorms, Tornadoes, Hail, Ice, Heavy Snow, Wildfire)	<ul style="list-style-type: none"> Increased landscaping costs Increased Risk of wildfires Increased damage to buildings and/or equipment Impacted electrical reliability Increased damage/maintenance costs Increased operational delays due to weather 	M	<ul style="list-style-type: none"> Confirm that wildfire protection plans are adequate: <ul style="list-style-type: none"> -Emergency Action Level Plans in place -Master Agreements in place with neighboring agencies Confirm safety practices are adequate: <ul style="list-style-type: none"> -Procedures, regular drills, public address announcements -Continuous improvements in employee notification systems 	<ul style="list-style-type: none"> Increase in human safety risks Increase in heat related illnesses 	L	<ul style="list-style-type: none"> Review all health and safety procedures to and update as applicable Communicate current conditions that might impact the health of workers, especially outdoor/field work 	<ul style="list-style-type: none"> Loss of productive working hours Reduced site access; longer commuting times 	L	<ul style="list-style-type: none"> Improve remote work procedures for applicable positions Ensure notifications when remote worker options are advised due to severe weather events and emergency situations such as wildfires and hail storms

Plans and Projected Performance

As a result of establishing the ORT team, ORNL is better positioned to address the need for organizational resilience elements in all future plans. The team, with ORNL leadership commitment, will continue to ensure that the appropriate events and risk elements are considered as part of ORNL programs and planning activities. Policies and procedures will be evaluated to determine whether they should be modified to consider organizational risks. Emergency response, workplace safety and health, and the most updated scientific knowledge will continue to be incorporated into all facets of organizational resilience.

Processes and actions for future activities include the following (for both new and existing buildings):

- Incorporate resilient design and management into the ORNL facilities planning process.
- Identify and evaluate vulnerabilities to natural hazard risks (e.g., storm events, flooding).
- Consider flood-proofing strategies and designs.
- Consider designs for enhanced wind resistance.
- Ensure continuity of operations and access to electricity in the event of an extended power outage.
- Improve energy performance of building envelopes and provide for occupant comfort in the event of power outages.
- As appropriate, use information modeling to assess design options and to improve decisions based on life cycle analysis.
- When cost-effective, adopt passive and natural design strategies over active and mechanical systems.

SC Supplemental Guidance Requirements - HEMSF

FY 2017 Supplemental Request from the Office of Science

ORNL Utility Service Program

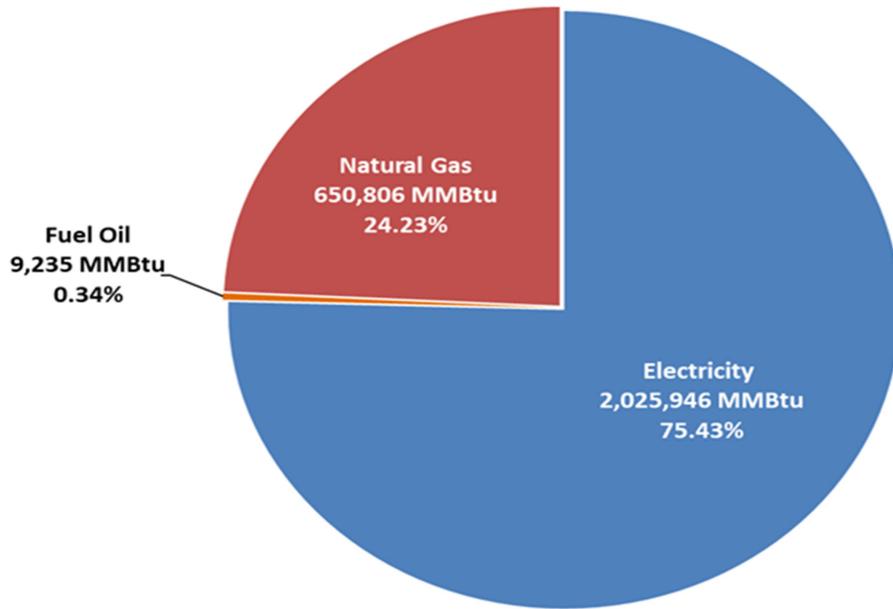
ORNL's utility services include electrical power, steam, chilled water, and potable/process water to support ORNL's mission and the research community. Electrical services include basic power needs as well as chilled water service and direct cooling applications. Steam is generated from a combination of fuel oil and natural gas. Natural gas and fuel oil are also used in direct heating applications. Potable water use supports mission-critical process applications as well as domestic water use, including restrooms and drinking water. ORNL's utility consumption and costs reflect the ORNL campus, the Spallation Neutron Source campus, and leased space.

Utility Consumption

Electricity is the largest energy commodity for ORNL, at 75% of the total energy consumption (see figure). Electrical services dominate ORNL's energy, primarily due to critical operations at HEMSFs. In FY 2017 the HEMSF buildings consumed 72% of ORNL's electrical energy, and current projections show an increase to peak at 84% by FY 2024 and then settle at 80% by the FY 2025 target/goal year. HEMSF buildings currently consume 51% of all ORNL water, and that number is expected to rise to approximately 71% and then settle to 67% by FY 2025.

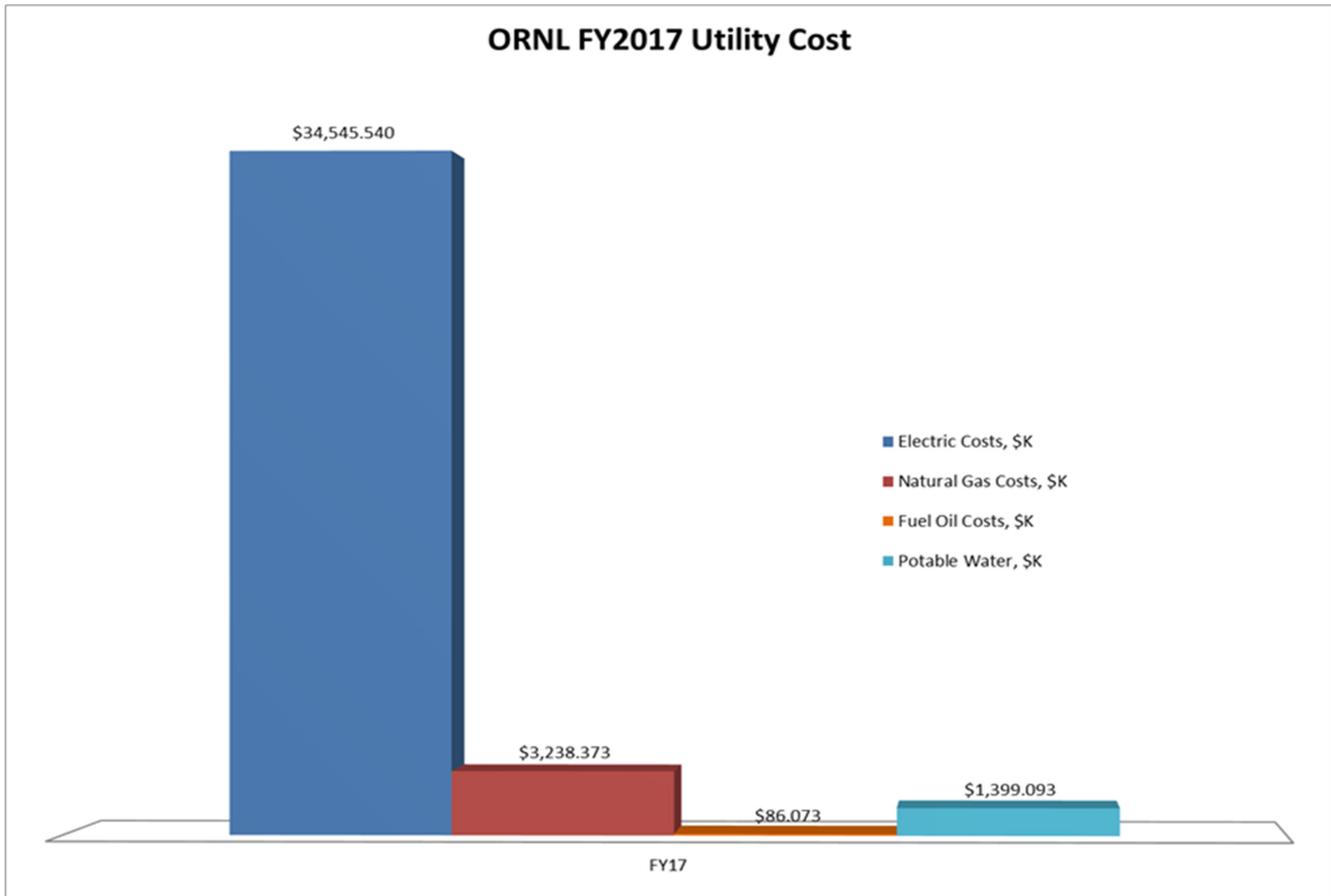
Natural gas is the primary fuel used for steam generation at the ORNL Steam Plant and the Melton Valley Steam Plant, and for hot water generation at the Central Utilities Building, supporting SNS. Other direct natural gas heating and research applications result in a total of 24.23% of energy consumption. Fuel oil, which is used for steam generation during curtailment and maintenance periods, direct heating applications, and emergency generator services, accounts for 0.34% of the energy consumed.

**ORNL FY2017
Utility Consumption
Million Btu of Purchased Energy/Fuel**



Utility Costs

Electricity is by far ORNL’s largest purchased energy source. It is also the most costly at \$34,545,540 in FY 2017. Natural gas and fuel oil costs are \$3,238,873 and \$86,073, respectively. Water is the third-largest purchased commodity at \$1,399,093 in FY 2017.

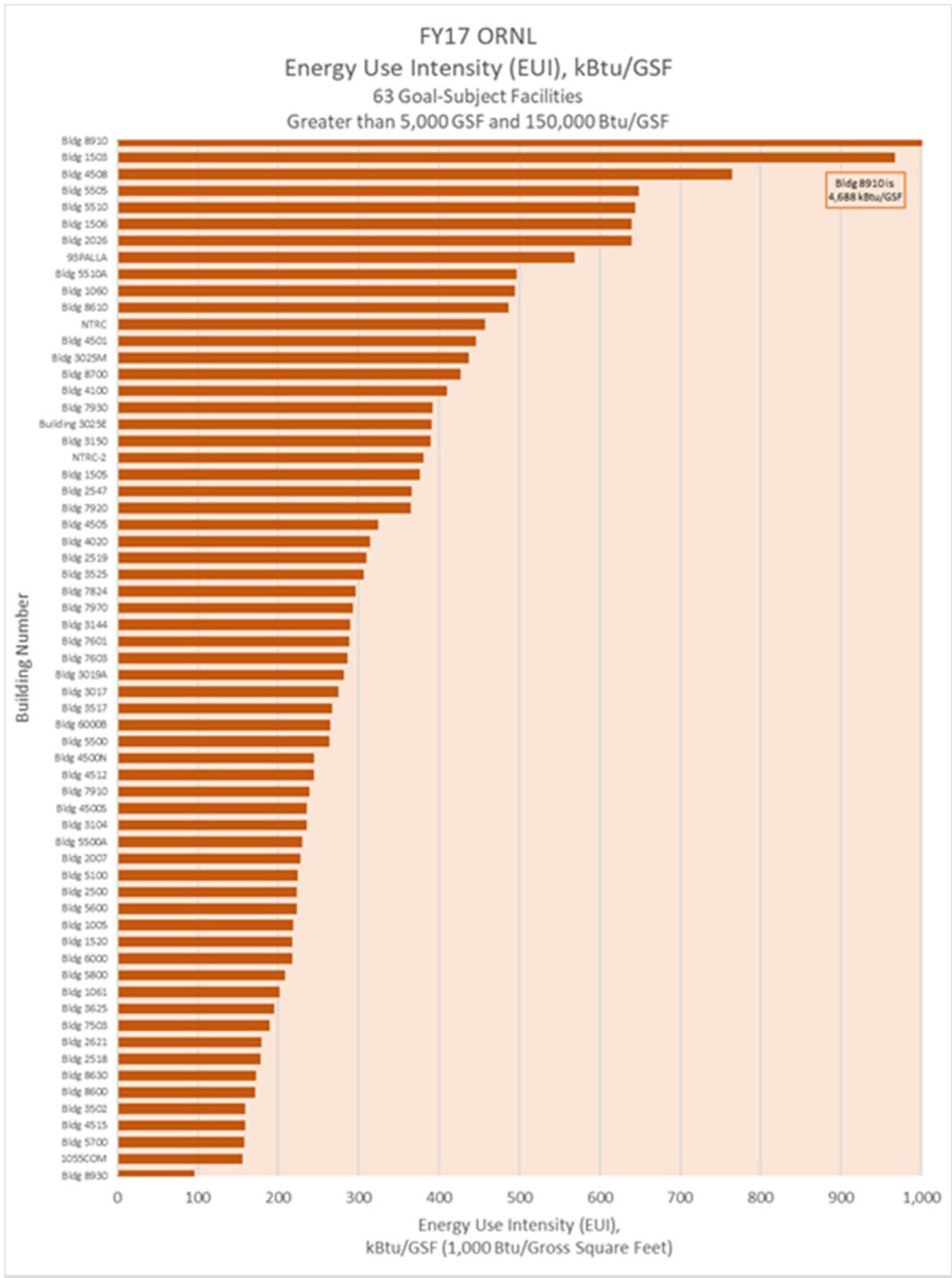


Energy Use Intensity (EUI)

EO 13693 established a new EUI baseline in FY 2015: 262,076 Btu/GSF with a goal to achieve the target of 196,557 Btu/GSF by FY 2025, using 2.5% annual target reductions.

Based on FY 2017 data, energy use in the buildings category at ORNL is 1,278 billion Btu, not including ORNL’s excluded facilities as defined by the Energy Policy Act of 1992. Given an area of 5,265,623 GSF of energy-consuming buildings, trailers, and other structures/facilities identified in the Facilities Information Management System (FIMS), the FY 2017 calculated EUI is 242,632 Btu/GSF. This results in a reduction of 7.4%, exceeding the interim goal of 5%.

The following chart identifies the EUI goal for subject buildings greater than 5,000 GSF with an EUI of 150,000 Btu/GSF or greater. In FY 2017 a total of 63 buildings meet the SC criteria. Those buildings will be the focus of energy conservation activities in the future because improvements in EUI are necessary in order to meet several of the DOE energy management goals and Scope 1 & 2 GHG emission reductions.



Electricity Usage Projections

ORNL’s four HEMSFs consume a substantial portion of ORNL’s total electrical power. By the GHG reduction target year of FY 2025, ORNL’s HEMSFs are projected to peak at 835,380 MWh and then settle to use 652,033 MWh, accounting for about 80% of all power consumed on the site.

The ORNL HEMSf utility consumption graph (compared with base site usage) illustrates the historical and projected power consumption for ORNL’s HEMSFs, of which three are designated as excluded facilities in the DOE FIMS

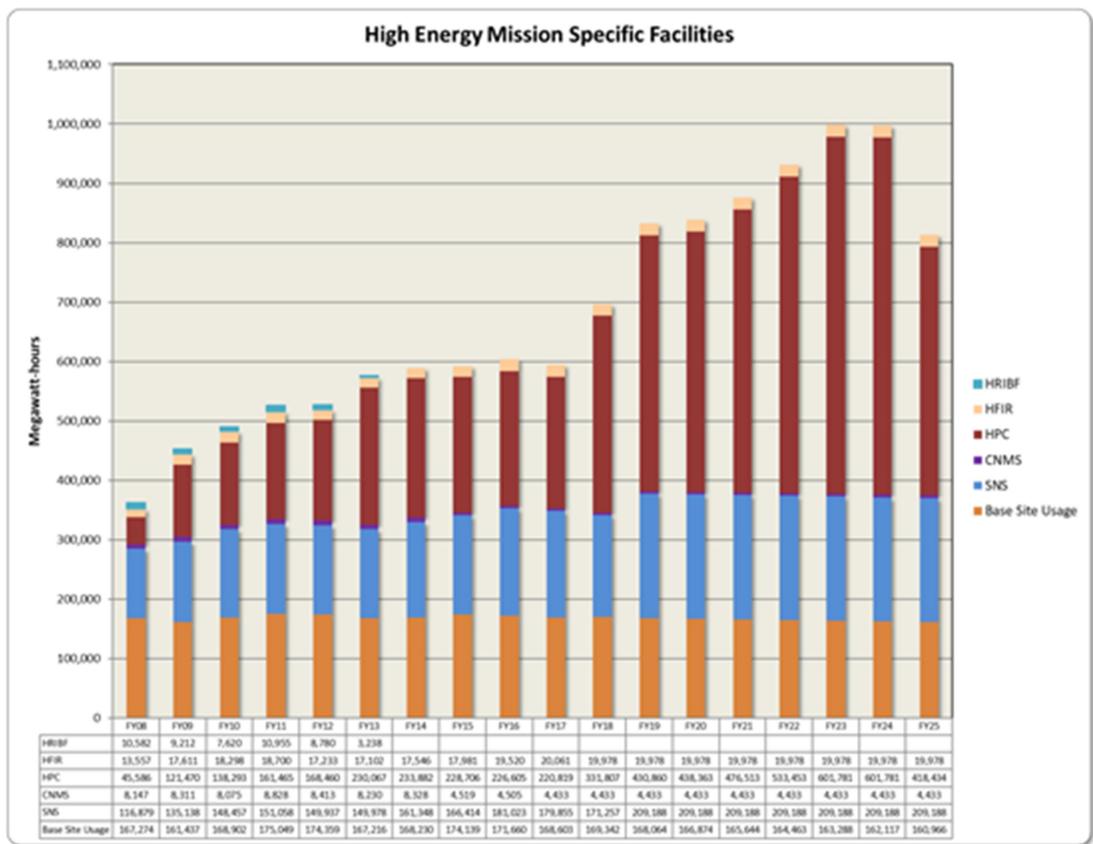
database. The following is a list of ORNL HEMSFs with definitions; a brief narrative describing each facility is included in this section. The Holifield Radioactive Ion Beam Facility (HRIBF) has been removed from the current HEMSF inventory due to a major reduction in mission, but it is shown in the graph for historical comparison purposes.

Beginning in FY 2018, significant growth is projected for the HPC areas. The program anticipates an 83% boost in technical power by FY 2025 above FY 2015 power levels, showing an 88% growth rate by FY 2019 and peaking in FY 2023 at more than 150% of the FY 2015 power. Research activities at SNS are also expected to decrease in FY 2018 for maintenance but are expected to return to normal operation in FY 2019. ORNL anticipates an increase in campus development, further escalating electrical demand going forward. The new development is expected to be in the form of energy-efficient facilities, and efforts to transition from older, less-efficient facilities will continue in order to optimize campus energy consumption.

Identification of ORNL HEMSFs

Facility Summary and Update on Electrical Projections

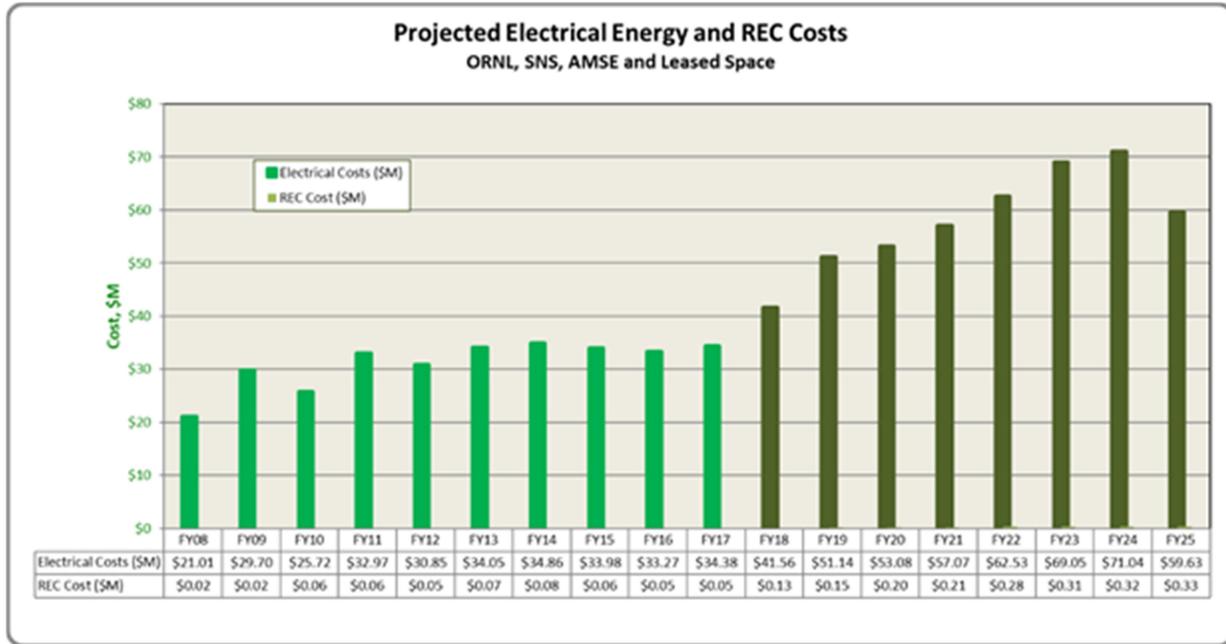
HFIR	High Flux Isotope Reactor	Fission Reactor
HPC	High Performance Computing	User Facilities
SNS	Spallation Neutron Source	Accelerator
CNMS	Center for Nanophase Materials Sciences	Nanoscience Facility
Base Site Usage	Power Usage in Addition to That of HEMSFs	Offices/Labs/Support



Electricity and REC Cost Projections

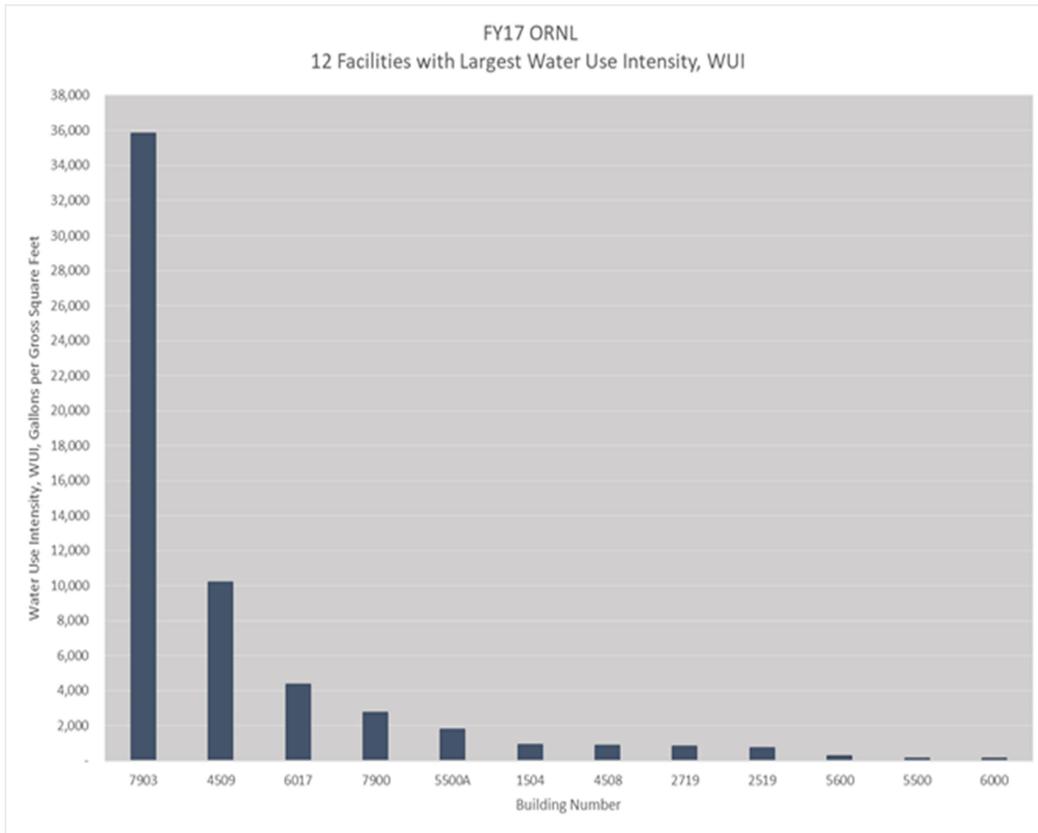
The projected electrical energy and REC cost graph includes anticipated TVA rate increases and indicates a strong growth in electrical consumption for HEMSFs through FY 2025.

In addition to the electrical energy costs, ORNL will purchase RECs to meet and/or exceed the Renewable Energy Target and the Clean Energy Target. REC purchases will be made from TVA’s Southeastern REC Pilot program and from the open market utilizing ORNL’s strategic purchasing guidance. The renewable energy and clean energy targets will increase each year to reach their respective final FY 2025 goals, which also complement the increasing energy consumption; therefore the costs will rise significantly by the FY 2025 period (see the figure).



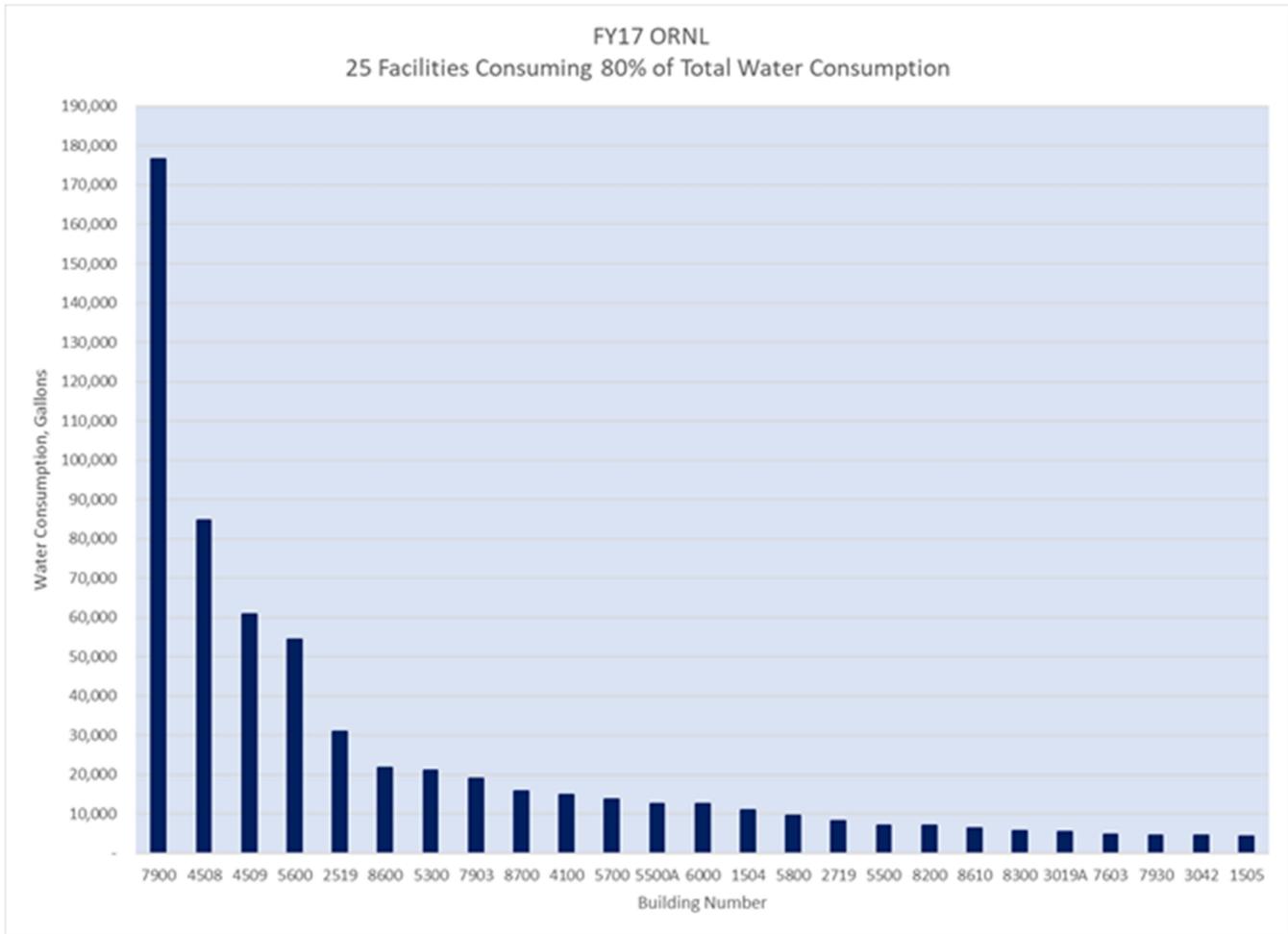
Water Management for SC supplemental Potable Water Intensity Use

Water use intensity at ORNL is dominated by water-intensive processes, including central utility plants and cooling towers in support of mission critical programs. ORNL’s 12 most water use intensive facilities are identified below.



Potable Water Use

Water consumption at ORNL totaled 768 million gallons in FY 2017. Approximately 25 buildings consume 80% of the water. As demonstrated below, the majority of the water is concentrated in 5 key facilities.



Brief Program Information for ORNL HEMSFs

Brief Program Information for ORNL HEMSFs

High Flux Isotope Reactor (HFIR)

The neutron scattering research facilities at 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. 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.



Computational Sciences Building (CSB)

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

OLCF has produced a number of supercomputers, each bearing the title "world's fastest computer" in its time, including Titan's high energy performance of more than 2,100 megaflops per watt.

The newest supercomputer, Summit, is projected to be at least five times as powerful as Titan while still maintaining a similar carbon footprint. Summit is expected to be available to researchers in 2018.



Spallation Neutron Source (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. 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 research on the structure and dynamics of materials in practically every scientific and technical field.

Center for Nanophase Materials Sciences (CNMS)

The CNMS program integrates nanoscale science with neutron science; synthesis science; and theory, modeling, and simulation. The facility is 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.



GHG Performance

GHG Performance: GHG Scope 1 & 2

Performance Status

In FY 2017, ORNL was again resolute in its commitment to sustainable operations and the reduction of GHG emissions wherever possible while remaining diligent to the DOE mission to provide valuable solutions to the nation's energy and security challenges. GHG emission goals are not normalized to mission or employee growth. Since the FY 2008 baseline, the energy consumption of critical operations has grown by 70%. A 50% reduction in emissions is more difficult to obtain in locations that have undergone significant growth such as that experienced at ORNL.

Major factors in the GHG inventory for FY 2017 performance are listed below. Details of the components' energy performance data are included in the GHG table below.

- Scope 1 GHG emissions estimate is 65,519 metric tons of CO₂ equivalents (MTCO₂e), a decrease of 27% from the FY 2008 baseline.
- Scope 2 GHG emissions totaled 279,881 MTCO₂e after renewable energy credits (RECs). This is an increase of 12% over FY 2008.
- The FY 2017 combined total of Scope 1 and 2 emissions is 345,400 MTCO₂e, an overall increase of 2% from FY 2008. While still short of ORNL's desired contribution to the DOE GHG reduction goal, this represents a considerable improvement over previous years in light of mission growth.

Scope 1 GHG Emissions (MTCO₂e)	FY 2008	FY 2017	Emissions (+/-)	Percent
Natural Gas, Facilities	48,563	34,567	(13,996)	-29%
SF6 Process Losses	27,102	26,475	(627)	-2%
Fugitive Gases	10,660	2,813	(7,847)	-74%
Fuel Oil, Facilities	1,968	685	(1,283)	-65%
Fleet Fuels	1,104	797	(307)	-28%
Minor Sources	203	182	(21)	-10%
Total Scope 1	89,600	65,519	(24,081)	-27%
Scope 2 GHG Emissions	FY 2008	FY 2017	Emissions (+/-)	Percent
Purchased Electricity	249,407	362,455	113,048	45%
Purchased RECs - GHG Avoided	-	(82,574)	(82,574)	n.a.
Net Annual Scope 2 GHG Emissions	249,407	279,881	30,474	12%
Scope 1 & Scope 2 GHG Emissions	FY 2008	FY 2017	Emissions (+/-)	Percent
All Sources, Combined Calculation	339,007	345,400	6,393	2%

Plans and Projected Performance

ORNL is committed to the DOE GHG Scope 1 and 2 reduction targets and has developed reduction estimates indicating that ORNL is on target to meet the FY 2025 target reduction goal of 50%. This projected success is based on a number of key projects and initiatives detailed in the SPO Dashboard narrative sections for Energy Management, Green Buildings, Fleet Management, Clean and Renewable Energy, and Fugitive Emissions.

- Scope 2 reductions represent a tremendous challenge due to continued growth in electricity demands for mission-critical facilities such as the Spallation Neutron Source (SNS) and high-performance computing (HPC) systems. The importance of ORNL's HEMSFs and the associated electricity that the facilities are projected to consume are detailed in the Supplemental SSP section of this report. Purchased electricity will grow as critical mission facilities expand to meet national research demands.
- Renewable and clean energy studies will continue to be investigated, and on-site projects will be implemented when economically feasible. The acquisition of RECs with the appropriate environmental attributes will be utilized as a strategy to mitigate GHG emissions when on-site renewable and clean energy projects are not cost effective.
- As discussed in the Fugitive Emissions Category of the SSP, SF⁶ inventories will be transferred from ORNL by the end of FY 2019.
- ECMs and other energy improvement projects will provide Scope 2 demand reductions and will combine for incremental relief during the performance period.
- ORNL and DOE leadership will continue to work with TVA, the regional power provider, in a joint commitment to initiatives that serve to reduce carbon emissions and to moderate the need for coal consumption during times of peak power demand. Decreases in carbon emissions are being realized, and the EPA eGRID emission rates for this region will continue to improve as the necessity for clean and efficient power production endures.

GHG Performance: GHG Scope 3

Performance Status

By definition, Scope 3 GHG emissions include those activities that organizations can influence but not control by business processes alone. As with Scope 3 emissions at most other federal workplaces, the emissions at ORNL are attributed to the following activities at the site:

- transmission and distribution (T&D) losses from purchased electricity,
- employee workplace commutes,
- employee business air travel, and
- employee business ground travel.

ORNL continues its overall commitment to communications to employees that encourage their engagement in GHG reduction. Influencing the actions of employees and their awareness of how those actions affect the carbon footprint of the organization is one of the foundational methods to achieve a more sustainable future. Employee outreach interactions are designed to focus efforts on the reduction of direct and indirect emissions in all actions. Communication is designed to reach management personnel, employees, and contractors to encourage sustainable practices in the workplace, at home,

and in the community. Details of employee commute projects can be found in the Regional and Local Planning SSP Dashboard narrative.

Activities described in detail in previous ORNL SSP submittals include projects that promote sustainable employee commuting options. Employees are educated in the benefits of using carpools, alternative work schedules, proper use of EV charging stations, and more efficient transportation options. Projects such as improved videoconferencing tools in lieu of expensive business travel continue to yield results in Scope 3 GHG performance. In FY 2017, ORNL SCI Teresa Nichols led a DOE/Sustainability Performance Office project to create a Telework Guide for DOE facilities to use. Details can be found in the Executive Summary Highlights. Details of ORNL Travel & Commute performance results can be found in the Travel and Commute section of this document.

The FY 2017 Scope 3 GHG emissions estimate is 40,560 MTCO₂e. Overall, the Scope 3 inventory experienced a 1% decrease from the FY 2008 baseline. Scope 3 performance indicators demonstrate that while the employee commutes, business air travel, and business ground travel categories have all improved, the 12% growth in T&D losses limits the overall performance. The following table summarizes the Scope 3 GHG inventory for FY 2017.

Scope 3 GHG Emissions Categories	FY 2008 MTCO ₂ e	FY 2017 MTCO ₂ e	Change MTCO ₂ e	Change %
T&D Losses	16,429	18,436	2,007	12%
Employee Commute	16,194	14,790	(1,404)	-9%
Bus. Air Travel	7,204	6,538	(666)	-9%
Bus. Ground Travel	1,169	796	(373)	-32%
Total Scope 3	40,996	40,560	(436)	-1%

Plans and Projected Performance

Projects and activities to promote Scope 3 GHG reductions include the following:

- REC purchases to meet clean and renewable energy goals will help offset the growth in T&D emissions due to the increased use of electricity at the site. The use of REC procurements will produce credits to offset T&D emissions by the target year.
- The incremental improvement and availability of videoconferencing tools will continue to have a positive effect on reducing business travel.
- ORNL will continue to encourage and monitor the progression of alternative work schedules, telework participation, and sustainable commuting options.

Appendix

Dashboard Data Accuracy Verification

Signed, scanned 12/06/2017

DOE SUSTAINABILITY DASHBOARD DATA
SELF-CERTIFICATION FORM

FROM: Oak Ridge National Laboratory
Department of Energy
Johnny O. Moore, Manager
Oak Ridge Site Office

TO: Sustainability Performance Office

DATE: December 6, 2017

SUBJECT: SELF-CERTIFICATION FORM FOR DASHBOARD DATA ACCURACY
VERIFICATION

The Department of Energy (DOE) annually reports the agency's greenhouse gas emissions, energy and water use, fleet optimization, green buildings, and renewable energy to comply with the sustainability goals mandated in E.O. 13693 and DOE Order 436.1 *Departmental Sustainability Directive*.

To fulfill the Department's sustainability reporting requirements, data was previously collected through the Consolidated Energy Data Report (CEDR) and verified by a Site's manager or Program Office through the SSP submission process. The CEDR has been retired and a new system for data collection, the DOE Sustainability Dashboard (Dashboard), has been created as the official DOE sustainability reporting tool.

I certify that the data submitted for the current fiscal year through the Dashboard as of December 7, 2017, for Oak Ridge National Laboratory has been accurately entered and completed to the best of my knowledge and expertise.

Johnny O. Moore
DOE Site Office Official – printed name


DOE Site Office Official – signature

12/6/17
Date

Contact Information:
Rawlins, Mary H.
Federal Project Director
Phone: (865) 576-4507
Email Address: rawlinsmh@ornl.gov

U.S. Department of Energy
DOE Sustainability Dashboard
Energy Consuming Excluded Facilities List in Accordance with
Section 541(c)(2) of the National Energy Conservation Policy Act as amended by the Energy Policy Act of 2005

DOE Site: 000L; Fiscal Year: 2017

Program/Program Office	Property Name	Property ID	Real Property Unique ID	Property Type	Ownership	Gross Sq Ft	Excluded Facilities Sq Ft	Exclusion Part	Exclusion Justification
EM	Air Compressor	78807	144682	Building	DOE Owned (D)	96	96	G - Separately Metered Intensive Load(s)	High-energy process load - Facility is metered and all lifecycle cost effective ECHs have been incorporated
EM	Backup Air Compressor Building	78805	144790	Building	DOE Owned (D)	149	149	G - Separately Metered Intensive Load(s)	High-energy process load - Facility is metered and all lifecycle cost effective ECHs have been incorporated
EM	Boiler Building	78806	144685	Building	DOE Owned (D)	300	300	G - Separately Metered Intensive Load(s)	High-energy process load - Facility is metered and all lifecycle cost effective ECHs have been incorporated
EM	Control Room	78803	144684	Building	DOE Owned (D)	264	264	G - Separately Metered Intensive Load(s)	High-energy process load - Facility is metered and all lifecycle cost effective ECHs have been incorporated
EM	Electrical Equipment Building	78802	144681	OSF	DOE Owned (D)	8	800	G - Separately Metered Intensive Load(s)	High-energy process load - Facility is metered and all lifecycle cost effective ECHs have been incorporated
EM	Processing Facility	7880	144679	Building	DOE Owned (D)	28528	28938	G - Separately Metered Intensive Load(s)	High-energy process load - Facility is metered and all lifecycle cost effective ECHs have been incorporated
SC	Stanley Washington DC Operations Office	8080	201001	Building	Contractor Leased (C)	1198	1198	C - Fully Serviced Lease	Fully-Serviced Lease
SC	Team Travel - RTRBET	8200	143304	Building	DOE Owned (D)	63471	63471	G - Separately Metered Intensive Load(s)	High-energy process load - Facility is metered and all lifecycle cost effective ECHs have been incorporated
SC	Washington Division	182GRAND	208532	Building	Contractor Leased (C)	1710	1710	C - Fully Serviced Lease	Fully-Serviced Lease

Property Program Office	Property Name	Property ID	Real Property Unique ID	Property Type	Ownership	Gross Sq Ft	Excluded Facilities Sq Ft	Exclusion Part	Exclusion Justification
SC	Central Exhaust Facility	8915	033854	OSF	DOE Owned (O)	0	285	O - Separately Metered Intensive Load(s)	High energy research load - Facility is metered and all lifecycle cost effective ECMs have been incorporated
SC	Central Helium Liquidator Facility	8530	090832	Build/Mag	DOE Owned (O)	14166	14166	O - Separately Metered Intensive Load(s)	High energy research load - Facility is metered and all lifecycle cost effective ECMs have been incorporated
SC	Commercial Storage Space	HT3UC2THG	09441	Building	Contractor Leased (C)	1130	1138	C - Fully Serviced Lease	Fully-Serviced Lease
SC	Computational Sciences Building	6680	141842	Building	Contractor Leased (C)	300938	49123	O - Separately Metered Intensive Load(s)	Facilities programatically account data center. ECMs have been implemented to optimize system and maximize efficiency but the energy consumption profile of the data center's high performance computers remains significantly different from that of a conventional facility.
SC	Diversion Tanks	8808	003513	OSF	DOE Owned (O)	4	352	O - Separately Metered Intensive Load(s)	High energy research load - Facility is metered and all lifecycle cost effective ECMs have been incorporated
SC	Enclosing and Support Aids	115LUNV	008849	Building	Contractor Leased (C)	27823	27823	C - Fully Serviced Lease	Fully-Serviced Lease
SC	Front End Building - 8006FE	8100	141360	Building	DOE Owned (O)	13568	15560	O - Separately Metered Intensive Load(s)	High energy research load - Facility is metered and all lifecycle cost effective ECMs have been incorporated
SC	HEAT Service Building - 8308HS	8340	141318	Building	DOE Owned (O)	4785	4785	O - Separately Metered Intensive Load(s)	High energy research load - Facility is metered and all lifecycle cost effective ECMs have been incorporated
SC	HG Plus Storage Baseline Facility	7900	97518	Building	DOE Owned (O)	64437	64437	O - Separately Metered Intensive Load(s)	High energy process load - Facility is metered and was evaluated as part of an ESFC. All lifecycle cost effective ECMs have been incorporated

Property Program Office	Property Name	Property ID	Real Property Usage ID	Property Type	Ownership	Gross SqFt	Excluded Facilities SqFt	Exclusion Part	Exclusion Justification
SC	Elyson Gallery - E366L	8308	14309	Building	DOE Owned (O)	5193	5193	G - Separately Metered Intensive Load(s)	High-energy research load - Facility is metered and all lifecycle cost effective ECMs have been incorporated
SC	Math-Program Research Facility	3308	28317	Building	Contractor Leased (C)	22033	4348	G - Separately Metered Intensive Load(s)	Excludes programmatically essential data center. ECMs have been implemented to optimize system and overall efficiency but the energy consumption profile of the data center's high performance computers remains significantly different from that of a conventional facility
SC	National Energy Security Center	2049	21624	Building	Contractor Leased (C)	21626	21626	C - Fully Serviced Lease	Fully-Serviced Lease
SC	RF Test Facility	8330	20834	Building	DOE Owned (O)	1381	1381	G - Separately Metered Intensive Load(s)	High-energy research load - Facility is metered and all lifecycle cost effective ECMs have been incorporated
SC	Ring HVAC Facility East	8425	14455	Building	DOE Owned (O)	1257	1257	G - Separately Metered Intensive Load(s)	High-energy research load - Facility is metered and all lifecycle cost effective ECMs have been incorporated
SC	Ring HVAC Facility West	8413	14453	Building	DOE Owned (O)	1257	1257	G - Separately Metered Intensive Load(s)	High-energy research load - Facility is metered and all lifecycle cost effective ECMs have been incorporated
SC	Ring Injection Dump	8320	20836	Building	DOE Owned (O)	4082	4082	G - Separately Metered Intensive Load(s)	High-energy research load - Facility is metered and all lifecycle cost effective ECMs have been incorporated
SC	Ring Service Building	8346	20835	Building	DOE Owned (O)	1891	1891	G - Separately Metered Intensive Load(s)	High-energy research load - Facility is metered and all lifecycle cost effective ECMs have been incorporated
SC	RTRT Service Building	8558	20833	Building	DOE Owned (O)	2855	2855	G - Separately Metered Intensive Load(s)	High-energy research load - Facility is metered and all lifecycle cost effective ECMs have been incorporated

Property Program Office	Property Name	Property ID	Real Property Unique ID	Property Type	Ownership	Gross SqFt	Excluded Facilities SqFt	Exclusion Part	Exclusion Justification
SC	Site Wide Electrical Distribution System	CAHFA-02	211573	OGF	DOE Owned (D)	0	4542	G - Separately Metered Intensive Load(s)	Electrical bus across transformers is inherent in their design. Energy loads are not influenced by conventional building energy conservation measures.
SC	Superconducting Radio Frequency Building	8328	284816	Building	DOE Owned (O)	14442	14408	G - Separately Metered Intensive Load(s)	High-energy research load - Facility is restored and all lifecycle cost effective ECHs have been incorporated.
SC	Target Building #1 - Beam Line 11	8711	202832	Building	DOE Owned (O)	2899	2820	G - Separately Metered Intensive Load(s)	High-energy research load - Facility is restored and all lifecycle cost effective ECHs have been incorporated.
SC	Target Building #1 - Beam Line 15	8713	207209	Building	DOE Owned (O)	2807	2807	G - Separately Metered Intensive Load(s)	High-energy research load - Facility is restored and all lifecycle cost effective ECHs have been incorporated.
SC	Target Building #1 - Beam Line 14A	8714A	207210	Building	DOE Owned (O)	2806	2806	G - Separately Metered Intensive Load(s)	High-energy research load - Facility is restored and all lifecycle cost effective ECHs have been incorporated.
SC	Target Building #1 - Beam Line 2	8702	202822	Building	DOE Owned (O)	4583	4503	G - Separately Metered Intensive Load(s)	High-energy research load - Facility is restored and all lifecycle cost effective ECHs have been incorporated.
SC	Target Building #1 - Beam Line 3	8703	202884	Building	DOE Owned (O)	2075	2050	G - Separately Metered Intensive Load(s)	High-energy research load - Facility is restored and all lifecycle cost effective ECHs have been incorporated.
SC	Target Building #1 - Beam Line 7	8707	202885	Building	DOE Owned (O)	4040	4040	G - Separately Metered Intensive Load(s)	High-energy research load - Facility is restored and all lifecycle cost effective ECHs have been incorporated.
SC	Target Helium Compressor Facility	8368	282116	Building	DOE Owned (O)	1177	1177	G - Separately Metered Intensive Load(s)	High-energy research load - Facility is restored and all lifecycle cost effective ECHs have been incorporated.