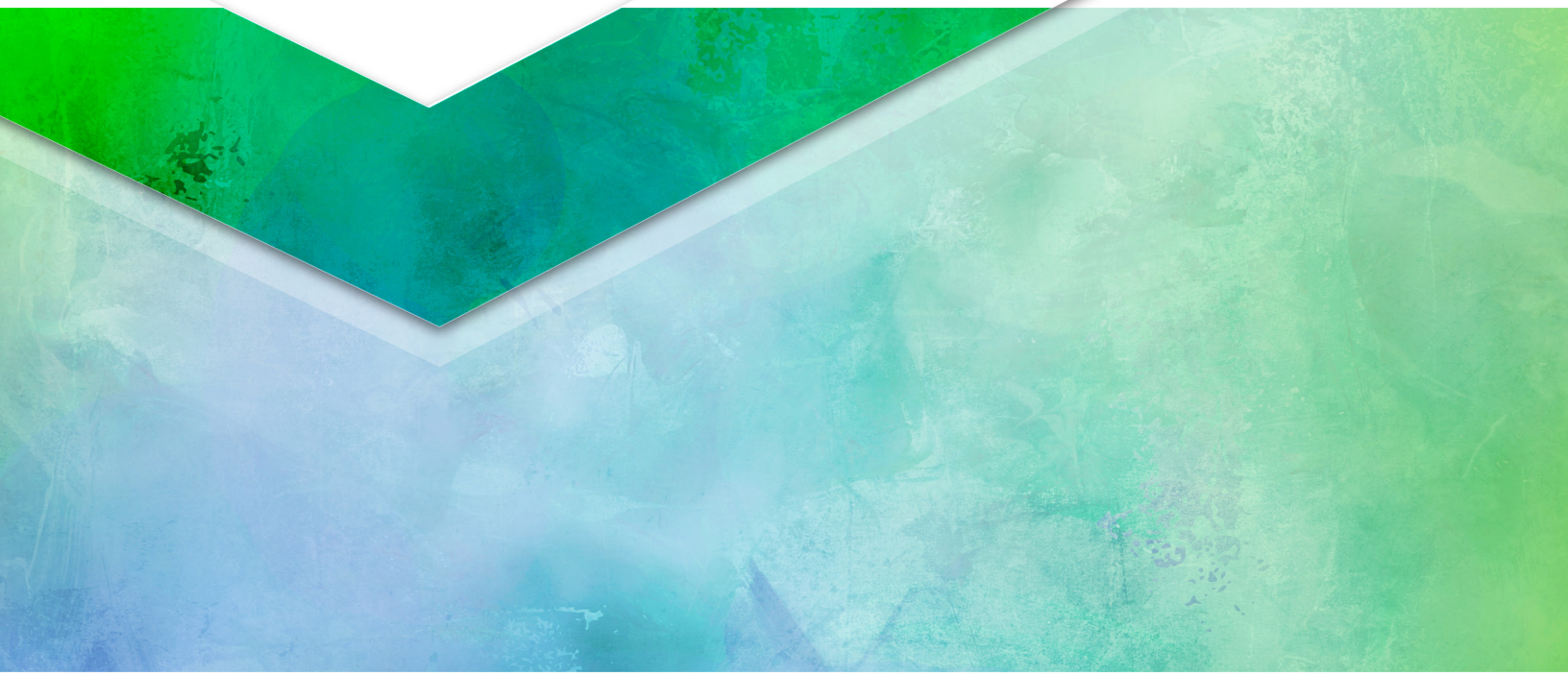
ORNL/SR-2016/699

OAK RIDGE NATIONAL LABORATORY

Site Sustainability Plan

with FY 2016 Performance Data



OAK RIDGE National Laboratory

U.S. DEPARTMENT OF ENERGY

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Oak Ridge National Laboratory

Site Sustainability Plan with FY 2016 Performance Data

November 2016

Prepared by

OAK RIDGE NATIONAL LABORATORY

Oak Ridge, Tennessee 37831-6283

managed by

UT-BATTELLE, LLC

for the

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SECTION GOAL

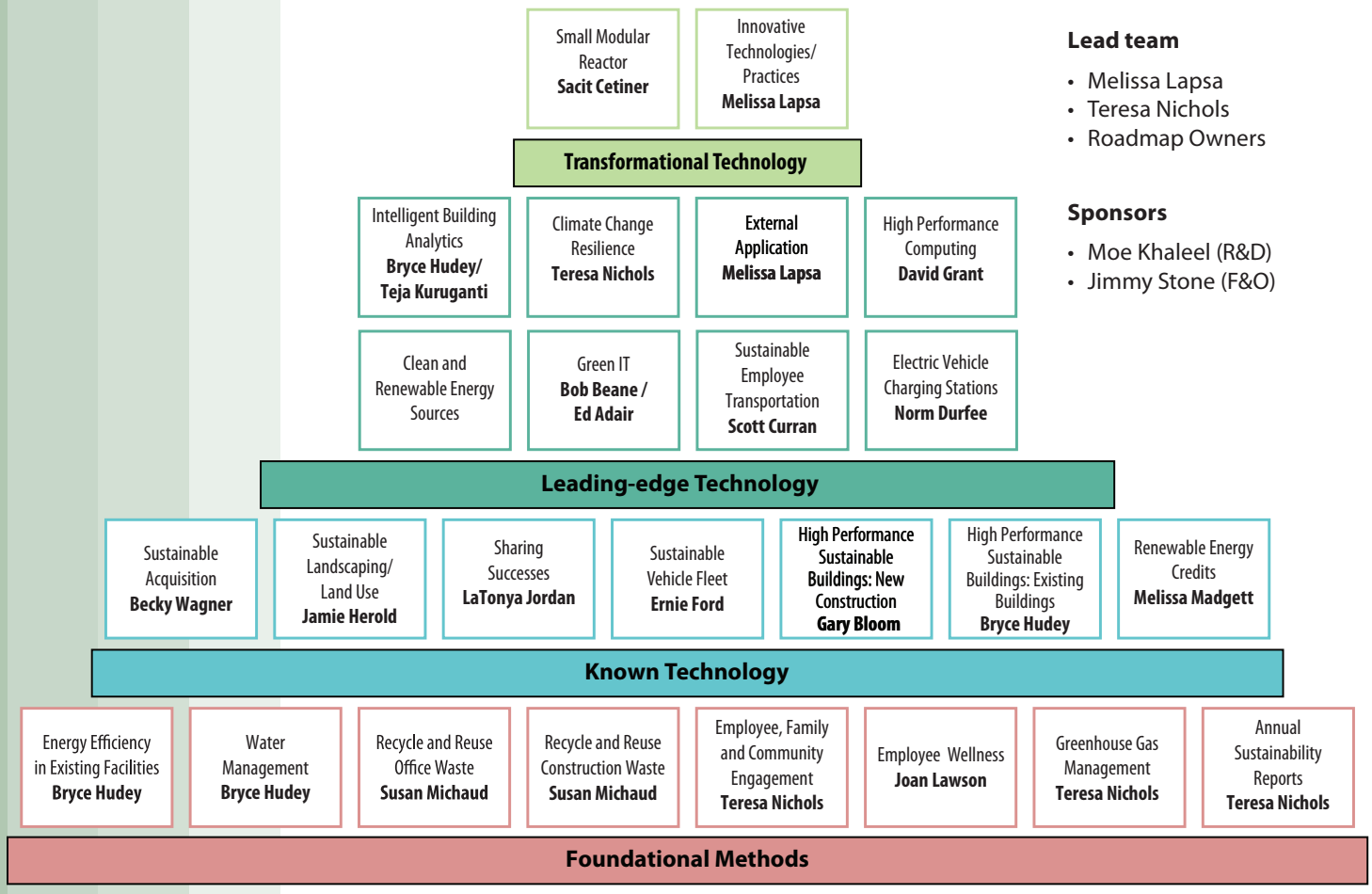
Contents

Abbreviations

AFV	alternative fuel vehicle
AMSD	Acquisition Management Services Division
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
B20	6% to 20% biodiesel blended with petroleum diesel
Btu	British thermal unit
C&D	construction and demolition
CCR	climate change resiliency
CCSI	Climate Change Science Institute
CDU	cooling distribution unit
CEDS	Central Energy Data System
CFC	Computation Facilities Complex
CFL	Computers-For-Learning
CFR	Code of Federal Regulations
CNMS	Center for Nanophase Materials Sciences
COP21	21st Session of the Conference of the Parties
DOE	US Department of Energy
E85 (flex fuel)	high-level ethanol-gasoline blends containing 51% to 83% ethanol
ECM	energy conservation measure
eGRID	EPA Emissions and Generation Resource Integrated Database
EISA	Energy Independence and Security Act
EO	executive order
EPA	US Environmental Protection Agency
EPACT	Energy Policy Act of 1992
EPEAT	Electronic Product Environmental Assessment Tool
ESPC	energy savings performance contract
EUI	energy use intensity
EV	electric vehicle
EVSE	electrical vehicle supply equipment
F&O	Facilities and Operations
FAR	Federal Acquisition Regulation
FAST	Federal Automotive Statistical Tool
FEMP	Federal Energy Management Program
FFV	flexible fuel vehicle
FIMS	Facilities Information Management System
FMD	Facilities Management Division
ft^2	square foot
FY	fiscal year
G/GSF	gallons per gross square foot
GHG	greenhouse gas
GP	Guiding Principles
GSA	General Services Administration
GSF	gross square foot
HEMSF	high-energy mission-specific facility
HFIR	High Flux Isotope Reactor
HPC	high performance computing
HPSB	high performance sustainable building
HRIBF	Holifield Radioactive Ion Beam Facility
HVAC	heating, ventilating, and air-conditioning
HVC	Hardin Valley Campus
IAV	Impacts, Adaptation, and Vulnerability
ILA	industrial, landscaping, and agricultural
IPM	Integrated Pest Management
IT	information technology
JCI	Johnson Controls, Inc.
KAT	Knoxville Area Transit
kWh	kilowatt-hour
LEED	Leadership in Energy and Environmental Design
LSD	Logistical Services Division
LSS	Laboratory Shift Superintendent
LSV	low-speed vehicle
MAP	multimodal access plan
MGY	million gallons per year
MSW	municipal solid waste
MT	metric ton
$MTCO_2e$	metric ton carbon dioxide equivalent
MWh	megawatt-hour
N/A	not applicable
NECPA	National Energy Conservation Policy Act of 1978
NEPA	National Environmental Policy Act
NTRC	National Transportation Research Center
OLCF	Oak Ridge Leadership Computing Facility
ORNL	Oak Ridge National Laboratory
ORO	Oak Ridge Office
ORR	Oak Ridge Reservation
OTC	once-through cooling
P2	pollution prevention
PC	personal computer
PHEV	plug-in hybrid electric vehicle
PSCC	Pellissippi State Community College
PUE	power usage effectiveness
PV	photovoltaic
R2	Responsible Recycling
RE	renewable energy
REC	Renewable Energy Credit
SBMS	Standards-Based Management System
SC	DOE Office of Science
SCI	Sustainable Campus Initiative
SF_6	Sulfur hexafluoride
SMR	small modular reactor
SNS	Spallation Neutron Source
SPO	Sustainability Program Office
SPOFOA	SPO Funding Opportunity Announcement
SPP	strategic pricing plan
SSG	Southeast Sustainability Group
SSP	site sustainability plan
SSPP	Strategic Sustainability Performance Plan
T&D	transmission and distribution
TEVAC	Tennessee Electric Vehicle Advisory Council
TRU	transuranic
TVA	Tennessee Valley Authority
Urban-CAT	Urban Climate Adaptation Tool
UT	the University of Tennessee

I. Executive Summary

Campus sustainability is part of an ongoing process of modernization at Oak Ridge National Laboratory (ORNL). Initiated in 2002, it grew to include the Sustainable Campus Initiative (SCI) as of 2008. The SCI embodies a diversity of areas, reflecting the multifaceted nature of sustainability and the resulting need for a holistic approach, by tapping ORNL's multiplatform science and technology expertise in a pathway critical in catalyzing change and shaping the Laboratory's future. The past year has shown significant progress for the SCI as well as for sustainable development at large, with the 21st Session of the Conference of the Parties (COP21) in Paris setting a new pace and direction for worldwide mitigation of climate change in the coming decades.



ORNL Sustainable Campus Initiative Roadmaps

Executive Order 13693, "Planning for Federal Sustainability in the Next Decade" (March 2015), was recognized in the COP21 negotiations as an "Intended Nationally Determined Contribution" to emissions reduction by the United States. The executive order raises federal leadership in energy, environmental water, fleet, buildings, and acquisition management as key elements in further climate change mitigation and adaptation by means of fostering innovation, increasing cost efficiency, and strengthening communities. With this form of leadership across the United States, federal agencies are to achieve a nationwide reduction of 40% in greenhouse gas emissions by 2025.

ORNL is proactively working toward meeting sustainability goals consonant with Executive Order 13693. Twenty-five identified areas of focus, from renewable energy and intelligent building analytics to community engagement, are categorized into four levels of development and elaborated on in this report. The four levels involve systems with foundational, known, leading-edge, and transformational dynamics. By

enabling the deliberation of various degrees of progress in the 25 identified areas, the SCI highlights both short- and long-term outlooks for development, contributing to Laboratory sustainability as well as transfer of technology and concepts needed to accelerate further progress of sustainable systems in the United States and worldwide. In fiscal year (FY) 2016, ORNL teams received a series of awards recognizing this progress, including the US Department of Energy (DOE) Sustainable Performance Office Green IT Innovators and Green Transportation Innovators awards, the DOE Office of Energy Efficiency and Renewable Energy's Workplace Charging Challenge Award, and the *Facility Maintenance Decisions* magazine's Sustainability Achievement Award for sustainable facilities. ORNL aims to maintain and expand its efforts in sustainability, in line with the Laboratory's mission to strengthen the nation's leadership in key areas of science: clean energy, environmental protection, and national security. As a national laboratory with inherent innovation capabilities to be leveraged in designing and testing systems of the future, ORNL has significant assets that will give it the opportunity to contribute to a sustainable future.

ORNL SCI awards

FY 2016 SUCCESS STORIES

During FY 2016, the SCI has had a series of successes and lessons learned, as elaborated upon in this report. The cases that are highlighted in this document all strongly indicate the need to consider the technological innovation, engagement, and community foundations influencing sustainability.

Battle of the Buildings

The Battle of the Buildings is a building electricity conservation competition held for the first time on the ORNL campus. Eight buildings having similar sizes and missions were selected for the Battle of the Buildings competition, which took place from July 5 to September 30, 2016. The occupants' electricity use was recorded and was shown in comparison to the electricity use for the previous year through real-time data analytics and visualization that was meant to drive team competitiveness. The winning building, which will be awarded by having a tree planted in its honor and a celebration lunch for its occupants, achieved accumulated energy savings of 23%. The second- and third-place contestants followed with savings of 14% and 8%, respectively. As expressed by the occupants of the winning team, "Brainstorming made us all get together, share ideas, and look at how to conserve energy. The brainstorm and collective thinking helped us to attain full engagement in the competition." Through competitiveness and a collective change in habits resulting in incremental impacts accumulating to a large effect, the Battle of the Buildings demonstrates the ability of behavioral change and mindfulness to influence energy utilization to a great degree.

Certificate presentation for Building 5002, winner of the ORNL Battle of the Buildings

SECTION GOAL

Future Fuels: E85 Pump Upgrades

Since FY 2005, ORNL has cumulatively decreased its petroleum consumption by 48.6% and has enhanced its alternative fuel use by 331%, exceeding DOE targets and demonstrating early commitment to sustainable transportation. This commitment persists for further development of vehicles and fuels. In September 2016, for example, a project called "Right at the Pumps" was carried out to effectively promote E85 fuel utilization, incorporating a makeover of the fuel station and pumps on campus with improved signage, including "Fuel up with E85" graphics for heightened awareness.

New Government electric vehicle charging stations installed in FY 2016

During the past five years, ORNL has led the effort to encourage the use of electric vehicles (EVs) by providing EV charging stations for government vehicles and for vehicles belonging to staff (see Sect. 5 of this report). The accompanying photographs show the new ORNL charging stations. One is located at the Main Campus and two are located at the Hardin Valley Campus. ORNL now has five EVs in its vehicle fleet and five government-only charging stations.

Two new EV charging stations on the Hardin Valley campus (left). Associate Laboratory Director Jeff Nichols (right) plugs in his directorate's first EV at the newest charging station on the ORNL main campus.

SECTION GOAL

The Science of Earth Day

ORNL's Earth Day, a main event reaching out to engage the ORNL community, took place over one week this year in April 2016. Earth Day involves a series of activities meant to trigger further reflection on environmental protection and sustainability. Activities in FY 2016 included a tour of the Additive Manufacturing Integrated Energy demonstration project (www.ornl.gov/amie), where a natural-gas-powered hybrid electric vehicle was on display; multiple seminars; an organized bike ride and 5k walk; and the opportunity to speak to representatives of various SCI projects and to view displays. Many researchers and organizations within and outside the Laboratory are addressing issues of sustainability, and Earth Day is an important annual occasion to collect and spread awareness on progress and different aspects of sustainability to the ORNL community.

Earth Day schedule of the week's events and seminar posters

Table 1 - Executive Summary Table of DOE Sustainability Goals Based on the SSPP and Executive Order 13693

SSPP Goal #	DOE Goal	Performance Status through FY 2016	Planned Actions & Contribution
Goal 1: Greenhouse Gas Reduction			
1.1	50% Scope 1 & 2 GHG reduction by FY 2025 from a FY 2008 baseline (2016 target: 22%).	The Scope 1 estimate is 58,026 $MTCO_2e$, a decrease of 35% from FY 2008. The Scope 2 estimate is 275,383 $MTCO_2e$, an increase of 10% from FY 2008 after purchased renewable energy credits (RECs). The Scope 1 and 2 combined estimate is 333,409 $MTCO_2e$, a decrease of 2% from the baseline year of FY 2008.	The Scope 1 reductions are on target as a result of implementation of energy conservation measures and energy savings performance contract (ESPC), the new steam plant system, and SF_6 process reductions. The Scope 2 reductions represent a substantial challenge due to growth in electricity demands for high-energy mission-critical facilities. REC purchases, Tennessee Valley Authority (TVA) partnerships, and innovative technologies will be used to meet the Scope 1 and 2 combined goal by the target year 2025.
1.2	25% Scope 3 GHG reduction by FY 2025 from a FY 2008 baseline (2016 target: 7%).	The Scope 3 estimate is 41,315 $MTCO_2e$. Overall, Scope 3 emissions have increased by 1%. Expanded electricity consumption resulting in a 10% increase in transmission and distribution losses limits the overall performance.	Ongoing focus on employee engagement areas such as responsible business travel, employee commutes, telework programs, and increased use of new academic bus service will ensure progress toward Scope 3 reductions. As with Scope 2, REC purchases will also produce credits to offset Scope 3 emissions by the target year 2025.
Goal 2: Sustainable Buildings			
2.1	25% energy intensity (Btu per gross square foot) reduction in goal-subject buildings, achieving 2.5% reductions annually, by FY 2025 from a FY 2015 baseline.	ORNL achieved a 5.4% reduction in energy use intensity in FY 2016, exceeding the 2.5% annual goal.	ORNL will continue to look for opportunities to reduce energy consumption.
2.2	EISA Section 432 energy and water evaluations.	The remaining covered facilities were evaluated to complete 4-year cycle.	ORNL will begin new, 4-year cycle by evaluating 25% or more of covered facilities. ORNL will leverage knowledge from previous cycles to conduct focused evaluations.
2.3	Meter all individual buildings for electricity, natural gas, steam and water, where cost-effective and appropriate.	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.
2.4	At least 17% (by building count) of existing buildings greater than 5,000 gross square feet (GSF) to be compliant with the *revised* Guiding Principles for HPSB by FY 2025, with progress to 100% thereafter.	ORNL has established a high-performance sustainable building (HPSB) inventory of 20 buildings or 15.5% of total applicable building portfolio in FY 2016.	Efforts will continue toward expanding the existing HPSB inventory to 17% and beyond.

SSPP Goal #	DOE Goal	Performance Status through FY 2016	Planned Actions & Contribution
2.5	Efforts to 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 planned for FY 2017. In addition, participation is continuing in local and regional transportation and sustainability organizations.
2.6a	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 formulating a strategy.	ORNL will define an implementation strategy.
2.6b	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.
Goal 3: Clean & Renewable Energy			
3.1	"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: 10% in FY 2016-2017, working towards 25% by FY 2025.	The purchase of RECs for the Renewable Energy Target resulted in 11.90% of the Clean Energy Target, exceeding the 10% interim goal for FY 2016.	ORNL plans to purchase additional RECs beyond the Renewable Energy Target to meet and/or exceed the Clean Energy interim target of 10% in FY 2017.
3.2	"Renewable Electric Energy" requires that renewable electric energy account for not less than 10% of a total agency electric consumption in FY16-17, working towards 30% of total agency electric consumption by FY 2025.	ORNL has purchased RECs to supplement on-site renewable energy generation to achieve the goal of having 16.1% of the electrical energy to be from renewable sources, exceeding the 10% interim goal for FY 2016.	ORNL plans to purchase sufficient RECs to off-set on-site renewable energy generation to meet or exceed the 10% interim goal for FY 2017. ORNL will continue to invest in economically feasible renewable energy projects on site to minimize the REC purchases each year.
Goal 4: Water Use Efficiency and Management			
4.1	36% potable water intensity (Gal per gross square foot) reduction by FY 2025 from a FY 2007 baseline (2016 target: 18%).	Water use intensity measured 137.9 G/GSF, a reduction of 21.8% to date, exceeding the 18% interim goal for FY 2016.	ORNL plans to continue to identify water conservation opportunities so that it makes the most efficient use of water resources, especially for processes that will increase water demand in FY 2017.
4.2	30% water consumption (Gal) reduction of industrial, landscaping, and agricultural (ILA) water by FY 2025 from a FY 2010 baseline (2016 target:12%).	N/A	N/A

SSPP Goal #	DOE Goal	Performance Status through FY 2016	Planned Actions & Contribution
Goal 5: Fleet Management			
5.1	30% reduction in fleet-wide per- mile greenhouse gas emissions reduction by FY 2025 from a FY 2014 baseline (2016 target: 3%; 2017 target: 4%).	The ORNL Fleet per-mile greenhouse gas (GHG) emissions baseline of 527 grams/mile is expected to remain stable in FY 2016. Fleet inventory, mileage, and fuel usage have remained relatively constant.	ORNL plans to support the per-mile GHG emission initiative through purchasing plug-in hybrid electric vehicle (PHEV) passenger vehicles whenever possible. ORNL also plans to replace current light-duty fleet vehicles with alternative-fuel vehicles (AFVs) and to acquire more efficient models when new vehicle purchases are required.
5.2	20% reduction in annual petroleum consumption by FY 2015 relative to a FY 2005 baseline; maintain 20% reduction thereafter (2016 target: 20%).	In FY 2016 ORNL achieved a 54.6% reduction in cumulative petroleum consumption relative to the FY 2005 baseline, exceeding the DOE target.	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 new requirements as specified in Executive Order (EO) 13693.
5.3	10% increase in annual alternative fuel consumption by FY 2015 relative to a FY 2005 baseline; maintain 10% increase thereafter (2016 target: 10%).	In FY 2016 ORNL achieved a 331% increase in cumulative alternative fuel consumption relative to the FY 2005 baseline, exceeding the DOE target of 160%.	ORNL plans to continue to use alternative fuel and to continue to ensure that the quality of biodiesel is maintained.
5.4	75% of light duty vehicle acquisitions must consist of alternative fuel vehicles (AFV) (2016 target: 75%).	In FY 2016, 100% of the light-duty vehicles purchased by ORNL were AFVs.	ORNL plans to continue to purchase AFVs from General Services Administration schedules as funds and approvals are provided.
5.5	50% of passenger vehicle acquisitions consist of zero emission or plug-in hybrid electric vehicles by FY 2025 (2016 target: 4%).	ORNL purchased two PHEVs in FY 2016 and has EV charging infrastructure (47 charging stations) in place on campus and at satellite locations. Three new government EV charging stations were installed in FY 2016.	ORNL is preparing for new FY 2025 targets while remaining attuned to other directives related to vehicle acquisitions.
Goal 6: Sustainable Acquisition			
6.1	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 2016, 100% of the applicable ORNL contracts contained terms and conditions that invoke requirements for sustainable acquisitions. The Lab-wide paperless initiative for all procurement card transactions was completed. As indicated in EO 13693, three Federal Acquisition Regulation clauses were added to the standard Commercial Items Terms and Conditions contracts beginning in January 2016.	ORNL plans to continue being proactive in procurement of sustainable items.

SSPP Goal #	DOE Goal	Performance Status through FY 2016	Planned Actions & Contribution
Goal 7: Pollution Prevention & Waste Reduction			
7.1	Divert at least 50% of non-hazardous solid waste, excluding construction and demolition debris.	ORNL achieved a 46% diversion rate in FY 2016. Although slightly less than the target, this rate represents continued improvement.	ORNL plans to continue mitigation measures and process improvements to close the gap for this goal in FY 2017 and beyond.
7.2	Divert at least 50% of construction and demolition materials and debris.	ORNL's diversion rate for construction and demolition debris for FY 2016 is 66%, exceeding the target.	ORNL plans to continue process improvements and to place additional focus on segregation of waste.
Goal 8: Energy Performance Contracts			
8.1	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 5.	ORNL has an existing ESPC in place with Johnson Controls, Inc., through FY 2031. ORNL continues looking at other potentials for on-site solar projects.
Goal 9: Electronic Stewardship			
9.1	Purchases – 95% of eligible acquisitions each year are EPEAT-registered products.	ORNL exceeded the 95% goal of purchasing EPEAT-registered products in FY 2016.	ORNL plans to continue with guided procurement to acquire EPEAT-registered products and to closely monitor nonstandard requests for electronic requisitions.
9.2	Power management – 100% of eligible PCs, laptops, and monitors have power management enabled.	At ORNL, 100% of eligible computers, monitors, and laptops are being actively power-managed.	ORNL plans to continue to actively ensure that all eligible computing equipment is power-managed.
9.3	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.
9.4	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 Computers for Learning (CFL) and Responsible Recycling (R2) certified reuse/recycle practices.	ORNL plans to continue to dispose of electronic equipment using CFL and R2 certified reuse/recycle practices.
9.5	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 2016 ORNL data centers experienced a portfolio power utilization effectiveness of 1.36, performance better 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.
Goal 10: Climate Change Resilience			

SSPP Goal #	DOE Goal	Performance Status through FY 2016	Planned Actions & Contribution
10.1	Update policies to incentivize planning for, and addressing the impacts of climate change.	ORNL's Climate Change Resiliency (CCR) team established in 2014, held its annual work session during the year to review climate change risk elements and event categories and their potential impacts to critical missions and operations, while considering specific geographic location and associated potential risk for climate change events.	The ORNL CCR team continues to facilitate the reviewing, updating, and implementation of policies that are applicable to climate change resilience.
10.2	Update emergency response procedures and protocols to account for projected climate change, including extreme weather events.	ORNL engages with state, local, and regional entities to address emergency response and preparedness.	The ORNL Emergency Response Management System tools are being utilized to ensure that procedures and protocols are reviewed and updated.
10.3	Ensure workforce protocols and policies reflect projected human health and safety impacts of climate change.	ORNL has several communication protocols in place for staff to receive timely, precise communications about Lab conditions. In 2016, ORNL replaced the existing internal notification system with an improved notification system advising staff with local emergencies, traffic, road conditions, inclement weather, protective actions and security situations, and other important information about the ORNL area.	The ORNL CCR team plans to continue to work directly with subject matter experts to ensure that procedures and protocols are reviewed and updated as needed.
10.4	Ensure site/lab management demonstrate commitment to adaptation efforts through internal communications and policies.	ORNL's CCR team consists of managers from key programs demonstrating a strong commitment to implementing and/or modifying adaptation efforts and to communicating existing and new policies to the staff.	ORNL's CCR team will continue meeting annually reviewing actions noted within their Resilience Risk Table determining the need for revising plans, procedures, and actions.
10.5	Ensure that site/lab climate adaptation and resilience policies and programs reflect best available current climate change science, updated as necessary.	ORNL is home to the Climate Change Science Institute (CCSI), a unique organization within the national laboratory system; it is dedicated to the study of climate. CCSI's Deputy Director is a member of ORNL's CCR team.	The study of climate change and its effects is an ongoing process for the CCSI, the CCR team, ORNL leadership, and subject matter experts as best practices evolve.

II. Performance Review and Plan Narrative

SECTION II

GOAL 1: GREENHOUSE GAS REDUCTION

1.1 GHG Reduction—Scope 1 & 2

DOE GOAL: 50% Scope 1 & 2 GHG reduction by FY 2025 from a FY 2008 baseline. (FY 2016 target: 22%).

In fiscal year (FY) 2016 Oak Ridge National Laboratory (ORNL) was again resolute in its commitment to sustainable operations and the reduction of greenhouse gas (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 (EO) 13693 and DOE sustainability initiatives.

The ORNL Sustainable Campus Initiative (SCI) continues its drive to integrate the sustainability message into organizational processes and procedures. Through employee engagement efforts, personnel have become more aware of how daily actions and facility operations can be modified to reduce carbon emissions. All of the individual sections of this plan will discuss strategies and tactics that will lead to the reduction of carbon emissions. In addition, a number of divisions are currently developing process improvement plans, and they will work together to promote sustainability and GHG emissions by source (covering all scopes), resulting in improved performance toward the attainment of site sustainability plan (SSP) goals.

As is the case with most DOE operational locations, ORNL's greatest source of GHG emissions is the result of purchased electricity—the primary contributor of Scope 2 emissions—something over which ORNL has little control. One of our most proactive endeavors in this area is working with the Tennessee Valley Authority (TVA), the regional electrical power provider, to encourage and support cleaner power generation practices that reduce carbon emissions whenever possible. In recent years, TVA has expanded its renewable energy inventory for cleaner power production, resulting in lower carbon emissions for transmitted electricity. This strategy will result in lower emission factors in the Emissions and Generation Resource Integrated Database (eGRID), which will help with Scope 2 GHG emissions in the long term. The eGRID tool is a comprehensive source of data on the environmental characteristics of almost all electric power generated in the United States and is governed by the US Environmental Protection Agency (EPA).

1.1.1 Performance Status

In FY 2016 ORNL leadership, the SCI, and the Facilities and Operations (F&O) Directorate continued to focus on effective strategies for the reduction of Scope 1 and 2 GHG emissions. Sustainable building practices, planning for efficient space management, and energy conservation measures (ECMs) are foremost in strategic initiatives that result in energy efficiency and the control of Scope 1 and Scope 2 carbon emissions.

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 basic ORNL mission. 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 2016, the HEMSF operations consumed 71% of ORNL's electrical energy and 50% of all the water that it used. Current projections to support growth in these critical research areas show an increase in all utility resource areas by FY 2025, especially electricity and water. More detailed analysis of the current performance and plans for these facilities is included in Section V of this report.

As ORNL anticipates and plans for a more efficient campus, development is also expected in conventional facilities. New construction and the renovation of existing buildings are designed using the best practices in the areas of energy efficiency and sustainable design. Efforts to transition from older, less-efficient facilities will continue to progress toward better management of offices and warehouse spaces and to optimize campus energy consumption.

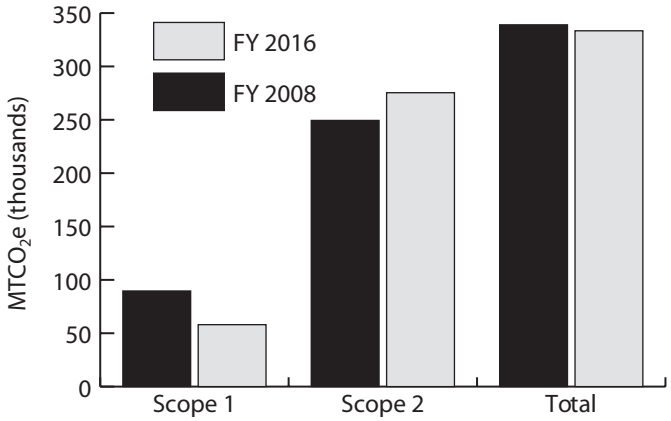
SECTION GOAL

ORNL aggressively strives to have a positive influence on achieving the overall DOE goal of a 50% reduction target for total Scope 1 and Scope 2 GHG emissions. The table shows the FY 2016 Scope 1 and 2 GHG emission inventory by source, and the associated graph shows the current performance compared to that of the FY 2008 baseline.

ORNL Scope 1 and Scope 2 GHG Emission Inventory (FY 2016 Compared to the FY 2008 Baseline)				
Scope 1 GHG Emissions ($MTCO_2e$)	**FY 2008**	**FY 2016**	**Increase (Decrease)**	**Change (%)**
Natural Gas, Facilities	48,563	36,655	(11,908)	-25
SF_6 Process Losses	27,102	17,168	(9,934)	-37
Fugitive Gases	10,660	2,295	(8,365)	-78
Fuel Oil, Facilities	1,968	895	(1,073)	-55
Fleet Fuels	1,104	819	(285)	-26
Minor Sources	203	194	(9)	-4
Total Scope 1 GHG Emissions	89,600	58,026	(31,574)	-35
Scope 2 GHG Emissions	**FY 2008**	**FY 2016**	**Increase (Decrease)**	**Increase/Decrease (%)**
Purchased Electricity	249,407	367,736	118,329	47
Purchased RECs - GHG Avoided	-	(92,353)	(92,353)	N/A
Net Annual Scope 2 GHG Emissions	249,407	275,383	25,976	10
Scope 1 and Scope 2 GHG Emissions	**FY 2008**	**FY 2016**	**Increase (Decrease)**	**Increase/Decrease (%)**
Combined GHG Calculation	**339,007**	**333,409**	**(5,598)**	**-2**

Major factors in the GHG inventory include the following for FY 2016 performance:

- Scope 1 GHG estimate is 58,026 metric tons of CO_2 equivalents ($MTCO_2e$), a decrease of 35% from the FY 2008 baseline. Scope 1 reductions are on target due to previously implemented ECMs, the results from implementation of the Johnson Controls Inc. (JCI) energy-savings performance contract (ESPC), and reductions in operational process emissions.
- In FY 2016, natural gas and fuel oil purchases for facilities decreased 8.7% and 69%, respectively, due in part to the three new steam boilers in the ORNL steam plant. This is compared to the use in the 12 months prior to the steam plant improvements.
- Scope 2 GHG emissions totaled 367,736 $MTCO_2e$ before renewable energy credits (RECs). Purchased RECs resulted in avoidance of 92,353 $MTCO_2e$ in GHG emissions, reducing the FY 2016 Scope 2 GHG estimate to 275,383 $MTCO_2e$, an increase of 10% over FY 2008. This increase in Scope 2 emissions is the result of growth in purchased electricity due to increases in the critical research mission of ORNL since the baseline year.
- The FY 2016 combined total of Scope 1 and 2 estimates is 333,409 $MTCO_2e$, an overall decrease 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. (See the ORNL Scope 1 and 2 chart.)



ORNL GHG Performance Status, FY 2016—Scope 1 and 2 to FY 2008 baseline

- Sulfur hexafluoride (SF_6) process losses decreased greatly from the baseline as plans for the decommissioning of the Holifield Radioactive Ion Beam Facility (HRIBF) continued to develop.
- Purchased electricity continued to grow as important mission facilities, such as world-class research in computational programs and other HEMSF programs continues to expand.
- To help offset the growth of GHG emissions from electricity, RECs totaling 97,000 MWh from renewable energy resources were secured in FY 2016.

1.1.1.1 SF_6 Progress

Sulfur hexafluoride (SF_6) is a key contributor to ORNL's Scope 1 GHG emissions inventory. Active management of SF_6 emissions will be necessary to meet DOE's overall reduction goal of 50% for Scope 1 GHG emissions. An overall awareness of the global warming potential of SF_6 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 SF_6 emissions.

The HRIBF tandem accelerator SF_6 inventory at the end of FY 2015 was approximately 203,040 lb. Losses during the year were normal process losses totaling 1,660 lb, which is less than the facility baseline of 2,500 lb/year as established as part of the ORNL FY 2008 GHG baseline analysis. Normal process losses differ from year to year due to a variety of factors, including the number of SF_6 transfer cycles to and from storage, operating temperatures, and pressures, and to the amount of recirculation of the gas in the accelerator. The SF_6 process loss in FY 2016 is calculated at 17,168 $MTCO_2e$ (from estimated releases of 1,660 lb), a 37% reduction from the FY 2008 baseline.

SF_6 Actual and Projected Emissions by Device

ORNL				Emissions (lbs)												
											Projected					
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	Total FY10 to FY15	FY16	FY17	FY18	FY19	FY20	Total FY16 to FY20
HRIBF	97322	203,040	0	2,500	10,400	1,700	1,326	2,008	1,766	19.700	1,660	1,500	0	0	0	3,160
Balance of Site	N/A	4,538	N/A	450	247	235	3	24	20	979	33	100	100	100	100	433
Total		207,578		2,950	10,647	1,935	1,329	2,032	1,786	20,679	1,693	1,600	100	100	100	3,593

As of the end of FY 2015, the DOE Office of Nuclear Physics no longer funds operation of the tandem accelerator and, consequently, it is being decommissioned. The SF_6 inventory remains and has been transferred from the accelerator to storage tanks, and the entire inventory is expected to be transferred from ORNL by the end of FY 2017. Until that time, the gas will remain in storage and all surveillance and maintenance activities associated with the SF_6 gas-handling system will continue as normal. In addition, facility staff members will perform periodic leak checks of the storage system and monitor the weight of the inventory.

1.1.1.2 Work Concludes at the Tandem Electrostatic Accelerator

ORNL's 25-MV Tandem Electrostatic Accelerator was shut down following the conclusion of a last round of experiments in late March 2016. The tandem had been operated intermittently in recent years. A series of experiments that ended in September 2016 was aimed at improving detection technologies for nuclear safeguards. Most recently, the DOE Office of Nuclear Physics funded radioactive decay studies of fission products that are abundant during the nuclear fuel cycle. The accelerator's pressurized sulfur hexafluoride gas, which acts as a high-voltage insulator, will be removed. The dense gas is very expensive, and with its removal it is unlikely that the tandem will ever run again.

Physics Division staff members and retirees gathered at a ceremony in the Holifield Radioactive Ion Beam Facility marking the March 31, 2016, conclusion of experiments at ORNL's 25 MV Tandem Electrostatic Accelerator

1.1.2 Plans and Projected Performance

Scope 1 GHG projections. Scope 1 reduction estimates indicate 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:

SF_6 process losses at HRIBF are expected to decline slightly in FY 2017 as the tandem accelerator is being decommissioned and will be significantly reduced once the inventory associated with the facility is transferred.

- The results of ECMs and energy audits managed by the Facilities Management Division (FMD) will provide continuous incremental progress toward the FY 2025 goals.
- Nonprocess 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.

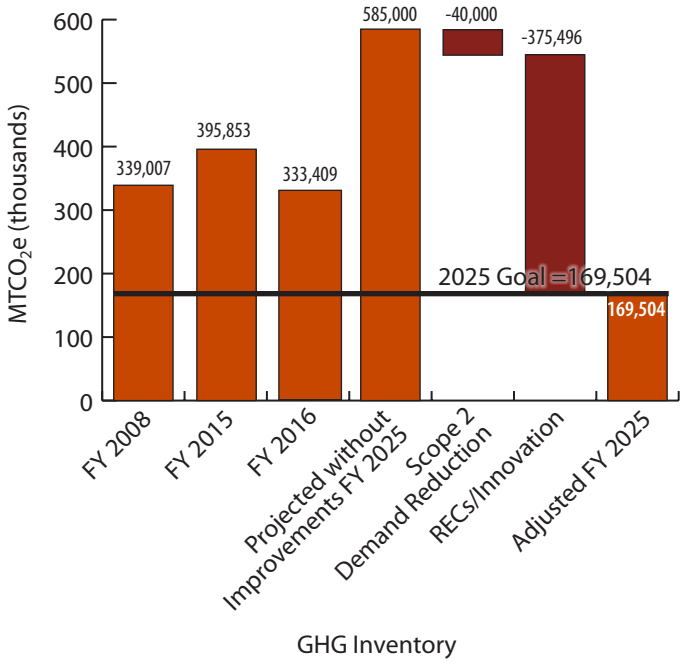
Scope 2 GHG projections. Scope 2 reductions represent a tremendous challenge due to continued growth in electricity demands for mission-critical facilities such as the Spallation Neutron Source (SNS) and the high-performance computing (HPC) systems. The importance of ORNL's HEMSFs and the associated electricity that the facilities are projected to consume are detailed in Section V of this report. Factors that influence Scope 2 reduction measures include the following:

- 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.
- ECMs and other energy improvement projects will provide Scope 2 demand reductions and will combine for incremental relief during the performance period.
- Viable clean energy projects are being explored at this time, and potential transformation technologies will continue to be studied as they are developed. In late FY 2016, ORNL enlisted an external expert to conduct an assessment to determine the financial feasibility of locating a large solar photovoltaic (PV) system at ORNL. Review and discussions from the report are planned in early FY 2017.

SECTION GOAL

- As ORNL's electrical power provider, TVA has committed to a number of initiatives that serve to reduce carbon emissions and to moderate the need for coal consumption during times of peak power demand. And as a federal entity, TVA is also expected to play a role in federal leadership in EO 13693 goals. Recent annual reports show that decreases in carbon emissions are being realized and that the EPA eGRID emission rates for our region continue to improve, as demonstrated in the current performance. As the TVA GHG output emissions improve, reductions in ORNL's Scope 2 GHG emissions performance will follow. The current carbon emission rate is 947 lb/MWh, lower that the eGRID national average of 1,137 lb/MWh and the regional average of 1,337 lb/MWh. In a recent meeting, TVA presented a corporate goal to reduce carbon emissions to approximately 600 lb/MWh by FY 2020. As the improvements in TVA clean power are eventually validated and included in future versions of eGRID tables, our regional Scope 2 emissions will continue to improve.

ORNL's updated Scope 1 and 2 waterfall chart is used to demonstrate the need for innovative and transformational technologies to help DOE realize the 50% reduction target for Scope 1 and 2 GHG emissions. The purchase of RECs will be used to temper the growth in Scope 2 emissions while renewable and clean energy projects continue to be evaluated.



ORNL Scope 1 and 2 GHG Reduction Plan

1.2 GHG Reduction—Scope 3

DOE GOAL: 25% Scope 3 GHG reduction by FY 2025 from a FY 2008 baseline (FY 2016 target: 7%).

By definition, Scope 3 GHG emissions include those activities that organizations can influence but not control by business processes alone. As with the 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 aimed at employees to 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, employees, and contractors to encourage sustainable practices in the workplace, at home, and in the community.

SECTION GOAL

1.2.1 Performance Status

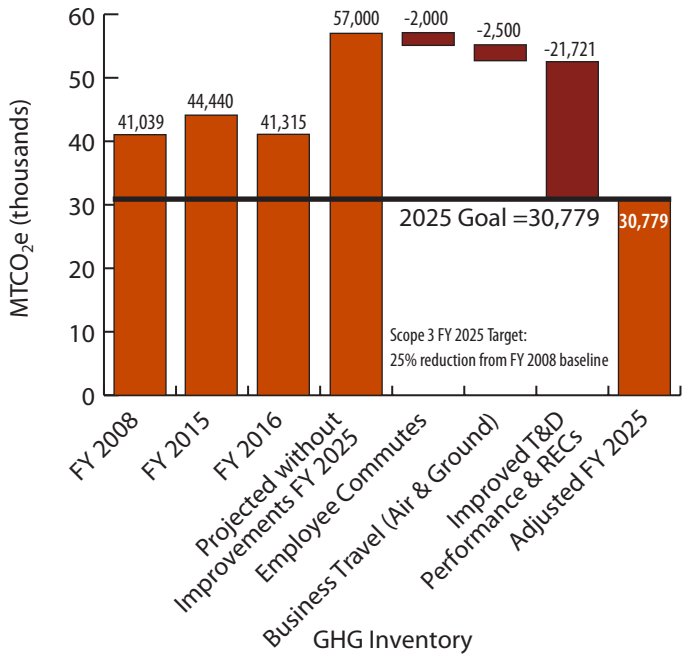
In FY 2016 the management of the SCI program continued to be the primary driver for the overall reduction of Scope 3 GHG emissions. Initiatives that work together to reduce indirect emissions include the following:

- Video teleconferencing tools/programs are being promoted for the avoidance of business travel when possible. In the last 12 months of operation, 16,066 teleconference meetings were held involving 65,299 participants, resulting in the avoidance of the financial and environmental costs of traditional business travel.
- ORNL continues to partner with Smart Trips™ promoting employee carpooling with 94 participants. Smart Trips™ provides driving incentives and ORNL provides designated parking spaces for those staff members who carpool.
- Over the past year, ORNL has continued to promote the addition of bus transit provided between ORNL, the University of Tennessee (UT), and Pellissippi State Community College (PSCC). ORNL works with our partners to offer three roundtrip routes each day allowing staff, students, and faculty free transportation to each of these campuses. Only positive responses have been received from the transit ridership. During the first academic year (August 2015–May 2016) the average daily ridership was 26. A summer route was established with two roundtrips each day and an average daily ridership of 14 was recognized. The bus began its regular route and resumed three rounds trips in August 2016 and will continue through May 2017. Ridership through September 2016 was at an all-time high of 30 average daily riders on a 36-passenger bus.
- Continued promotion for telework is ongoing at ORNL and SCI captures data from Human Resources and IT organizations. Currently 32 staff telework on a regular basis.
- There are no Scope 3 emissions to report for ORNL leased space. However, SCI will continue to work closely with the ORNL Real Estate organization in promoting the development of new processes and procedures as found in EO 13693.

The FY 2016 Scope 3 GHG emissions estimate is 41,315 $MTCO_2e$. Overall the Scope 3 inventory grew by 1% 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, a 10% growth in T&D losses limits the overall performance. The following table and figure summarize the Scope 3 data for FY 2016.

ORNL Scope 3 GHG Emission Inventory (FY 2016 Compared to the FY 2008 Baseline)

Scope 3 GHG Emissions ($MTCO_2e$)	FY 2008	FY 2016	Increase (Decrease)	Change (%)
T&D Losses	16,429	18,104	1,711	10
Employee Commutes	16,193	15,753	(440)	–3
Business Air Travel	7,204	6,538	(666)	–9
Business Ground Travel	1,169	884	(285)	–24
Other	44	—	(44)	—
Total Scope 3	**41,039**	**41,315**	**276**	**+1**



ORNL Scope 3 GHG Reduction Plan

1.2.1.1 ORNL Scope 3 GHG Reduction Plan

At the end of FY 2016, the ORNL employee workforce had experienced a 9% increase since the FY 2008 baseline year. Even with more employees, reductions have been made in Scope 3 GHG emissions attributable to employee commuting and business travel. These achievements are due to strong engagement with employees, management, and regional resources aimed at encouraging carpooling, ride shares, alternative work arrangements, and responsible business travel. While most Scope 3 categories have shown impressive improvements, a 10% increase in T&D losses (associated with the increase in purchased electricity) has limited overall performance to date.

SCI roadmap owners and team members have continued to successfully work on issues such as incentives for carpooling and the advancement of management commitment to alternative work arrangements at ORNL. Efforts have been initiated to develop mechanisms to track the number of people who are teleworking, using alternative workweek arrangements, and making use of teleconferencing to avoid business travel. Programs include the following.

Employee Commuting Options and Carpool Promotion and Participation. ORNL continues its partnership with SmartTrips™, a program of the Knoxville Transportation Planning Organization. As a result of the outreach and promotional efforts, 94 ORNL employees currently use SmartTrips™ to log their environmentally friendly commuting practices. ORNL continues to promote sustainable employee commuting practices. Examples include the provision of solar-assisted electric charging parking spots available for employee vehicles as well as ORNL fleet plug-in vehicles and preferred parking spaces for registered employee carpools. Thirteen carpools that involve three or more riders were registered in FY 2016. ORNL has no formal registration for two-person carpools; however, information from the SmartTrips™ program and a commuter survey allows us to estimate the amount of utilization.

EV Charging Stations. ORNL is a leader in the region in promoting electric vehicle (EV) use and has been actively participating in regional workplace charging efforts. A total of 47 electric vehicle supply equipment (EVSE) parking spots are available at the ORNL main campus and at the Hardin Valley Campus (HVC). The total includes 25 solar-assisted charging stations, 1 DC Fast Charger, and 21 Level-2 charging stations. There are now five EVs in ORNL's government vehicle fleet. In addition, ORNL continues to be a member of DOE's Workplace Charging Challenge.

SECTION GOAL

Since ORNL's research/demonstration period ended September 30, 2016, beginning in October 2016, an EV Owner's Club was established. For a flat annual fee, employees may join the club and have access to 42 EV charging stations across the main campus and at HVC. Maintenance of these stations is funded by the club, using the proceeds from the members' annual fees. Currently, the new club has 42 active members. Dr. Thom Mason is shown in the figure plugging in his EV.

Laboratory Director Thom Mason and his Tesla electric vehicle

Alternative Work Schedules. ORNL Human Resources reported that 135 employees were on compressed work week schedules: 69 working a 9/80 shift (80 hours in 9 working days as opposed to the typical 10 days), and another 34 working a 4/10 shift (four 10-hour days each week as opposed to the typical five 8-hour day week), and 32 employees have established formal telework agreements (working one or more days from home each week). The SCI team will continue to work with Payroll and IT for the possibility to include a telework designation in the payroll system when feature upgrades are introduced. In addition, ORNL is leading an effort on telework best practices, partnering with five other DOE labs. A final report and toolkit will be finalized and available in FY 2017.

Business Travel. ORNL has experienced a reduction in business air and ground travel due to a better awareness of the benefits of conservative travel and improved teleconferencing tools. ORNL continues to emphasize the benefits of conservative conference travel, environmentally friendly practices such as carpooling or taking public transportation while on business travel, and the added benefits of the use of teleconferencing tools whenever practical. Since the implementation of the Blue Jeans videoconferencing system this tool has proven effective in managing business travel. In the last 12 months of operation, 16,066 teleconference meetings were held involving 65,299 participants, resulting in the avoidance of the financial and environmental costs of traditional business travel.

This year significant improvements in the user interface were received, making it easier than ever to host or join a video conference and to share data from any platform (desktop, mobile, and room-based systems). Additionally, improvements to the integration with the ORNL communications platform, Microsoft Office and Outlook, enhanced the ability for executive administrators to manage Blue Jeans meetings for their supervisors through the delegation feature of Outlook. Another major capability was introduced, Prime Time events, which offers a new dimension for video collaboration targeting very large (potentially thousands) and diverse crowds for webinar type events. ORNL has utilized this for four major events during the year with great reviews from the user community.

1.2.1.2 Support for Cyclists and the Multimodal Access Plan

ORNL is preparing for new goals related to the multimodal access plan (MAP) for commuters as directed in EO 13693. ORNL continues to promote biking to work. ORNL's main campus and satellite campus locations provides access to showers, lockers and bicycle storage. ORNL has an informal bicycle club, and SCI is extremely proud to report that Dr. Thom Mason, ORNL Laboratory Director, averages commuting to ORNL by bike at least two days each week averaging about 200 commuter miles in 2016. In addition, ORNL provides over 100 on-site bikes for staff (who have completed training) to use to commute across campus reducing reliance on vehicles.

1.2.2 Plans and Projected Performance

Because of the nature of Scope 3 GHG emissions and the fact that such emissions are beyond the direct control of organizations, reductions are dependent upon strong communications with employees and regional partners. At ORNL, SCI uses employee engagement as the primary tool to ensure progress toward Scope 3 reductions related to employee commutes and business air and ground travel. The rural setting of ORNL is a barrier to the development of public transportation options; therefore, a key for SCI is to continue promoting innovative commuting options and alternative work schedules, and continue providing support for the UT/ORNL/PSCC bus transit, making it free to all riders. ORNL is committed to reducing Scope 3 GHG emissions and the following efforts are currently under way to help meet the Scope 3 GHG reduction goals.

1.2.2.1 Efforts related to employee transportation and commuting

ORNL will continue to maximize transportation options and community outreach by coordinating with local, state, and federal telecommute and rideshare agencies, including further development of regional transportation planning partnerships such as SmartTrips™. The Laboratory will also continue its employee outreach and education programs to increase participation in commuting options and telework alternatives, including maintaining and updating promotional tools and websites to assist employees in making informed decisions. In addition, SCI has already drafted a commuter survey. In FY 2017, it will be finalized and distributed, and the results will be analyzed.

1.2.2.2 Efforts related to business air travel and business ground travel

Several federal, DOE, and ORNL travel initiatives emphasize the overall benefits of reduced business travel. Travel policies aimed at reducing cost also lead to more efficient use of time and lessen GHG emissions by curtailing the use of travel-related fuels. ORNL will continue to promote the initiatives that have resulted in the current successes in this Scope 3 performance as well as promoting the advantages of using the Blue Jeans Videoconference system.

1.2.2.3 Efforts related to T&D losses

As the target year of FY 2025 approaches, the ORNL research missions will continue to grow, and GHG emissions attributed to T&D losses from purchased electricity are expected to increase. The cost-effective acquisition of RECs with the appropriate environmental attributes will also be utilized as a strategy to mitigate Scope 3 GHG emissions. The reduction of GHG emissions resulting from T&D losses is dependent upon ORNL's engagement with TVA to work in tandem to establish clean power production goals and to upgrade the T&D infrastructure. ORNL has a strong working relationship with TVA, and both the DOE Oak Ridge Site Office and ORNL have taken steps to strengthen those bonds in recent years. The Bethel Valley substation helps reduce T&D losses and to improve the reliability of medium-voltage distribution. The Laboratory has taken a proactive position and included TVA as a key member of its solutions team for cleaner electrical grid emissions, which will also reduce T&D losses.

ORNL's updated Scope 3 waterfall chart is used to demonstrate the current gap in the 25% reduction target goal. Improved T&D performance and the Scope 3 benefits of REC purchases will be the primary tools needed to reach the new goals by the target year of FY 2025.

Herb Debban and Charles Bruce

SECTION 2

GOAL 2: SUSTAINABLE BUILDINGS

2.1 Energy Intensity Reductions

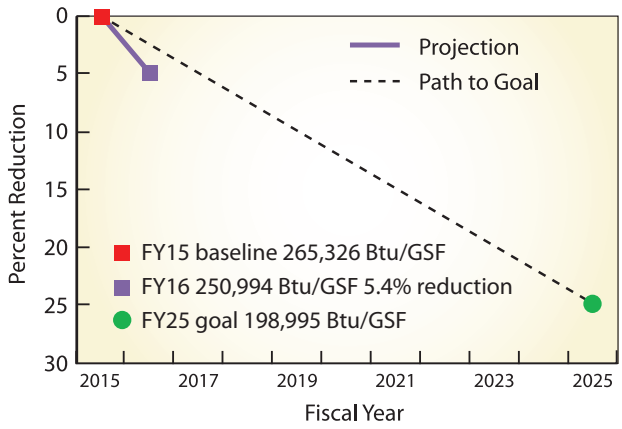
DOE GOAL: 25% energy intensity British thermal unit/gross square footage (BTU/GSF) reduction in goal-subject buildings, achieving 2.5% reduction annually, by FY 2025 from a FY 2015 baseline. (FY 2016 target: 2.5% Reduction).

2.1.1 Performance Status

EO 13693 established a new baseline in FY 2015 265,326 Btu/GSF with a goal to achieve the target of 198,995 Btu/GSF by FY 2025, using 2.5% annual target reductions.

ORNL has been employing best practices methodologies in the construction of energy-efficient new facilities, repurposing existing facilities to better align with mission and resources for effective operations, and demolition of inefficient legacy facilities. Aggressive energy reduction activities in current facilities are combined with ongoing audits and the ECM program, new efforts in building commissioning, benchmarking energy consumption, and best management practices.

Based on FY 2016 data, energy use in the buildings category at ORNL is 1,305 billion Btu, not including ORNL's excluded facilities as defined by the Energy Policy Act of 1992 (EPACT). Given an area of 5,191,415 GSF of energy-consuming buildings, trailers, and other structures/facilities identified in the Facilities Information Management System (FIMS), the FY 2016 calculated energy use intensity (EUI) is 250,994 Btu/GSF. Below are the list of 91 ORNL facilities greater than 5,000 GSF and with an EUI over 150,000 Btu/GSF. These will be the focus of energy conservation activities in the future.

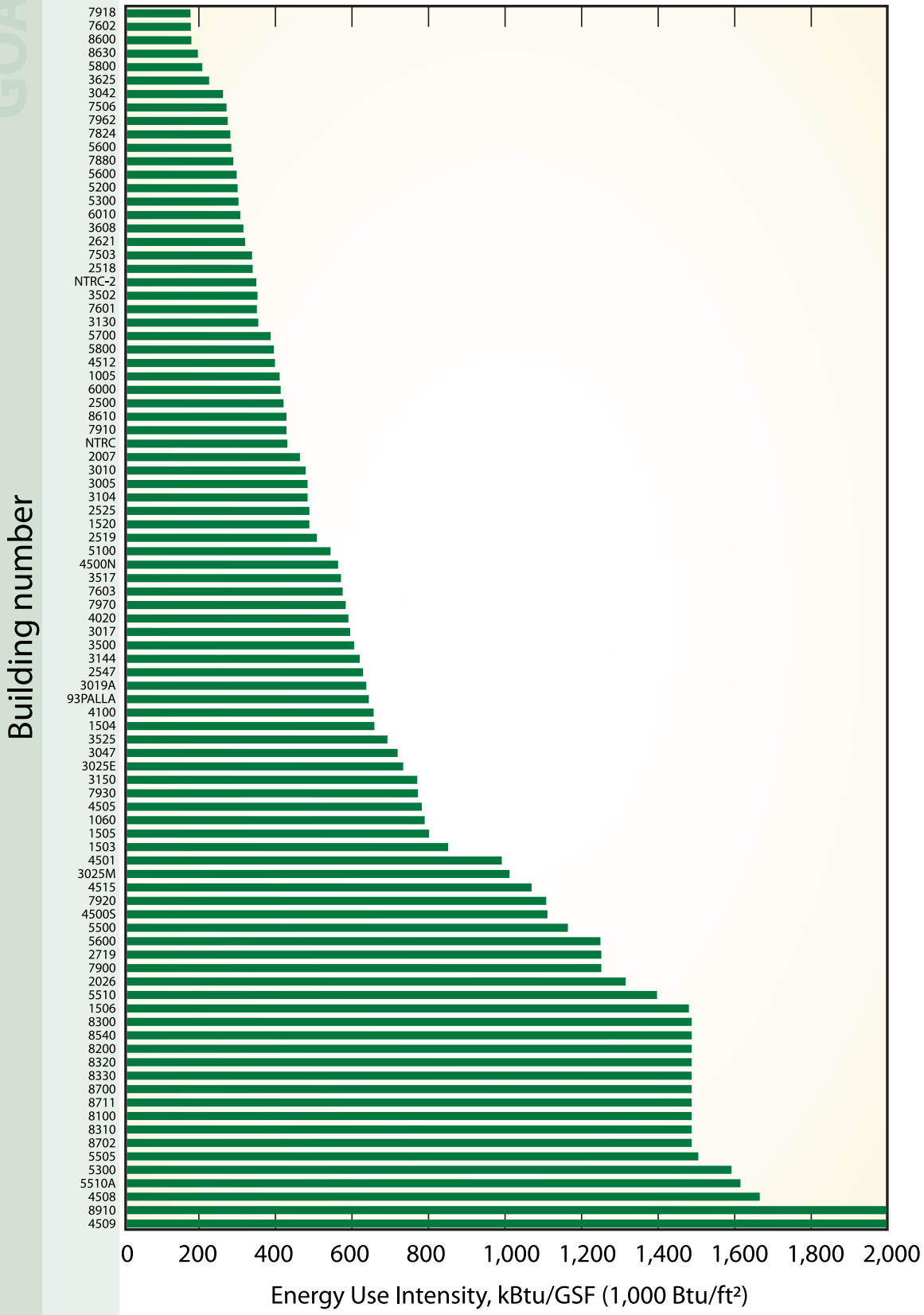


ORNL energy intensity reduction summary

2.1.2 Plans and Projected Performance

ORNL has performed well in its first year of performance toward EO 13693 and will work to sustain these performance improvements while continuing to look for opportunities to drive down energy intensity. This objective will be supported by the continued operation of the ECMs implemented by the JCI ESPC and by the ORNL integrated, in-house energy management program.

An ESPC with JCI is a significant component of ORNL's energy management strategy. The delivery order with JCI was awarded in July 2008 and was accepted in July 2012. Positive results from this ESPC will continue to be experienced into the future. The ESPC ECMs included steam system decentralization, lighting upgrades, water conservation, building management system improvements, mechanical equipment upgrades, and steam production improvements.



ORNL energy use intensity—91 buildings greater than 5,000 GSF and 150 kBtu/GSF

SECTION GOAL

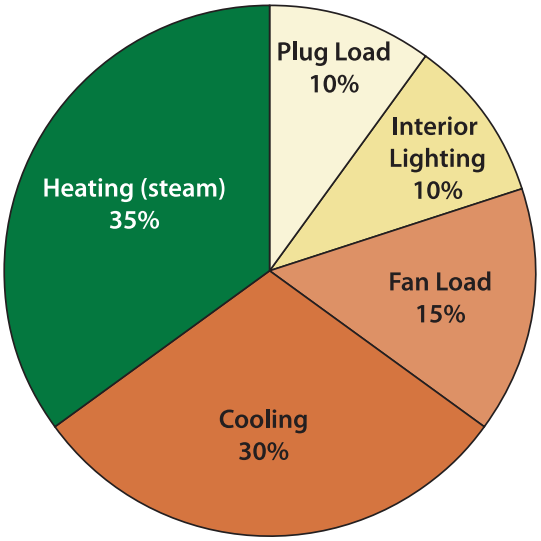
2.1.2.1 In-house energy management

ORNL's in-house energy management strategy revolves around utility meter data with a "measure-to-manage" philosophy. Meter data provide the basis for benchmarking, which sets priorities for energy auditing. Energy audits identify ECMs that include building envelope repairs, high-efficiency equipment upgrades, and heating, ventilation, and air-conditioning (HVAC) control system optimization. Existing building commissioning efforts have proven beneficial for realizing energy savings potential by adjusting parameters of existing systems, consistent with current usage conditions. To sustain the resulting performance and savings achievements, ongoing commissioning leverages utility meter and building automation system data for monitoring trends and identifying anomalies.

2.1.2.2 Recommissioning laboratories—a focus on ventilation

Many of ORNL's most energy intensive buildings are laboratories so to continue achieving site energy intensity goals, laboratories are being examined for optimization opportunities.

In FY 2016, one such laboratory, Building 1005, was subject to an optimization process to evaluate the demand for ventilation and adjust the buildings ventilation rates accordingly. A meticulous risk assessment and hazard banding assignment ensured that ventilation rates to maintain a safe environment were fully characterized. This process revealed that the building's total ventilation rates could be lowered more than 50% which resulted in an estimated energy savings of $50,000 annually. These savings were achieved through modifications to building control set points and sequences that lowered air flow volumes and introduced schedules.



An energy end use breakdown for Building 1005 reveals that 80% of energy use can be related to ventilation (fan load, cooling, heating).

2.1.2.3 Chilled Water System Improvements

Several activities occurred for the chilled water service in FY 2016:

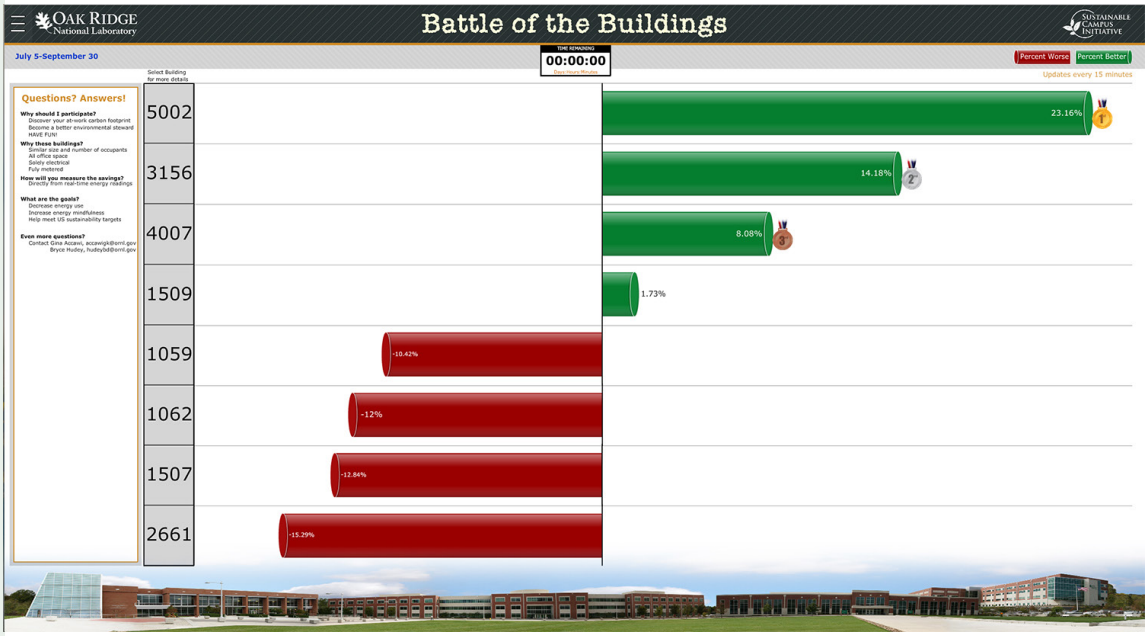
- The 4510 cooling tower refurbishment included safety enhancements such as handrails and new deck for improved personnel safety. Other equipment replacements included new motors, gearboxes, drift eliminators and fan blades to return the cooling tower to original performance specifications.
- Five Trane chillers in Building 4509 were modernized to replace vintage components including upgraded control panels to improve response time and auto-control valves for enhanced automation. Other renovations included a new high efficiency purge system to minimize refrigerant loss.
- The chilled water work center shop received an update including new office equipment and work tools to provide better response time and higher quality of service.

Refurbishment of the 4510 cooling tower

Trane chillers modernized in Building 4509

2.1.2.4 Battle of the Buildings: Impact of behavioral change

ORNL's commitment to energy conservation can also be shown with the Battle of the Buildings, a building electricity conservation competition held July–September of FY 2016. The winning building achieved accumulated savings of 23% and the top three accomplished savings of over 9,700 kWh, in comparison to the last quarter of FY 2015. The results can be seen in the image below. The competition has shown that individuals can have a high impact on energy conservation, highlighting the importance of both technology-oriented and behavioral change in sustainability efforts. More building contests will be scheduled in the future to continue encouraging more sustainable practices at ORNL.



Screenshot of the real-time data visualization shared with all participants in the FY 2016 Battle of the Buildings.

SECTION II

2.2 EISA Section 432 Energy and Water Evaluations

DOE GOAL: EISA Section 432 energy and water evaluations, benchmarking, project implementation, and measures follow-up.

2.2.1 Performance Status

ORNL has made good progress on the energy audit program, having completed the fourth year of another four-year cycle in FY 2016. Section 432 of the 2007 Energy Independence and Security Act (EISA) requires that 25% of 75% of facility energy use be audited each year, with audits repeated on a four-year cycle. (Note: evaluation by an energy service company for a site-wide initial proposal in preparation for an ESPC is acceptable as fulfilling this four-year requirement.)

The ESPC evaluation in FY 2008 by JCI provided the first 100% audit of the ORNL campus. In FY 2009 ORNL chose to proceed with a second round of audits, although doing so was not required at that time because of the JCI initial proposal, to provide additional detail on potential ECMs that could be carried out using in-house operating staff and funds. The audits also provided a ready list of ECMs in the event that supplemental funds became available. This second round of audits (completed in FY 2012) evaluated 3.2 million square feet of building space.

In FY 2013 ORNL began a new audit cycle and elected to modify the associated statement of work to focus on specific energy and water use issues and avoid duplication of work conducted during the previous rounds. This approach has proven to be very successful in identifying HVAC optimization opportunities that require only minor capital modifications and use intelligent control sequences of operation to maximize the potential of existing systems. In many cases, these audits serve as the first phase of an existing building commissioning process and as a foundation for follow-on efforts.

In FY 2016, ORNL utilized Remote Building Evaluation Services for the first time. This service was applied to seven buildings of different types to evaluate its effectiveness as a part of ORNL's graded approach to energy auditing. Results from this process were favorable and this method will continue to be used where appropriate in combination with traditional American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) level audits and walkthrough audits.

Recommended energy and water conservation measures from all audits are compiled on a composite list for prioritization, tracking, and periodic reevaluation to verify that they are still pertinent. Primary prioritization is established by life-cycle cost and benefit analyses, but secondary factors are also taken into consideration to facilitate alignment with leadership level priorities and to identify measures that have the best potential for implementation.

2.2.2 Plans and Projected Performance

In FY 2017 ORNL will begin a new 4-year energy audit cycle and will continue with a graded approach to energy auditing using ASHRAE audits as well as remote building analytics, fault detection and diagnostics, retrocommissioning and walkthrough evaluations. Specific emphasis will continue to be applied to ensuring the quality and feasibly of recommended energy and water conservation measures. Utilizing walkthrough evaluations, ORNL will engage in-house facility managers and facility engineers to identify lighting, building envelope, and other energy conservation measures that become apparent through the course of their daily functions. By quantifying the energy economics associated with these opportunities, ORNL's and energy efficiency and sustainability personnel will aid facilities personnel in the organization and prioritization of these items to promote the attention that they deserve.

Continued focus will be placed on improving the breadth and depth of ORNL's benchmarked building portfolio. The EPA 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 ORNL's Central Energy Data System (CEDS) are expected to be integral to streamlining and automating data flow to the ENERGY STAR Portfolio Manager.

ORNL Energy Audit Results in Annual Square Footage and Percentage of Campus				
Fiscal Year Annual Energy Audited (106 Btu)		Annual Percentage of Covered Facility Energy Audited (%)	Annual Gross Square Footage Audited (ft^2)	Audit Type/Level
2013	432,353	21	1,068,788	ASHRAE Level 2
2014	168,773	8	648,393	ASHRAE Level 2, Walk-Through
2015	115,749	5	362,974	ASHRAE Level 2, Walk-Through
2016	1,393,734	66	1,496,787	Remote, Walk-Through, Desk Audit

2.3 Metering for Individual Buildings

DOE GOAL: Meter all individual buildings for electricity, natural gas, steam, and water; where cost-effective and appropriate.

ORNL created an extensive-site-wide metering plan as part of the FY 2015 SSP, that included the current status and future plans for all metered utilities on campus. This metering plan is a comprehensive document that charts a course for ORNL's continued advanced metering deployment that is consistent with the *November 2014 Update to the Federal Building Metering Guidance.* Current DOE directives focus on adding electricity, natural gas, steam, and water meters where cost-effective and appropriate. The formal metering plan will be updated on a four-year cycle, while working toward annual progress in areas that have been identified for improvement.

The ORNL metering plan utilizes the Federal Building "appropriateness" for metering and prioritization methodologies. This plan also details the estimated quantity of funding and personnel required for its implementation. Because the SSP guidance is cognizant of the new EO 13693 and federal financial stewardship, the term "where cost-effective and appropriate" indicates that locations for new meter installations will need to be carefully evaluated.

All advanced meters included in the metering plan will be connected to ORNL's CEDS for data archiving and analysis. This system has the ability to log multiple parameters from each meter on a standard 15-minute interval. This system also enables meter data trend analysis, report generation, energy awareness dashboard deployment, normalization for weather and other factors as well as data export for use in other analyses. A utility cost analysis and allocation module within the CEDS called "EnergyCAP" will be used to automate utility cost distribution, generate management reports, and push monthly energy data to EPA's ENERGY STAR Portfolio Manager for benchmarking.

Personnel charged with analysis of energy data will include the site energy manager, Utilities Division management, and F&O management. The energy manager will be responsible for processing energy data to make it actionable for F&O management who have operational control of energy-consuming buildings. The Utilities Division staff engineer, in charge of energy cost accounting, will process meter data to inform utility cost allocation, bill verification, and management reporting.

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 installation labor force, utility outages or service interruptions required to accommodate installations, and technical challenges.

SECTION II

2.4 High-Performance Sustainable Buildings Guiding Principles

DOE GOAL: At least 17% (by building count) of existing buildings greater than 5,000 gross square feet (GSF) to be compliant with the revised Guiding Principles for HPSB by FY 2025, with progress to 100% thereafter.

2.4.1 Performance Status

ORNL's high performance sustainable building (HPSB) inventory totaled 20 building or 15.5% of total applicable site buildings in FY 2016, all aligning with the *Guiding Principles (GPs) for Federal Leadership in Sustainable Buildings*.

In prior reports ORNL included third party facilities in HPSB total because these buildings were previously grandfathered. The revised Guiding Principles for HPSB stipulate that contractor leased facilities should not be included in HPSB accounting. ORNL's third party facilities are categorized in 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 proven effective in keeping us on track for continued progress. HPSB candidates have been identified based on building space use, existing metering infrastructure, and identified 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.

ORNL HPSB efforts have begun to shift from office buildings to include laboratory and mixed use buildings as experience with the GPs has grown. Significant efforts have been focused on evaluating the operation of existing systems and their suitability with respect to current facility use. Temperature and airflow set points and equipment operating sequences were examined with the intent to right-size and achieve maximum efficiency potential from existing systems. Occupant comfort and known conditions were also taken into consideration for a holistic evaluation of building performance. Modifications were made to implement occupancy-based lighting control, and standardized occupant-controlled task lighting was found to align with the GPs.

In FY 2016, ORNL utilized an Sustainability Performance Office Funding Opportunity Announcement (SPOFOA) award to install eight new steam meters on the site's most significant steam consuming buildings. This project was originally scheduled to be completed over two consecutive summers (due to scheduling and impact of steam outages required to conduct installation), but facilities and operations personnel were able to complete the entire job in just one summer. The meters all connect to ORNL's CEDS and will provide an important foundational component for future HPSB conformance.

While all of the GPs contribute to the betterment of buildings, the existing building commissioning process has proved most 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. Because of this, identifying, evaluating, and adjusting HVAC airflow volumes, set points, and control sequences and related actions have proven to provide the best return on investment. ORNL realizes that achieving HPSB status is not the end but rather just the beginning of an ongoing cycle of "plan, do, check, act" to ensure the persistence of savings and potentially even increase them over time.

2.4.2 Plans and Projected Performance

In FY 2017, ORNL will be evaluating the revised HPSB Guiding Principles and assessing the site's building inventory to determine the best compliance path approaching the FY 2025 target year and thereafter, as we seek 100% compliance. ORNL will continue with projects funded by the SPOFOA including lighting control and retrocommissioning, working toward a planned completion in October 2017. With a "plan-do-check-act" strategy, emphasis will be placed on ensuring that the level of performance of buildings in the existing HPSB inventory is sustained. As it becomes increasingly more challenging to apply the GPs to more complex buildings, intensive effort and often capital investment are required to make significant changes toward reduction

of 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.

The Chemical and Materials Sciences Building (4100), a high performance sustainable building

2.5 Regional and Local Planning

DOE GOAL: Efforts to increase regional and local planning coordination and involvement.

2.5.1 Performance Status

2.5.1.1 Regional Outreach

During FY 2016 the Southeast Sustainability Group (SSG) continued to review project opportunities based on the four key areas of its charter (sustainable transportation, low-carbon power generation, energy efficiency, and water and waste management). The primary project under consideration is the installation of solar capacity across the region to offset power being used by plug-in EVs. SSG is composed of research, academic, and industry partners throughout the southeastern United States with a shared vision for advancing sustainability in the region—defined primarily as the EPA's Region IV (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, and Native American groups in the region).

2.5.1.2 Transportation Efforts

ORNL and the leaders of the Sustainable Campus Transportation Roadmap actively engage in regional and local planning for sustainable transportation as well as outreach activities for the enhancement of sustainable transportation in the entire southeast region. In 2016, SCI coordinated with state and regional transportation programs to help create more effective, efficient, and affordable regional transportation and commuting options. Staff members from ORNL were active in participation in local and regional organizations, including service on the Board of Directors of the East Tennessee Clean Fuels Coalition and focusing on regional sustainable transportation options. These meetings are important in interactions with regional stakeholders, including

Knox Area Transit (KAT), City of Knoxville, Smart Trips™, and others. ORNL remains committed in coordinating with local, state, and federal telecommute and rideshare initiatives. The route linking ORNL to PSCC continues to be a success, and ORNL remains committed to its partnership with UT and PSCC (photo below).

Sustainable Campus Initiative team member thanks regular bus riders for using the UT/ORNL/PSCC daily transit

Specific outreach efforts included the following:

- A draft report on the evaluation of an ORNL commuter shuttle bus system to reduce Scope 3 GHG emissions was completed.
- ORNL participated in TEVAC, the Tennessee Electric Vehicle Advisory Council.
- A paper entitled "Sustainable Commuting for Students, Faculty, and Staff" was submitted to the International Journal of Sustainability in Higher Education. In addition, a presentation on this paper was given by the SCI co-leader at the 3rd World Symposium on Sustainable Development at Universities, September 2016.
- ORNL continued its engagement with UT and PSCC regarding the bus route.
- ORNL participated in the TN Workplace Charging Challenge.
- ORNL employees were encouraged to participate in Smart Trips™.
- ORNL collaborated with the local DOE Clean Cities coalition and regional stakeholders; ORNL involvement included board service and active participation in quarterly meetings.

2.5.1.3 Other Regional and Local Sustainability Planning Activities

ORNL is a leader in the region in promoting electric vehicle use and has been actively participating in regional workplace charging efforts, including the installation of 47 EVSE charging stations at the ORNL main campus and at the ORNL Hardin Valley campus. See Section 1.2, "GHG Reduction—Scope 3," for more information on ORNL charging stations.

A speaker from ORNL participated in the October 2014 Southeast Alternative Fuels Conference, held in Raleigh, North Carolina. The conference featured sessions on smart travel, including trends in the southeast regarding transit, telecommuting, and ridesharing as well as sessions on public-private partnerships.

SECTION GOAL

2.5.2 Plans and Projected Performance

ORNL will continue to pursue existing and new activities in support of sustainable transportation, complete employee commuting report, and look at feasibility for implementing recommendations:

- continue active participation in SSG;
- further prepare for new EO goals and a MAP for commuters;
- further develop the regional transportation planning partnerships with SmartTrips and KAT;
- report on the Southeast Alternative Fuels Conference, focusing 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.

2.6 A. Net Zero Buildings, Existing Buildings

DOE GOAL: 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 will begin to assess its existing building portfolio and attempt 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. Cost-effective on-site life-cycle renewables 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 other appropriate forums.

2.7 B. Net Zero Buildings, New Construction

DOE GOAL: Net Zero Buildings: All new buildings (>5,000 GSF) entering the planning process designed to achieve energy net-zero beginning in FY 2020.

In improving building efficiency, performance and management, in line with the new EO 13693, all new ORNL buildings with a gross square footage over 5,000 entering 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 is actively assessing opportunities and challenges of new building construction in order to identify designs with the highest potential to reach net-zero energy, waste and/or water. This facilitates long-term, well-grounded building planning and the implementation of activities enabling the development of new net-zero buildings on the ORNL campus.

2.7.1 Performance Status

ORNL took part in a series of interviews by the Pacific Northwest National Laboratory with DOE sites, contributing to learnings, best practices and challenges seen during the laboratory's efforts. Through the collective involvement of multiple national laboratories in the assessment, best practices and common challenges could be identified in order to drive widespread progress further towards meeting the EO 13693 net-zero building requirements. A key learning point from the interviews is the importance of communication, integrated across the board with early involvement in planning and decision-making. Collective knowledge-sharing, such as the case of this interview series, will continue be important in advancing net-zero efforts.

SECTION GOAL

2.7.1.1 Success story: ORNL Logistics Building 7120 – LEED Gold Certification

Building 7120 exterior

Project Recognition. The new ORNL Logistics Building 7120 has received Leadership in Energy and Environmental Design (LEED) Gold Certification, making it the sixteenth LEED-certified building at ORNL, further recognizing the Laboratory's efforts for sustainable buildings. Additionally, the building won the United States Green Building Council Tennessee 2015 Green Light Award at the Green Light Awards Gala.

Summary Results. Building 7120, replacing the 58-year old building 7018, which had poor energy performance and inefficiencies, was completed August 2015, with a value of $6.874 million and gross square footage of 26,000 GSF (38% office space, 62% warehouse space). The building incorporates customized pre-engineered structures as well as advanced electricity and water metering. Considering the building's logistical function, its design integrated deliberation on ORNL shipping flows through centralization and more efficient truck and auto access, thereby reducing total paved area. Planning for LEED began early in the design process, in line with DOE guiding principles for HPSBs. Criteria include the maximization of open space while maintaining functionality, minimized HVAC and refrigeration system emissions, high-performance building envelopes, high solar reflectance roof surfaces, waste diversion through on- and off-site recycling, LEED innovation credits, and more.

These efforts have significantly aided in mechanical load reduction, having led to energy savings of more than 30%, and water savings of 38.5%. In addition to conservation measures, the building design is also dedicated to alternative energy. For example, 20% of the total parking area is dedicated for alternative fuel vehicles (AFVs). Building 7120 will be included in the laboratory's HPSB inventory. ORNL has been recognized in the sphere of sustainable buildings, and is committed to taking this further with more projects in planning.

2.7.2 Plans and Projected Performance

ORNL is transitioning from LEED to focus on the Guiding Principles for Sustainable Federal Buildings for all current and future new construction projects. ORNL is planning to conduct an analysis that examines design and operational utility data from a recently constructed, LEED-Gold certified facility to understand the technical and cost distance between this building and the proposed net-zero requirements. Additionally, improvements required to the facility and their Life-Cycle Cost for meeting net zero may be studied, developed and documented.

SECTION 3

GOAL 3: CLEAN AND RENEWABLE ENERGY

3.1 Clean Energy Goals for Total Electric and Thermal Energy

DOE GOAL: Percentage of total electric and thermal energy from renewable and alternative sources shall be not less than: 10% in FY 2016-2017, working towards 25% by FY 2025.

Beginning in FY 2016, EO 13693 expands energy goals to include clean alternative energy sources in addition to the previous goals related to renewable electrical energy. Goals include thermal energy from renewable and alternative sources. Pursuing clean sources of energy will improve energy and water security while ensuring that federal facilities will continue to meet mission requirements and lead by example.

Alternative energy projects for the clean energy target include the following, in addition to the purchase of RECs when cost-effective:

- installing thermal renewable energy on site and retaining corresponding renewable attributes or obtaining equal-value replacement RECs where applicable,
- installing combined heat and power processes on site,
- installing fuel cell energy systems on site,
- utilizing energy from new Small modular reactor (SMR) technologies, and
- utilizing energy from a new project that includes the active capture and storage of carbon dioxide emissions associated with energy generation.

The purchase of RECs for the Renewable Energy Target (Goal 3.2) can also be counted toward the new Clean Energy goal. ORNL REC purchases in FY 2016 resulted in achieving a benchmark of 12% of the Clean Energy Target to exceed the 10% interim target in FY 2016.

3.2 Renewable Electric Energy Goals

DOE GOAL: Renewable electric energy sources shall be not less than10% of total electric consumption in FY 2016–2017, working towards 30% by FY 2025. (FY 2016 Target: 10%).

ORNL plans and actions are moving toward achievement of the DOE Order 436.1 goal of providing 7.5% of the site's electrical consumption from renewable sources by FY 2015 and 25% by FY 2025 and beyond. EO 13693 indicates no less than 10% in FY 2016.

Until recently at ORNL, renewable energy (RE) was generated primarily by small research-oriented PV systems. A 5 kW PV array was brought on line in early FY 2008, and a 50 kW PV array began providing electricity in FY 2009. A 47 kW PV array for EV parking canopy went on line in FY 2011 and may also be used to offset the power used for 25 EV charging stations. Smaller rooftop PV arrays at Building 4100 (30 kW) and Building 3114 (13.4 kW) also contribute to ORNL's on-site RE generation capabilities.

Single-axis 5 kW photovoltaic array on the ORNL campus

SECTION GOAL

3.2.1 Performance Status

Currently, ORNL has identified multiple sources of RE to offset the site total electrical consumption of 603,313 MWh, including the following:

- 141 MWh of electricity produced on site by the five solar arrays account for approximately 0.047% of ORNL electricity, which includes the double bonus allowed for on-site generation at federal facilities. Associated RECs are retained for use by the site.
- ORNL participated in the TVA Southeastern REC pilot by purchasing 6,000 MWh of renewable energy in FY 2016.
- ORNL purchased 91,000 MWh of RECs from wind resources in 2016.
- ORNL consulted with REC brokers for the possibility of RECs available for purchase from Indian Lands. Brokers indicated difficulty in identification of available RECs on the Green-e Energy market.
- At 16.1%, the total RE (production plus all RECs) of 97,141 MWh exceeds the FY 2016 goal of 10.0%.

As an additional benefit of meeting the RE goals, energy generated from approved renewable sources—either generated on site or purchased from off-site vendors—may be allocated to new or significantly renovated buildings to assist in achieving LEED certifications for the rating desired. This approach will ensure that new buildings and major renovations maintain their dedicated renewable resource in case future funding is limited and would not permit a Laboratory-wide REC purchase. ORNL has dedicated RECs for two LEED-certified buildings: 4500-N Wing 3 and the 8930 Chestnut Ridge Maintenance Shop, qualifying all their electrical consumption for a "net zero" energy application for LEED certification.

3.2.2 Plans and Projected Performance

In late FY 2016 ORNL contracted with an external expert to provide an independent review of a previous solar PV assessment completed in December 2015 by National Renewable Energy Laboratory. Th assessment was completed to determine the financial feasibility of locating a large solar (1 to 5 MW capacity) PV system at ORNL. Currently SCI and F&O are reviewing the assessment to discuss with ORNL management. Pumped storage and hybrid hydro/solar systems are other renewable projects in consideration for additional analysis. An internal draft report, *ORNL Sustainable Campus Initiative Renewable Resources Potential for Electricity Generation*, was written and is under review and consideration. The following strategies have been mapped to meet the annual progression toward the 25% goal by FY 2025:

- RECs—ORNL will periodically monitor the REC open market and will consider purchases as they are needed to meet the renewable goal.
  - Renewable energy resources (RECs and/or bundled energy) from Indian Lands will be included in the open market search for purchase consideration. Because of the high cost of on-site RE projects, the search for renewable production is challenging.
  - The purchase quantity of RECs will include the amount to meet or exceed both the Renewable Target and the Clean Energy Target when renewable thermal energy is not available. REC purchases can also help to offset Scope 2 emissions and are counted toward Scope 2 GHG reduction goals.
  - ORNL will use multiple purchases throughout the year based on energy consumption projections and REC pricing to allow strategic purchasing of RECs 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 on-site electrical generation can be developed and implemented. ORNL's primary strategy is to develop on-site capabilities before considering other options.
  - It is anticipated that the growing demand for RECs in general, and specifically the demand for REC projects that have been on line for less than 10 years, will drive an open market price increase for RECs.
  - ORNL will develop specific REC strategic purchasing guidance to help incorporate these strategies in a living document to help determine the best value for REC purchasing. Guidance will also include dedication of REC to specific buildings for LEED certification or other goals.
- SMRs—ORNL is supporting a strong regional commitment to clean energy, facilitated by the potential construction of an SMR that could be built by TVA with prospective financial support (possibly clean energy certificates) provided by DOE, the DOE Oak Ridge Office (ORO), and/or ORNL. TVA has submitted its Early Site Permit Application to the Nuclear Regulatory Commission to assess the potential for construction and operation of SMR units at its Clinch River site near Oak Ridge.*

** Tennessee Valley Authority (May 13, 2016). Press release retrieved from https://www.tva.gov/Newsroom/Press-Releases/TVA-Submits-Early-Site-Permit-Application-For-Clinch-River-SMRs.*

SECTION II

GOAL 4: WATER USE EFFICIENCY AND MANAGEMENT

4.1 Potable Water Use Intensity

DOE GOAL: 36% potable water intensity (G/GSF) reduction by FY 2025 from a FY 2007 baseline. (FY 2016 target: 18%).

EO 13693 continues the federal commitments established by prior directives with a goal of 36% reduction in water use intensity (WUI) by the FY 2025 target year. DOE set a WUI reduction goal for potable water in FY 2007 relative to an FY 2007 baseline. ORNL has long been aware of the benefits of effective water management, and, by FY 2007, as a result of a variety of operational initiatives, ORNL had already experienced a 57.2% reduction in water use compared with its highest water use (experienced in FY 1985).

4.1.1 Performance Status

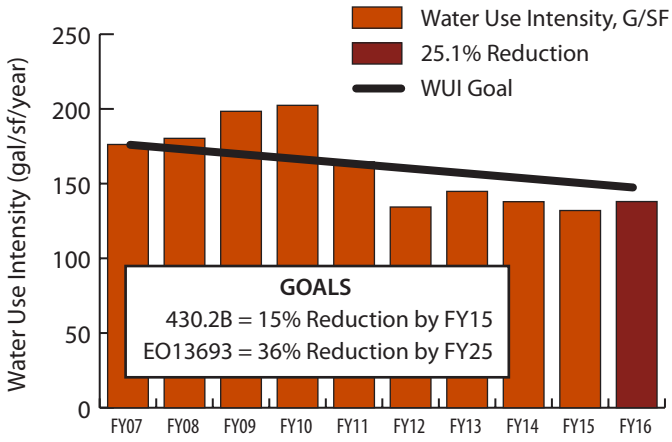
ORNL has developed an aggressive plan to reduce water consumption that includes repairing leaks, replacing old lines in the site water distribution system, and eliminating once-through cooling (OTC) where possible. The cumulative result of these efforts is a WUI of 137.9 G/GSF in FY 2016, a reduction of 21.8% from FY 2007, which exceeds the incremental goal of a 18% reduction.

- Significant WUI improvement activities were initiated in FY 2008 upon the award of an ESPC, resulting in savings of 170 million gallons per year (MGY).
- ORNL was highlighted in *Tennessee Utility News*, Second Quarter 2016, for its rapid response to repairing a 20-inch water main. The rupture released 50-75 gallons per minute of potable water during a very cold, wet and snowy February in 2016. With help from area utilities and a dedicated, multidiscipline craft, ORNL Utilities completed the repair and mission-critical operations were not impacted.


Working Against the Clock,
ORNL's Mechanical Utilities Shines

- The ORNL Utilities Division has worked with two different leak detection companies to identify and repair leaks in the water distribution system across the site. In addition, the Utilities Division has replaced identified sections of piping and has repaired leaks found in the process of replacing lines. An effort by FMD to identify and repair leaks within buildings has also resulted in significant water savings. In addition, the research and development organizations have installed stand-alone coolers or flow reducers where OTC could not be eliminated.
- Building 4100 experienced several leaks over a short 3-month period which have been repaired.
- ORNL continues to repair and replace a very old and leaky water distribution system with new backflow preventers in several building, along with piping reconfigurations to correct plumbing problems. Fire hydrants and post indicator valves in the distribution systems have also been replaced as needed.

- To better understand water use at ORNL, a water-metering plan is being implemented. Many of ORNL's most significant water-consuming facilities have been metered with advanced meters. The meters are connected to the ORNL CEDS and are collecting interval data. In addition, many of ORNL's cooling tower makeup water supplies are metered; most of the metering devices are advanced meters. In FY 2016 another advanced meter was installed with wireless connectivity in a key location on the site's water distribution system, expanding a foundation for additional distribution-side meters in the coming years.
- Rain sensors have been installed and connected to irrigation controllers to temporarily discontinue irrigation after recent rainfall.



ORNL water use intensity goal

4.1.2 Plans and Projected Performance

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

- Planned growth to support ORNL's HPC mission is projected to result in additional water consumption for cooling towers. Water consumption for this additional capacity is expected to peak in FY 2018 at 280 MGY.
- Several new locations on the site water distribution system will be evaluated for advanced metering. Deep analysis of accumulated water meter interval data will be an increased focus area.
- Several water-saving initiatives are under way or planned through FY 2020 that are anticipated to save an additional 11 MGY of potable water.
- One safety shower was replaced in FY 2016 and five more are scheduled for replacement with piping reconfigurations at a remote location after a significant leak was discovered.
- A project to install two ozone disinfecting generators will reduce OTC by incorporating closed loop methodology, expected to reduce water consumption in FY 2017.
- In FY 2017, a project to eliminate OTC in Building 4508 and to replace it with a closed-loop chilled-water loop will be completed and will save an estimated 80 to 100 MGY.
- Enhancements have been identified regarding landscape irrigation installations and maintenance activities and to improve configuration control irrigation systems.
- An upgrade for one of ORNL's reservoirs is under way.
- An enhanced site-wide water balance is being developed to better account for specific water end uses and establish prioritization for additional advanced water meters. This effort will also serve to identify new water conservation opportunities.
- System flushing is needed at the completion of water system/distribution projects, including cooling tower media exchange, as well as to support building/area construction and demolition activities, which can consume a large amount of water. Coordination of activities will help ORNL better support and identify these sources of water consumption. ORNL's water consumption has supported water quality efforts to 'turn over' water in reservoirs and long distribution runs with little demand. Manual flushing methodology

has been used to maintain the water quality in reservoirs and long runs of distribution piping with small demand. This flushing methodology is a large consumer of water, but 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. An auto-flusher has been installed at the Experimental Gas-Cooled Reactor in late FY 2016 and will be evaluated for use in other locations as warranted.

- 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 will need to be aggressive in pursuing additional water-savings opportunities to offset mission-specific demands in order to align with the FY 2025 goal established with EO 13693.

4.2 Industrial, Landscaping, and Agricultural Water Consumption

DOE GOAL: 30% consumption reduction of industrial, landscaping, and agricultural (ILA) water by FY 2025 from a FY 2010.

Industrial, landscaping, and agricultural (ILA) water is considered to be nonpotable freshwater used for aiding processes such as cooling, washing, and manufacturing or for irrigation and other uses related to the production of agricultural products. Because all water at ORNL is potable water, all water used at ORNL will be included in the potable water category, and no water will be included in the ILA category.

4.2.1 Performance Status

Not applicable.

SECTION 04

GOAL 5: FLEET MANAGEMENT

5.1 Fleet-Wide Per-Mile GHG Emissions

DOE GOAL: 30% reduction in fleet-wide per-mile greenhouse gas emissions (GHG) by FY 2025 from a FY 2014 baseline. (FY 2015 target: 3%; FY 2017 target: 4% reduction).

5.1.1 Performance Status

All performance measures in the Fleet goal areas are supported by validated data provided by the Federal Energy Management Program (FEMP) via the Federal Automotive Statistical Tool (FAST) system. In FY 2016 and in prior years updated and validated FAST data have not available until after the SSP is submitted.

The FY 2014 baseline per-mile GHG emissions calculation of 527 grams/mile was established by the Sustainable Program Office (SPO) and is available in the DOE Sustainability Dashboard. FY 2016 FAST data are not yet available, but fleet inventory, mileage, and fuel usage have remained relatively constant. The FY 2016 per-mile GHG performance is expected to remain stable in that the Fleet inventory has not increased and usage remains at or near 100% capacity.

5.1.2 Plans and Projected Performance

ORNL plans to support the per-mile GHG emission initiative through purchasing plug-in hybrid electric vehicle (PHEV) passenger vehicles whenever possible. ORNL also plans to replace current light-duty fleet vehicles with AFVs and to acquire more efficient models when new vehicle purchases are required. Vehicles are replaced only when mileage, age, and maintenance-cost criteria are met.

5.2 Reduction in Fleet Petroleum Consumption

DOE GOAL: 20% reduction in annual petroleum consumption by FY 2016 relative to a FY 2005 baseline; maintain 20% reduction thereafter.

Note: Fleet vehicle data are available in the Federal Automotive Statistical Tool (FAST) system. Fuel calculations are in natural units of gallons, not gasoline gallon equivalents.

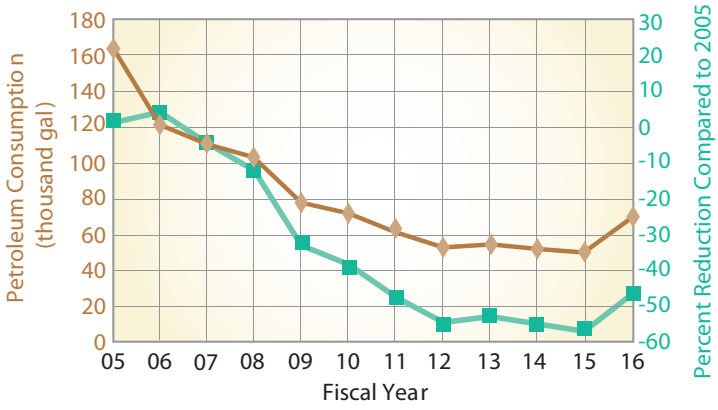
5.2.1 Performance Status

Fuel data for FY 2016 reflects that ORNL has exceeded the cumulative target of 20% decrease in petroleum consumption by achieving a cumulative decrease of 54.6% compared to the 2005 baseline, as shown in the figure. ORNL has strategically placed 100 bicycles throughout the campus for staff use in order to help with sustainability goals, including the reduction of fleet vehicle use. Twenty-two percent of the LSVs used on campus are EVs. Under the auspices of the SCI, two diesel-powered LSVs from the ORNL fleet were evaluated on the vehicle dynamometer in the Fuels, Engines, and Emissions Research Center to benchmark their fuel economy and emissions. The report noted that results show excellent fuel economy of 22 to 36 miles per gallon, much higher than expected for this type of non-road vehicle, and much higher than would be expected from light-duty sedans or pickup trucks used in similar service.

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 ORO local utilization mileage goal of 94% has been exceeded with 99% utilization.

5.2.2 Plans and Projected Performance

As funding is provided, as appropriate approvals are granted, and as the mission dictates, ORNL will continue to replace inefficient vehicles with AFVs and hybrids; replace heavy-duty vehicles with units that have a smaller gross vehicle weight rating; and, when possible, replace gasoline LSVs with electric LSVs.



Petroleum consumption and cumulative percentage decrease from FY 2005

ORNL's planned fleet measures include the following:

- zero waivers for using petroleum fuel in alternative-fuel vehicles (AFVs),
- promotion of Lab-wide E85 alternative fuel use,
- zero missed opportunities for fueling AFVs with alternative fuels,
- replacement of older vehicles with AFVs and hybrids as funding allows,
- continued emphasis of initiatives that will decrease idling practices by personnel,
- procurement of hybrid vehicles to provide the on-site taxi/shuttle activity with fuel-efficient vehicles, and
- continued reduction of vehicle miles traveled (e.g., through teleconferencing, trip consolidation, use of mass transportation).

The risk assumption associated with this goal is related to the availability of alternative fuels. ORNL currently has four types of fuel available on the site: unleaded gasoline, E85, biodiesel, and diesel. If E85 or biodiesel becomes unavailable, or if any technical problems with these fuels or fueling infrastructure arise, gasoline and diesel fuel will have to be used.

5.3 Fleet Alternative Fuel Consumption

DOE GOAL: 10% increase in annual alternative fuel consumption by FY 2015 relative to a FY 2005 baseline; maintain 10% thereafter.

Note: Fleet vehicle data are available in the FAST system. Fuel calculations are in natural units of gallons, not gasoline gallon equivalents.

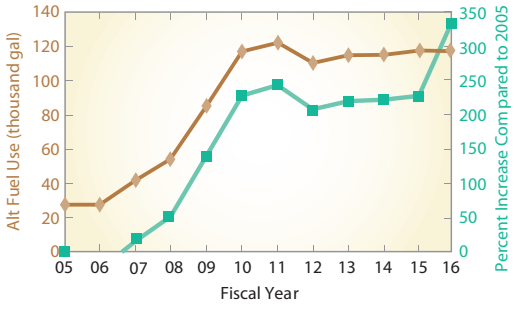
Fuel data for FY 2016 reflect that ORNL alternative fuel use has increased from the 2005 baseline by 331%, far exceeding the target. The graphs included in this section demonstrate ORNL's commutative progression in alternative fuel use in percentage increases per year and in comparison of alternative fuels with traditional petroleum products. Petroleum use continues to decline as alternative fuels prove to be available and are used.

5.3.1 Performance Status

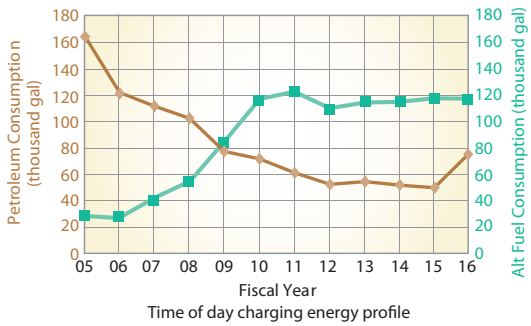
ORNL currently has three alternative fuel pumps on site and an on-site fueling truck that dispenses B20 biodiesel fuel to equipment and vehicles.

An outside fuel test laboratory frequently tests the E85 fuel at ORNL to determine the ethanol content. Any interruptions in the availability or quality of alternative fuels could quickly lead to reduced alternative fuel use and increased petroleum use, which would set back our progression toward SSP goals. Now that the vehicle purchases have been made for FY 2016, 63% of the fleet is made up of flexible fuel vehicles (FFVs). In addition, 86% of the vehicles, including recently purchased PHEVs, can use alternative fuel.

SECTION GOAL



Alternative fuel consumption and cumulative percentage increase from FY 2005 to the present.



Comparison of petroleum vs. alternative fuel consumption from FY 2005 to the present.

ORNL works to market the use of E85 fuel at the ORNL Fuel Station. In September 2016 the ORNL Fuel Station was updated with new graphics on each fuel pump, and the entire Fuel Station was given a fresh coat of paint and better signage.

ORNL continues to be a leader in the Southeast for alternative fuel fleet use and remains involved in alternative fuel outreach through partnerships with the local DOE Clean Cities program (East Tennessee Clean Fuels) and by providing experts at local public outreach and education events. Such events highlight ORNL's experience and expertise in alternative fuel use. ORNL's educational outreach efforts help the public make informed decisions regarding the benefits of alternative fuel use and challenges associated with it.

5.3.2 Plans and Projected Performance

ORNL's planned fleet measures include continuing to replace older vehicles with AFVs as funding will allow. ORNL is continuing to focus on flexible fuel passenger vehicles and on obtaining approved B20–capable vehicles when possible. A total of 25 vehicles were purchased in FY 2016, consisting of light-duty, medium-duty, and heavy-duty vehicles and passenger vehicles. Nineteen of the acquired vehicles were AFVs, and two were plug-in hybrid sedans. There are now five plug-in hybrid sedans in ORNL's 439-vehicle fleet, and 86% of fleet vehicles are AFVs. ORNL is also continuing to procure electric LSVs as funds allow and when missions can use such equipment. If funding is maintained and vehicle appropriations are granted, ORNL anticipates purchasing 19 to 20 new AFVs each year.

To continue ORNL's progress toward the goal of zero missed opportunities for fueling AFVs with alternative fuels, AFV fuel use will continue to be assessed on a monthly basis. Funds and availability of fuels continue to challenge the fleet program.

5.4 Light-Duty Vehicle Acquisitions

DOE GOAL: 75% of light-duty vehicle acquisitions must consist of alternative fuel vehicles (AFVs) and each year thereafter

Note: Fleet vehicle data are available in the FAST system.

5.4.1 Performance Status

ORNL continues to support the AFV acquisition requirement by purchasing available FFVs from the General Services Administration (GSA). Additional purchases will continue to depend upon available funding and approval. In FY 2016 19 light-duty vehicles were purchased, representing 100% of vehicles that could be purchased with alternative fuel capability.

SECTION GOAL

5.4.2 Plans and Projected Performance

ORNL will continue to replace vehicles that meet the criteria in the *Code of Federal Regulations* (41 CFR 102-34.270) with AFVs as funding and appropriations allow.

Costs continue to be higher for hybrid vehicles and/or EVs than for E85- or B20-compatible vehicles. Until initial costs of EVs are comparable to the costs of other vehicles, the decision to purchase EVs will continue to be a challenge. In addition, EV selection on the GSA vehicle-ordering system is limited compared with the selection of FFVs and B20-compatible vehicles.

ORNL on-site fuel pumps have two E85 pumps and one B20 pump, along with the fuel truck, which accommodates vehicles and equipment that cannot use the fueling station. To continue to successfully use B20 in compatible vehicles, ORNL will continue to monitor the quality of the B20 fuel.

ORNL has a total of 439 agency-owned vehicles. A total of 25 vehicles were purchased in FY 2016, consisting of light-duty, medium-duty, and heavy-duty vehicles and passenger vehicles. Nineteen are AFVs, and two are plug-in hybrid sedans. There are now five plug-in hybrid sedans in ORNL's 439 vehicle fleet, and 86% of fleet vehicles are AFVs. If funding is maintained and vehicle appropriations are granted, ORNL anticipates purchasing 19 to 20 new AFVs each year.

5.5 Zero Emission or Plug-in Hybrid Electric Vehicles

DOE GOAL: 20% of passenger vehicle acquisitions must consist of zero emission or plug-in hybrid electric vehicles by FY 2020, working towards a goal of 50% by FY 2025.

Note: Fleet vehicle data are available in the FAST system.

5.5.1 Performance Status, Plans, and Projected Performance

ORNL began purchasing PHEVs in FY 2013. We now have a total of five PHEVs in the fleet, including Ford CMAX Energi and Ford Fusion Energi vehicles. As funding is available and as appropriations for purchasing passenger-carrying vehicles, we will continue to acquire these type of vehicles in support of the EO goals.

ORNL has installed and will continue to install on-site EV charging infrastructure to support the goal of acquiring PHEVs. ORNL had previously installed a FleetCarma telematics device on one PHEV (a Ford CMAX Energi) to collect data on use, battery charging, and fuel economy of the vehicle on a pilot basis. The device records 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 driving details and driver behavior details, charging details, including type of charger and summary of time of day, are recorded. This year, four additional FleetCarma C5 telematics devices were purchased. They have advanced capabilities, including automatically transferring data to a FleetCarma web portal where ORNL fleet management and ORNL researchers can access the data. The data will continue to be used in making decisions of where to best utilize PHEV and charging infrastructure as more PHEVs are added to the ORNL fleet.

SECTION 6

GOAL 6: SUSTAINABLE ACQUISITION

6.1 Sustainable Acquisition and Procurement

DOE GOAL: Promote sustainable acquisition and procurement to the maximum extent practicable, ensuring BioPreferred and biobased provisions and clauses are included in 95% of applicable contracts.

6.1.1 Performance Status

The Lab-wide paperless initiative for all purchasing card transactions was completed. As a result, the paperless process will facilitate internal and external reviews of purchasing card transactions, make approving manager reviews easier, and eliminate at least 80 reams of paper per year and 320 reams in constant records management mode (at least 2 sheets of paper per transaction × 20,000 transactions per year/500 sheets per ream = 80 reams × 4 years of paper retention = 320 reams or $11,200).

All applicable contracts in FY 2016 contained terms and conditions that invoke requirements for sustainable acquisitions.

As indicated 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:
- All of the 23,546 unique subcontracts, purchase orders, and task orders and 69,886 purchase issues against blanket ordering agreements meet the DOE procurement requirements.
  - Terms and conditions issued with blanket ordering agreements not only contain all FAR provisions, but also include additional requirements for promoting and providing environmentally preferable products.
  - The Contracts Division includes subcontract language with key commodity suppliers requiring that they provide detailed reports on the purchases of electronics products designated ENERGY STAR and Electronic Product Environmental Assessment Tool (EPEAT).
- Simplified procurements of minor purchases made using an authorized purchasing card are exempt from provisions related to sustainable acquisition. During FY 2016, 25,290 purchasing card transactions were made.

6.1.2 Plans and Projected Performance

The Acquisition Management Services Division (AMSD) established a Lab-wide paperless initiative for all purchasing card transactions to accomplish savings in paper and toner expenses and storage requirements. AMSD will report metrics as a result of paperless purchasing card initiative showing savings related to paper, toner, office supplies, energy and storage.

Through ORNL Marketplace, send notices to our Marketplace vendors asking them to avoid idling of vehicles and send reminders for drivers to follow the anti-idling guidance. The plan is to have ORNL Transportation send similar notices to all of the common carriers.

Market Place Vendor Fair

GOAL 7: POLLUTION PREVENTION AND WASTE REDUCTION

Note: All municipal solid waste (MSW) generated by ORNL is sent to an industrial landfill located on DOE ORO property. To eliminate double counting of GHG emissions, ORNL MSW data are entered as "0" in the DOE Sustainability Dashboard because the environmental management prime contractor counts all MSW for the entire ORO landfill as Scope 1. ORNL is responsible for the reduction of MSW, and the reporting in this section tracks progress toward meeting DOE waste generation reduction goals.

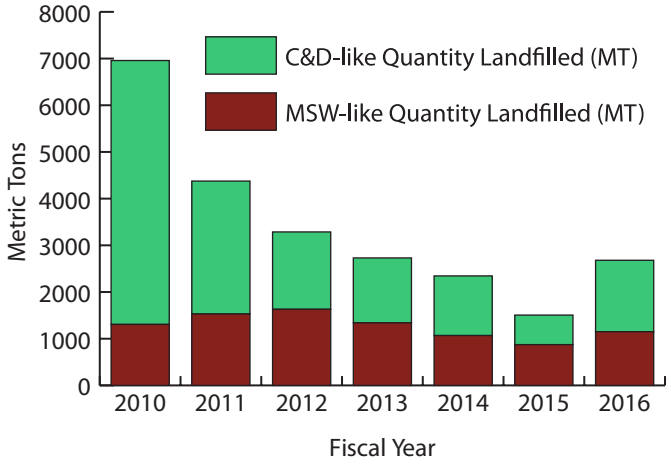
ORNL's pollution prevention (P2) plan embodies the commitment of ORNL management and staff to reduce waste generation and toxicity; to promote sustainable acquisition and resource conservation; to embrace sustainability, stewardship philosophies, and sustainability measures; and to fully comply with state, federal, and DOE requirements concerning P2.

The regulatory-required P2 program and plan document the elements of the program, capture ongoing and planned activities, and are wholly supportive of DOE's sustainability program initiatives. Accomplishment of the ORNL goals, outlined as follows, requires the merger of administrative and cultural changes with new technologies and procedures:

- The generation of waste and pollutants is minimized through source reduction. ORNL has long focused on source reduction as the primary way of reducing waste generation, including sanitary, hazardous, and radioactive waste.
- The philosophy is incorporated in our work controls for research and operational activities:
  - practices to keep exposures as low as reasonably achievable,
  - chemical hygiene,
  - work control procedures, and
  - National Environmental Policy Act (NEPA) project reviews.
- The P2 focus has been to reduce the amount of material going to the landfill.
  - Development and use of contract language requiring construction contractors to recycle as much construction debris as possible and to report the recycled amounts has resulted in significant amounts of material being diverted from the landfill.

- For routinely generated waste, it was previously determined that as least 30% of the material in the trash could have been recycled in established programs. To improve compliance with goals, as in past years, additional recycling containers have been distributed to offices and breakrooms. Large recycling bins are provided in many areas, preventing 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 and construction and demolition waste, including off-site recycling of scrap metal, pallets, and broken furniture.

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. As shown in the following bar charts, 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 construction and demolition (C&D) waste sent to on-site landfills by the Lab (see chart).



ORNL municipal solid waste and construction and demolition landfilled waste trends

7.1 Reductions of Nonhazardous Solid Waste, Other than C&D Waste

DOE GOAL: Divert at least 50% of nonhazardous municipal solid waste, excluding construction and demolition debris.

7.1.1 Performance Status

ORNL's diversion rate for MSW in FY 2016 reached 46% as supported by data reported in DOE's Sustainability Dashboard. Through a series of coordinated efforts ORNL was able to achieve a significant increase in the last two years compared to the prior years. ORNL has continued its initiatives and best management practices to reduce the amount of material going to the landfill, including the following:

- Materials going into trash cans and dumpsters are monitored to determine whether there are additional materials that have the potential for source reduction, recycling, or resale.
- Special recycling initiatives are supported and promoted to maximize recycling and duplication of these efforts. An example is the Physics Division Library elimination of hard copy documents as library resources are now available electronically.
- ORNL examined several MSW-generating operations to identify additional diversion efforts that could increase ORNL's diversion. In FY 2016, the recycle of wooden pallets was implemented and approximately 4,000 pallets were diverted from the landfill. ORNL contracts with an external vendor to pick up the pallets on a regular basis and the vendor pays ORNL an annual fee for this arrangement.

- Carpet recycling also transitioned from a project-by-project activity to a Lab-wide initiative in FY 2016. One carpet-recycling project in FY 2016 totaled 670 yd^2 (670 yd^2/125.664 oz/ yd^2 = 2.631 tons).

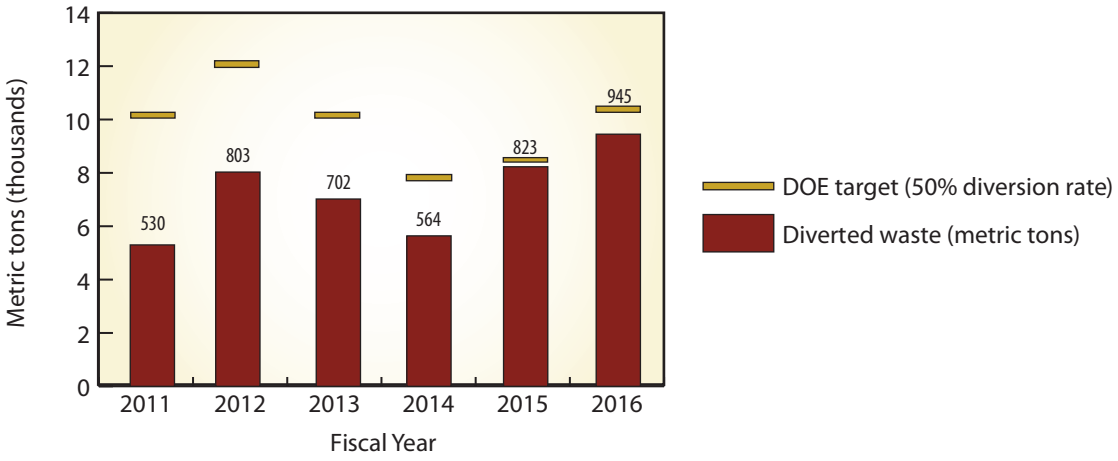
Recycled carpet (2,631 tons)

- ORNL is always looking at opportunities for composting. In FY 2016, ORNL was invited to participate in discussions by the City of Oak Ridge regarding the possibilities of implementing a regional partnership for composting. The initial meetings prompted a tour to two very successful composting sites in the neighboring counties. The picture shows P2 staff, SCI staff, and others at the Sevier Solid Waste Inc. Composting Facility.

ORNL staff and others at Sevier Solid Waste Inc, Composting Facility

Findings of missed recycling opportunities are presented to personnel to reinforce the mission of P2. A number of targeted meetings were offered in FY 2016. ORNL also provided information and gave presentations to DOE Headquarters and other DOE facilities concerning ORNL's Earth Day and various sustainability efforts.

- Communications with divisions and facility managers concerning which materials are acceptable in the recycling streams (e.g., fiberboard, colored paper) have continued to be enhanced, and efforts have been made to help them find additional outlets for saleable and recyclable materials.



Municipal solid waste diversion

7.1.2 Plans and Projected Performance

ORNL will continue its initiatives and best management practices to reduce the amount of material going to the landfill and recognizes the nonattainment for this goal with a current performance of 46% diversion rate. 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; and
- evaluating and implementing recycling of any new material streams identified.

SECTION 7

7.2 Construction and Demolition Materials and Debris

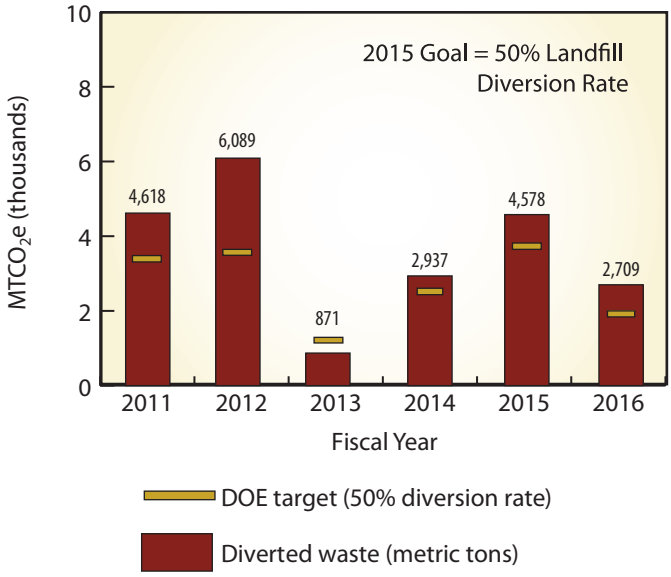
DOE GOAL: Divert at least 50% of construction and demolition materials and debris.

7.2.1 Performance Status

In FY 2016, ORNL achieved a 66% diversion rate for C&D materials and debris exceeding the 50% goal and ORNL has exceeded the goal since 2010 with the exception of FY 2013.

In recognition of cost-savings opportunities, certain wastes were disposed of as C&D debris rather than low-level radioactive waste as a result of efforts to extensively characterize wastes from demolition activities that would have otherwise been sent off site for costly disposal as low-level radioactive waste. This effort allowed ORNL to determine that those wastes could be sent to the on-site landfills, which reduced waste management costs but also prevented the Laboratory diversion rate from being higher.

Additionally, demolition waste generated in FY 2016 contained materials that prevented recycling. In FY 2016, materials from several ORNL activities were reused and recycled, including 998 MT of asphalt millings from an FY 2016 paving project and 103 yd³ of soil as clean cover at the ORO landfill.



Construction and demolition waste diversion

7.2.2 Plans and Projected Performance

ORNL will continue efforts such as the following to divert C&D wastes:

- Effective contract language has been developed and used that requires construction contractors to recycle as much C&D debris as possible and to report the recycled amounts. That language will continue to be included in contracted construction projects.
- Building on the successful C&D recycling for construction contracts, ORNL expanded a C&D collection program started in FY 2011 for remodeling debris from activities in existing facilities. A location was identified and is used for storing recyclable wallboard, rubble, wood, ceiling tiles, and metal, and a vendor has been contracted to conduct the recycling activities. The collection of remodeling debris will continue across the facility.
- Internal NEPA reviews are conducted for most projects performed at ORNL. The reviews promote discussion with project engineers to plan for the reuse of soils, concrete, asphalt, and other C&D materials. The P2 program team will continue to provide input on these reviews.
- Project managers and engineers include recycling opportunities in the project planning process, ensuring cost-effective diversion results.

SECTION GOAL

7.2.2.1 Integrated Pest Management and Landscape Management

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 2016 accomplishments to include

- 74 ash trees were removed from campus due to Emerald Ash Borer infestation (i.e. they were dying and removed for safety concerns);
- Bird exclusion practices were utilized (mesh netting and sheet metal);
- Invasive plant removal was conducted along portions of White Oak Creek and First Creek; and
- New landscaping plant purchases were checked for fire ants.

ORR IPM includes invasive removal, hazard tree removal along roads, forest pest monitoring (emerald ash borer, walnut twig beetle, hemlock woolly adelgid, gypsy moth).

*During Earth Day at ORNL, Jamie Herold, ORNL Plant Ecologist, discusses the importance of protecting pollinator health and distributes Butterfly milkweed (*Asclepias tuberosa*) seeds for individuals to begin their own gardens for attracting butterflies and other pollinators at home.*

SECTION GOAL

GOAL 8: ENERGY SAVINGS PERFORMANCE CONTRACTS

8.1 Energy Performance Contracts

ORNL will work with DOE, the SPO, and the DOE Office of Science (SC) Program Office as needed to assist in the development of agency-wide plans to meet the new FY 2017 targets for ESPCs as directed in EO 13693.

ORNL's ESPC with JCI was the primary mechanism for achieving the goals established to meet 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.

ORNL's Steam System Upgrades

The three new dual-fuel natural gas/fuel oil boilers (replacing two vintage boilers and the Biomass Gasification System that experienced operational difficulties) have been in operation in FY 2016, and reductions in natural gas and fuel oil consumption have been achieved.

Steam distribution decentralization and steam production efficiency improvements further improve ORNL's steam service and reliability.

Modernizing Facilities

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

New boilers installed in the ORNL Steam Plant

SECTION II

GOAL 9: ELECTRONIC STEWARDSHIP

9.1 Electronic Purchases

DOE GOAL: 95% of eligible acquisitions each year are EPEAT-registered products.

9.1.1 Performance Status

In FY 2016, ORNL met the requirements for electronics purchases with respect to EPEAT, Energy Star, and FEMP. ORNL deployed a guided procurement system to route staff to the standard electronic device ordering system.

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. When necessary, nonstandard hardware may be requested by staff. Established automated procurement governance ensures that each nonstandard request is reviewed to see if the device complies with cyber security, configuration management, EPEAT, Energy Star, and FEMP requirements.

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. ORNL installed a group of workstations for computer-aided design n FY 2016 to meet a specific design requirement. Currently those systems are Energy Star certified but are not registered with EPEAT.

9.2.2 Plans and Projected Performance

ORNL's Green IT sustainable campus roadmap for FY 2017 includes the following:

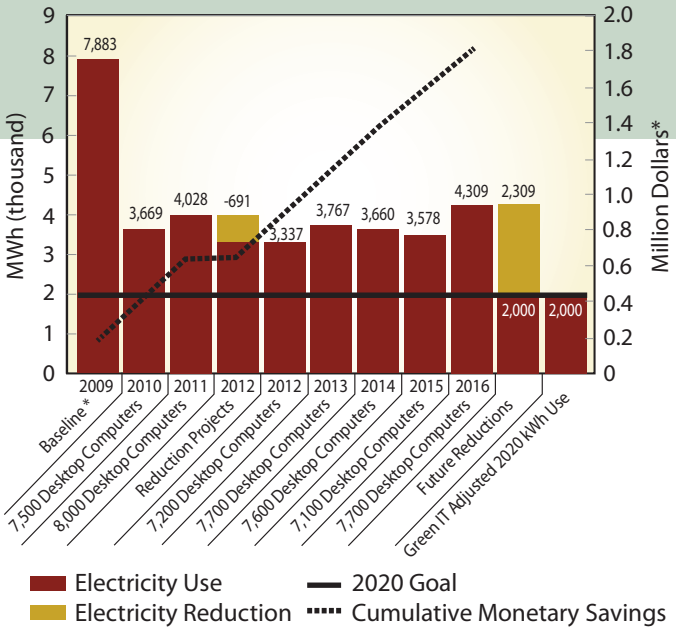
- ORNL will focus on minimizing the number of print devices that are purchased and will guide staff toward a standard set of shared network printers.
- ORNL will continue to closely monitor requests for nonstandard (i.e., non-EPEAT) computers, monitors, and laptops.

9.2 Power Management of Electronic Equipment

DOE GOAL: 100% of eligible desktops, laptops, and monitors have power management enabled.

9.2.1 Performance Status

As shown in the figure, ORNL has successfully met the electronic stewardship goal of power-managing 100% of the eligible personal computers (PCs), laptop computers, and monitors in use by Laboratory staff since 2009. The progression of estimated power management electricity savings is shown.



2020 goal = 2,000 MWh, cumulative savings = $1,808,947

9.2.1.1 ORNL electricity and cost savings from power management.

FY 2016 energy and cost savings by utilizing a power management application are summarized in the following table.

Baseline Energy Consumption Comparison

	Annual per PC Average	All 7,700 PCs
Summary of Annualized Energy Consumption Data		
Baseline Consumption (kWh)	1051	8,092,700
Consumption with Surveyor (kWh)[a]	560	4,308,611
Energy Savings (kWh)	491	3,784,089
GHG Reduction (lb)	670	5,157,713
Energy Reduction (%)	46.8	
Summary of Annualized Energy Costs		
Baseline Cost ($)	59.91	461,284
Cost with Surveyor ($)a	31.89	245,591
Cost Savings ($)	28.01	215,693
Cost Savings (%)	46.8	

[a] Determined by the Aptean Verdiem Surveyor power management application.

The following Green IT policies and procedures are still in active use at ORNL:

- ORNL IT offers standard computer hardware through three qualified vendors on Marketplace. The vendors are required to sell EPEAT-certified computers, monitors, and laptops. Senior management must approve exceptions.
- All ORNL Windows computers, including servers, desktops and laptops, are required to have a secure screen saver (password required) 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 between 1 and 20 minutes. The graphical user interface only allows users to select 10-minute intervals. Settings are checked and changed, if necessary, every 12 hours by automated systems. There is an exception process in place for users to exempt a system from having a password-protected screen saver when needed to meet mission goals.
- 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.
- All Windows desktops are required to be power-managed. The ORNL power management tool collects power use data on all laptops but is not used for managing power. The user performs laptop power management within the operating system. Devices registered as instruments or servers are excluded from power management. There is an exception process in place for users to exempt a system from power management when needed to meet mission goals. Laptops and off-network computers utilize power management features built into the operating system to manage power use.

9.2.2 Plans and Projected Performance

ORNL plans to upgrade the Lab device power-management software to provide security enhancements and to improve reporting. ORNL's Green IT Sustainable Campus Roadmap for FY 2017 includes continued operation of the computer power management and monitoring system and an upgrade of the ORNL power management software to improve power management capabilities. The upgrade will enable the power management of the latest versions of Windows and Mac OS operating systems.

SECTION II

9.3 Automatic Duplexing

DOE GOAL: 100% of eligible computers and imaging equipment have automatic duplexing enabled.

9.3.1 Performance Status

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

ORNL plans to update print management documents and strategy with respect to the DOE *Sustainable Print Management Guide* once the guide is finalized.

A slide explaining shared printing was prepared and is now included in new employee orientation so that new employees are made aware of the ORNL shared-printing policy.

9.3.2 Plans and Projected Performance

ORNL's Electronic Stewardship automatic duplexing FY 2017 planned efforts include the following:

- ORNL will continue to use implement shared network print devices with automatic duplexing set as a default.
- ORNL will continue to reduce the number of local print devices by providing additional shared network printers.

9.4 End of Life

DOE GOAL: 100% of used electronics are reused or recycled using environmentally sound disposition options each year.

9.4.1 Performance Status

In FY 2016, ORNL met this goal with 100% of used electronics being reused or recycled using environmentally sound disposition options. These options include transfer to other DOE contractors, nonprofits, and schools, such as through 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 the Lab's electronics that have reached end of life. ORNL 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 recyclers' procedures and certifications for compliance with all regulations, using best practices, and are in good standing with professional recycling associations. Acknowledging the Lab's success, ORNL received a 2014 Federal Green Challenge National Award in the electronics category for its sustainable electronics stewardship efforts and specifically for using a R2-certified recycler to recycle its electronics.

SECTION GOAL

9.4.2 Plans and Projected Performance

ORNL's Electronic Stewardship (end of life) FY 2017 planned efforts include the following:

- ORNL will continue to use the CFL Program to reuse viable electronics.
- ORNL will continue to use an R2 certified recycler to recycle its electronics that have reached end of life.

9.5 Data Center Efficiency

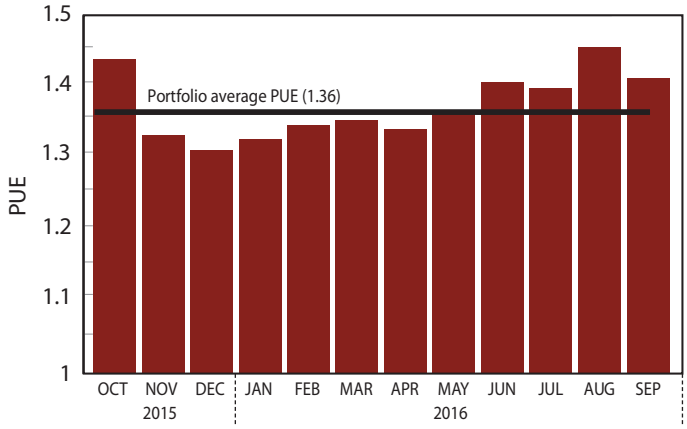
DOE GOAL: Data Center Efficiency—Establish a power usage effectiveness (PUE) target in the range of 1.2–1.4 for new data centers and less than 1.5 for existing data centers.

9.5.1 Performance Status

ORNL's Computational Facilities Complex (CFC) strives to continually improve all facets of its operation. The CFC reported a data center portfolio power usage effectiveness (PUE) of 1.36 for FY 2016. PUE is a metric used to show the efficiency of a facility's data center support infrastructure. Examples are given in the following list of improvements and strategic industry engagement to facilitate continued infrastructure enhancements to increase facility energy use efficiency:

- ORNL is proud that we have continued our relationship with the UT Reliability and Maintainability Center for its fifth year and will continue into the next fiscal year. HPC systems consume significant energy when in production. Increased facility uptime translates to higher HPC system utilization and less wasted energy. If a problem with facility infrastructure impacts the HPC production systems, then the science mission is delayed as simulation results are lost, while the power usage remains relatively high. The CFC Reliability Program brings significant operational value by increasing equipment life through an effective predictive maintenance program and by keeping the overall complex operating as efficiently as it can. This year's work updating our computerized maintenance management system supports assets being installed for Summit, ORNL's next HPC system. We also are working to establish key performance indicators that will help guide our efforts moving forward.
- A new cooling distribution unit (CDU) serving rear door heat exchangers and HPC cold plates was installed for the early access system for Summit. The CDU provides a dedicated secondary warm-water (20°C) loop that mimics the design specifications for the Summit system to be installed in 2017. We are gathering system performance data from the CDU and the HPC systems on this loop to validate our expectations of how the larger system will operate. Currently, this mechanical system is using just 2.5 kW of pump energy to remove up to 120 kW of heat generated by the early access system, transferring that heat directly to the facility's chilled water system.
- An older Cray XE6 system was replaced with an XC40 system that will allow warmer cooling supply temperatures in the future.
- Involvement with the Energy Efficient High Performance Working Group (https://eehpcwg.llnl.gov/) continued. This working group is composed of counterparts at other national laboratories and other individuals from industry, including HPC system integrators and other facilities hosting HPC. Subgroups include Infrastructure (Liquid Cooling, Controls, total power usage effectiveness, and Energy Reuse Effectiveness); Computing Systems (Procurement Considerations, HPC Grid Integration, and System Workload Power Measurement); and Conferences (Industry Engagement). This year's Infrastructure Team's focus has been on dynamic controls for improved energy efficiency for liquid-cooled HPC systems.
- A staff member was promoted to a corresponding member of the ASHRAE Technical Committee 9.9—Mission Critical Facilities, Data Centers, Technology Spaces, and Electronic Equipment (http://tc99.ashraetcs.org/). Engagement with this group serves two purposes: to stay attuned to the direction and aggregate knowledge of the industry and to provide a conduit to share lessons learned and expertise back into this industry for the betterment of all. ASHRAE recently published Standard 90.4, Energy Standard for Data Centers. It is being reviewed to determine compliance gaps between ORNL's data centers and to determine its direction of intent if DOE or code requirements adopt the standard in the future.

Cooling distribution piping for the new early-access system for Summit



ORNL data centers monthly power utilization effectiveness for FY 2016

- Staff recently participated in the High Performance Computing Operational Review, which is a gathering of facility operators from various national laboratories. This collaborative meeting served to be a setting in which system designs, best practices, and lessons learned were shared.
- A specialized subteam composed of ORNL staff has been established and holds regularly scheduled meetings to discuss ongoing efforts to maintain and improve the CFC's metering, metrics, and reporting of information related to the data center that is important to management and engineering.
- Real-time PUE calculation has been audited for accuracy, and precision will continue to be improved by additional metering being added to simplify the automation and to improve the accuracy. Our automated PUE calculation is roughly 800 lines of code and provides system-level PUE in accordance with the industry definition. Challenges with data quality are being addressed. Validation of sensor input data ensures that the PUE calculations are not compromised by incomplete or erroneous data sources. The code was rewritten to easily add and remove computer systems as they move through their life cycle.
- Power metering has been added to the chillers in the 5600 data center for insight into their operational efficiencies at different loads and outdoor conditions.

ORNL's CFC Data Centers have an annual PUE of 1.36. The chart shows how the annual PUE trended month to month during FY 2016.

9.5.2 Plans and Projected Performance

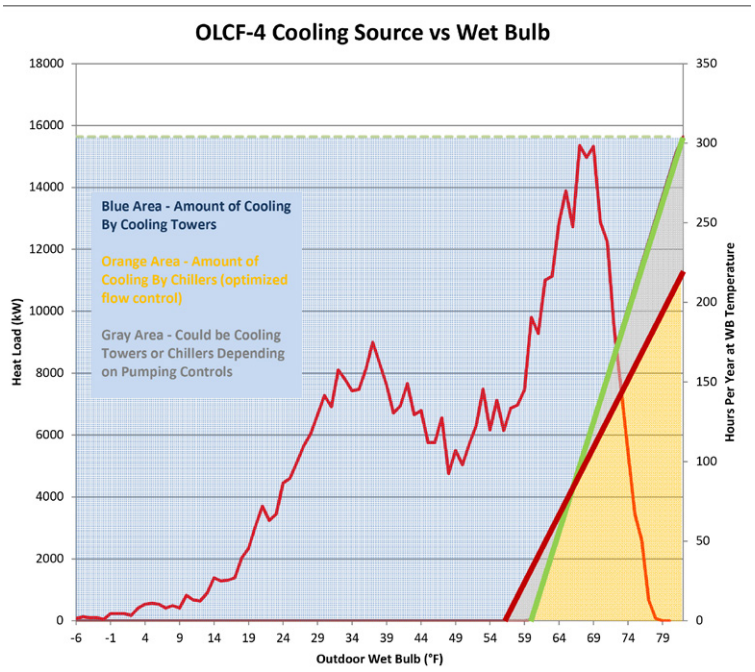
Engineering staff have identified several areas in which to pursue additional energy savings. Challenges include maintaining the current level of redundancy, controls stability, and system resiliency. Areas and directives where ORNL CFC will seek energy savings in FY 2017 are summarized in the following list:

- ORNL is investigating the feasibility of improving PUE at lower utilization levels of the overall capacity of the facility's chiller-based systems.
- ORNL is investigating the feasibility of increasing cooling temperatures to specific systems to allow chiller-less cooling during some parts of the year.
- ORNL is engaging in the DOE Better Buildings Challenge: Data Center Accelerator program with a goal to futher realize a 25% improvement in PUE by the year 2020. With Summit being brought on line, the bulk of the improvements to the ORNL Data Center portfolio will come from the addition of this new data center.

SECTION GOAL

- The facility modifications required for the OLCF-4 HPC system (Summit) continue. This data center will incorporate a waterside economizer, which will enable chiller-less cooling for more than 60% of the year. The data center will leverage both direct (on-chip) cold plate technology and rear door heat exchangers to capture 100% of the HPC system heat generated, and the HPC system fans will provide the only air movement required for cooling the data center. The data center will have an auxiliary variable refrigerant flow air-handling system that will filter the air and control upper humidity levels based on dew point. It is expected that the design will result in a PUE of better than 1.15.
- New water-side economizing cooling towers and piping bridge construction are being installed to support warm-water HPC systems beginning with OLCF-4's Summit. The pipe bridge design includes future-proofing that will support additional warm-water piping to more cooling towers that may be associated with future HPC systems.
- To achieve enhanced performance, dynamic cooling controls are being developed that will pull in data such as the predicted outdoor atmospheric conditions, Summit's internal telemetry and projected power usage, and available cooling capacity from the facility. The dynamic controls are intended to provide higher utilization of the economizing cooling towers, minimize pump energy, and keep the chilled water systems operating in a stable state without compromising the output of Summit. The figure illustrates one possible scenario where changing the flow and temperature to Summit will allow minimization of the usage of chilled water, maximizing the usage of the economizers, and improving the PUE of Summit. By integrating the different systems, flow to the system will be minimized, return temperature maximized, and allowable excursions of flow and temperature taken advantage of to minimize and delay the use of compressor-based cooling as much as possible.
- The electrical transformers are very close to the electrical switchboards for the system. This minimizes transmission losses. They are also located outside the building, which eliminates the need for the supplementary cooling that would be needed if they were located inside. The transformers are oil-cooled, which provides for extended service life and cooler operating conditions. These transformers are also K-rated, with the highest efficiency of conversion available.
- All pumps and fans have variable frequency drives to allow energy savings when cooling loads are less than design.
- Current plans are to not include humidification in the data center since the manufacturer has indicated that the equipment is made to operate in the 2015 ASHRAE Recommended Inlet Guideline.

New central energy plant expansion construction with pumps and heat exchangers will support Summit.



OLCF-4 cooling source vs. wet bulb. The straight red and green lines represent two different flow rates and supply temperatures to the system at a given heat load.

GOAL 10: CLIMATE CHANGE RESILIENCE

10.1 Update Policies to Address and Plan for Climate Change Impacts

DOE GOAL: Update policies to incentivize planning for, and addressing the impacts of climate change.

ORNL is taking an integrated and proactive approach to including sustainability efforts and climate change resiliency into the operational planning process. The Climate Change Resiliency (CCR) Roadmap is an important part of the SCI Roadmaps Projects Structure. This roadmap includes the ORNL CCR team, which was chartered in FY 2014. The team includes representatives from F&O and research programs to ensure continued collaboration and focus on the climate change topic between operations and scientific research staff. Members represent F&O senior management, site strategic planning, environmental management, natural resources, SCI, and the deputy director for the Climate Change Science Institute (CCSI) at ORNL. The roadmap owners and the CCR team held annual work sessions to review climate change risk elements and event categories and their potential impacts to critical missions and operations while considering our specific geographic location and associated potential risk for climate change events.

SECTION GOAL

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:

- continue to develop knowledge of the impacts of climate change risks and their effects on ORNL,
- 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 climate change best practices into the facilities planning process and the design of new agency buildings.

The updated ORNL Climate Change Resilience Risk Table is included below. The CCR team will continue to review and update the table annually as conditions change and as best practice procedures are identified.

ORNL Climate Change Resilience Risk Table, Updated in FY 2016

Climate Hazard	Operations			Personnel			Productivity		
	Consequence	Risk	Actions	Consequence	Risk	Actions	Consequence	Risk	Actions
Average Temperature	Increased rate of material degradation. Potential increase in disease and pests. Permit and compliance issues.	L	Low risk impacts, review consequences.		L			L	
High Temperatures	Increased cooling costs for buildings and equipment. Decreased heating costs. Increased landscaping costs. Increased demand on equipment (e.g. chillers/substations). Peak demand could exceed TVA contract limits TVA could ask for voluntary curtailments or force blackouts (blackouts are not likely).	M	Review and analyze design standard changes Identify impacts of discharged heat in White Oak Creek through engineering study. Continue proactive discussions and negotiations with TVA to ensure power reliability.	Increased heat-related illness (outdoor/field work). Reduced building thermal comfort.	L		Increased heat-related illness (outdoor/field work). Loss of productive working hours.	L	
Average Rainfall	No average rainfall impacts anticipated.	L			L			L	

Climate Hazard	Operations			Personnel			Productivity		
	Consequence	Risk	Actions	Consequence	Risk	Actions	Conse-quence	Risk	Actions
Heavy Rainfall	Potential flooding from White Oak Creek. Increased water damage to build-ings, equipment, utilities. Operational delays due to weather. Unintended remobilization of unearthed hazardous materials. Bypass water limit permits. Sewage and wastewater treatment plants. Adverse effects on Natural Resources attributes	M	Modify flow restrictions in White Oak Creek. Performance Measure in place to clean storm drains on a frequency of every six months. Ensure pumps are in place. Review south side flow. Rework emer-gency plans to include handling "flooding situa-tions". Review designs Run sensitivity analysis on all land use and planning vari-ables.	Increased potential of flood-related injury/death Reduced site access; longer commuting times. Trees and other vege-tation can be planted to improve resilience to floods.	L		Increased rate of flood-related injury/death. Reduced site access; longer commuting times. Loss of productive working hours.	L	
Severe Weather (Droughts, Thunder-storms, Tornadoes, Hail, Ice, Heavy Snow, Wildfire)	Increased land-scaping costs. Increased risk of wildfires. Possible permit violations and increased costs for White Oak Creek. Increased damage to buildings and/or equipment. Impacted electrical reliability. Increased safety risks. Increased damage/maintenance costs. Increased opera-tional delays due to weather.	M	Confirm that wildfire protec-tion plans are adequate: Emergency action level plans in place. Master agree-ments in place with neighboring agencies. Current actions in place. Confirm that safety practices are adequate: Procedures, regular drills, public address announcements. Laboratory Shift Superintendent Alert System in place.	Increased human safety risks. Increase in heat related illnesses.	L	Review all health and safety proce-dures to and update as applicable. Commu-nicate current conditions that might impact the health of workers, especially those who work outside.	Loss of productive working hours. Reduced site access; longer commuting times.	L	Improve remote work proce-dures for applicable positions. Ensure notifica-tions when work break increases are needed due to extreme tempera-tures.

SECTION GOAL

10.1.1 Future Activities and Facility Planning

As a result of establishing the CCR team, ORNL is better positioned to address the need for climate change resiliency elements in all future plans. The team 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 climate risks.

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.
- Assure 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 improve decisions based on life cycle analysis.
- When cost-effective, adopt passive and natural design strategies over active and mechanical systems.

10.2 Emergency Response

DOE GOAL: Update emergency response procedures and protocols to account for projected climate change, including extreme weather events.

ORNL has engaged with state, local, and regional entities to address emergency response and preparedness. These 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;
- coordinating with other first-response entities to mitigate risk in extreme events;
- furnishing first responders in emergency situations; and
- planning for and respond to emergency situations that can be attributed to climate change 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 climate change impacts.

10.3 Workforce Health and Safety

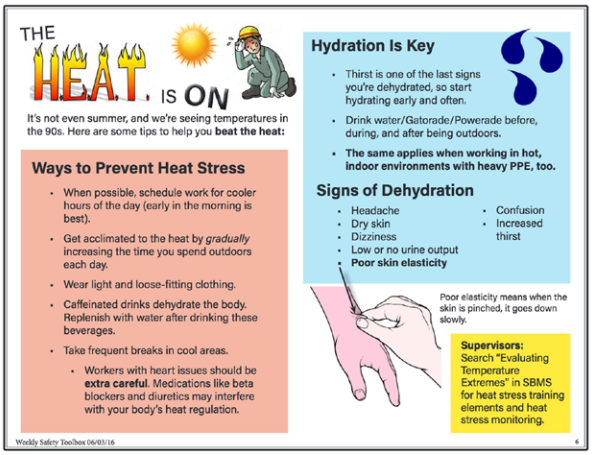
DOE GOAL: Ensure workforce protocols and policies reflect projected human health and safety impacts of climate change.

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:

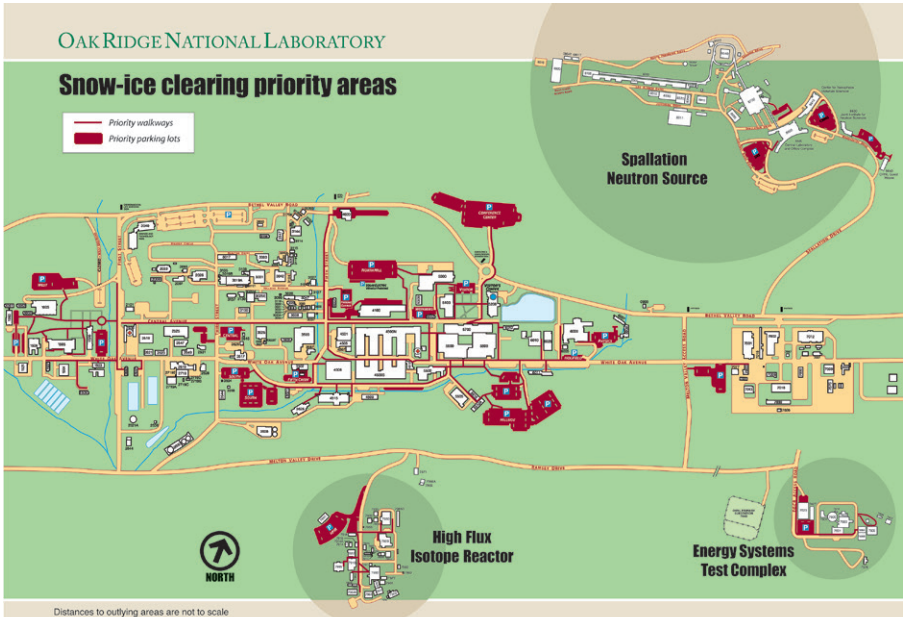
- Staff can check the ORNL Weather Line and ORNL Today for current conditions.
- In 2016, ORNL replaced the existing internal notification system with Laboratory Shift Superintendent (LSS) Alert, an improved notification system for advising staff of local emergencies, traffic, road conditions, inclement weather, protective actions and security situations, and other important information about the ORNL area. Staff are encouraged to register for this notification service to receive critical information by phone, email, and text, and many are participating. In addition, regular news articles, posters, electronic messages, and Scala reminders are some of the tools used to promote the new LSS Alert system.
- The Standard-Based Management System (SBMS) contains the online procedure, "Handle Absences Related to Weather, Adverse Events, and the Laboratory's Operational Status."
- ORNL instituted a more formalized system of identifying priority areas for snow removal.

10.3.1 Climate Extremes at ORNL: Hot and Cold

One area of concern and key focus for ORNL is staff safety during inclement weather events for both heat and cold weather extremes. In 2016 the East Tennessee area experienced an extended period of days where high temperatures reached over 90 degrees and heat and humidity indexes were remained high for several weeks. During that time the Worker Safety Toolbox, a weekly newsletter for workers and supervisors, covered heat issues continually. Below is an excerpt of one of the many reminders issues during this period of extreme hot and humid weather.



Conversely, last winter ORNL and surrounding communities received a combination of ice, snow, and single-digit temperatures, making travel to ORNL hazardous on some days. However, ORNL made various arrangements to accommodate staff members who had to determine what would be best, given their particular circumstances, whether at work or at home. Supervisors were directed to work with staff to the maximum extent allowed, and flexible work schedules are in place to allow staff members who are eligible to make up missed time, including allowing staff to telework from home where possible. 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 the Lab during times of icy weather and snowfall (see the map). In addition, staff and supervisors will be reminded of the importance of making safe choices, including telework. The CCR team will analyze extreme weather days and telework participation for the next SSP.



SECTION 10

10.4 Management Commitment

DOE GOAL: Ensure site/lab management demonstrates commitment to adaptation efforts through internal communications and policies.

ORNL has a strong commitment to adaptation efforts and to communicating existing and new policies to the staff. The mission of the ORNL CCR team is integrated into all aspects of F&O senior managers; utilities managers; staff in site strategic planning, environmental management, and natural resources; the SCI; and the deputy director for the CCSI. The CCR team held its annual working session in FY 2016 to review ORNL's Climate Change Risks and Actions and to ensure that actions noted in FY 2014 were being addressed, to review existing policies and new guidance, and ORNL's continued implementation plans pertaining to CCR.

Additionally, Laboratory Director Thom Mason provides monthly messages containing updates on a multitude of current topics. Always included is 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. In addition to holding regular monthly and expanded quarterly meetings with all ORNL managers, Dr. Mason has a blog and a Twitter account, and staff members are encouraged to post comments, concerns, and questions on any topic. Their comments are addressed in an expeditious manner.

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.

10.5 Climate Change Science Integration

DOE GOAL: Ensure that site/lab climate adaptation and resilience policies and programs reflect best available current climate change science, updated as necessary.

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. 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.

SECTION GOAL

10.5.1 Urban Resiliency and the ORNL IAV Team

ORNL's science research staff in 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 these methods span multiple scales, from local to global, and rely on advanced computer models and diverse datasets 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.

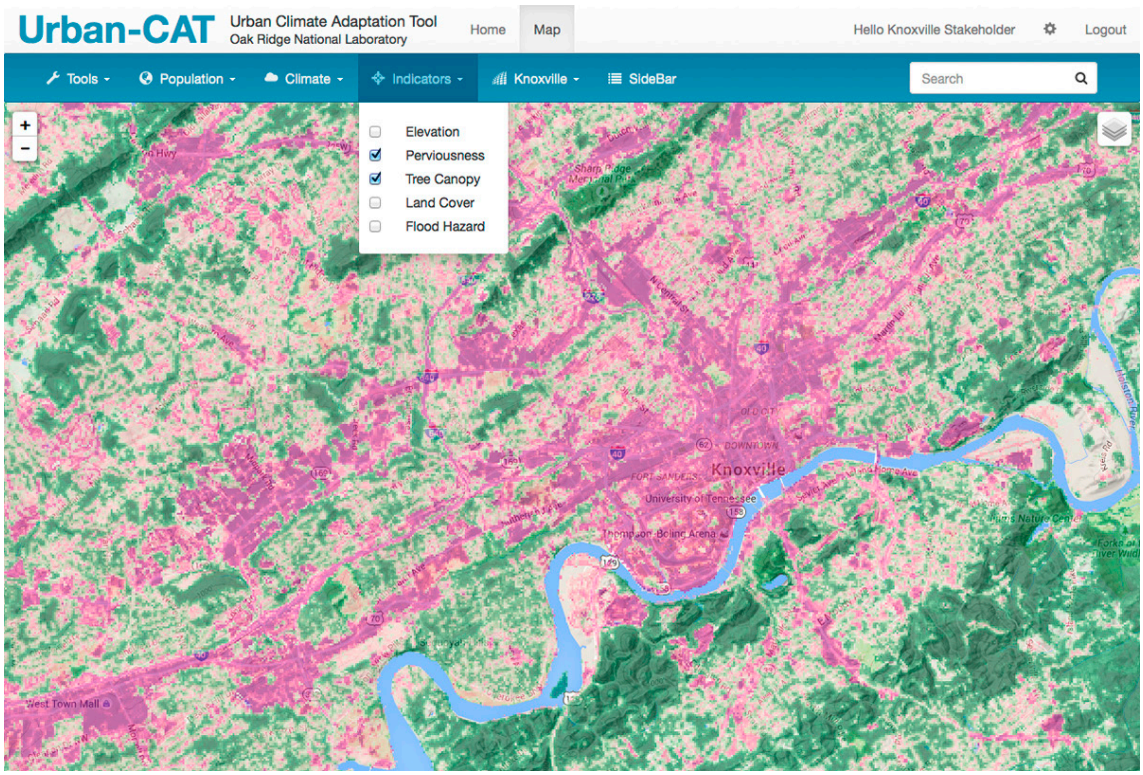
The mission of the ORNL IAV Team is to "enhance understanding of the physical and cyber risks, challenges, and opportunities of the integrated framework of population, energy, water, transportation, and policy to improve reliability and resiliency of infrastructure services under changing and extreme climate conditions."

The purpose of the IAV Team is to

- design and develop improve analytical methods and tools that will enable improve monitoring and modeling of infrastructures for performance reliability and situational awareness;
- develop novel data, computational models and visualization of large interconnected infrastructure networks to assess interdependency and cascading consequences of disruptive events; and
- develop data, modeling, and simulation capabilities for comparative evaluation of land use planning and urban design scenarios to enable environmentally sensible and socially adaptable infrastructure investment choices.

10.5.2 Urban-CAT—Improving Resiliency One Community at a Time

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 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.



Urban–CAT screenshot

The Urban-CAT platform addresses this 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.

Changing storm water runoff amounts and patterns have been identified by various sources as among the likely impacts of a changing climate for many cities, including the Knoxville/Oak Ridge area. For the prototype Urban-CAT tool, the team is focusing on storm water runoff and using green infrastructures such as trees to alleviate urban flooding and costly storm water management. This simple yet elegant solution has multiple benefits beyond the immediate one of flood control, including health benefits, air quality benefits, and canopy benefits.

Urban-CAT is funded through ORNL's Laboratory Directed Research and Development program, the project is a direct response to the President's Climate Data Initiative, a broad effort to leverage open government data resources with tools to help communities become more resilient to climate change.

10.6 Dashboard Survey

DOE GOAL: Discuss answers from the climate change resiliency survey that was completed in the Dashboard.

Input to ORNL's climate change resiliency survey was completed by Teresa Nichols, ORNL's CCR team facilitator, SCI co-leader, and SSP report manager, and by Herb Debban, F&O Directorate director of programs. The input has been included in the ORNL Dashboard. Contact: Teresa Nichols, nicholsta@ornl.gov.

In recognition of the important goal of addressing climate change impacts on missions and operations, the ORNL SCI chartered the CCR team in FY 2014, and an official SCI Roadmap began in FY 2015. CCR representatives include subject matter experts from a number of F&O Directorate and research programs to ensure that continued collaboration and focus on this topic is maintained. The CCR team includes members from F&O Directorate senior management, site strategic planning, environmental protection services, laboratory protection, natural resources, utilities, the energy manager, and the CCSI deputy director. The CCR team has conducted extensive annual work sessions since 2014 to review climate change risk elements and event categories and their potential impacts on the ORNL mission and operations.

Per the SPO SSP Guidance for FY 2014 performance, ORNL completed the web-based survey as directed in Objective 1 of SSP Goal 9: "DOE Climate Change Adaptation Screening Assessment." The completed screening survey was submitted to the DOE-sponsored survey site in December. Before final submission of the site-level survey, appropriate operations and emergency experts were consulted to ensure the accuracy of the answers to the assessment questions.

III. Fleet Management Plan

A. Fleet Management Organization Structure

The ORNL Fleet Management's structure is part of Fleet and Transportation Services in the Logistical Services Division (LSD). LSD reports to the F&O Directorate.

B. Fleet Procurement

Vehicles are chosen for replacement based on the Federal Replacement Standards (41 CFR 102-34.280), which states the minimum miles and age of a vehicle that can be replaced. In addition, the maintenance costs and the mission that the vehicle supports are also part of the criteria for choosing vehicle replacement.

Authority for the acquisition of passenger-carrying vehicles is contained in the annual Appropriation Act and is provided through the DOE ORO fleet manager. Vehicle acquisition approvals are granted by ORNL's DOE Site Office Operations and the ORO fleet manager.

C. Fuel Infrastructure

ORNL's fueling infrastructure makes available four types of fuel, unleaded, E85, diesel, and biodiesel (B20). There are no barriers in acquiring vehicles as long as they can use one of those types of fuels. ORNL has an effective fueling infrastructure for AFVs.

D. Vehicle Use Policies

Vehicles are provided to divisions based on mission needs. The vehicles are then assigned to the appropriate group within that division. Vehicles can then be designated as a pool vehicle, where several employees utilize the vehicle, or it can be assigned to one or several employees as an operational vehicle. Operational vehicles are used by craft crews such as pipefitters, carpenters, painters, and grounds maintenance personnel to maintain ORNL's buildings and grounds infrastructures. ORNL has a site-wide procedure that describes the requirements and rules for use of government-owned vehicles.

ORNL currently employs vehicle telematics that track use, performance, and charging data for one fleet PHEV. Telematics were also installed in one of the non-plug-in hybrid fleet vehicles.

Through ORNL on-site communication channels, employees are advised to avoid idling of vehicles. Also, posters are displayed as reminders to drivers to follow the anti-idling guidance.

ORNL is required through the ORO fleet manager to meet an annual motor vehicle local-utilization goal of 94%. ORNL's local-use objectives are summarized in the table; the outcomes are shown in the vehicle utilization chart. Each year, a certain mileage requirement is assigned per vehicle and is submitted to the ORO fleet manager in an annual report. If a vehicle does not meet this mileage requirement, justification is required as to why a vehicle needs to be retained in the fleet.

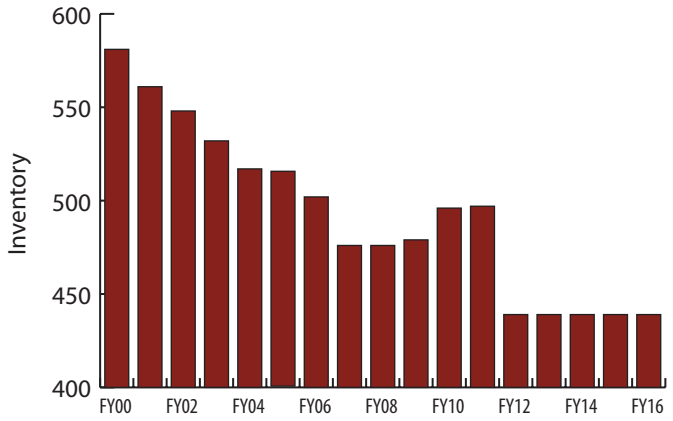
ORNL Local Use Objectives for FY 2016

Vehicle Category	Local Use Goals (Miles Required per Fiscal Year)
Small Geographical Area	1200
Operations/Maintenance	1500
DOE Site Office	1200
Buses/Taxis	3000
Special Purpose	No mileage standard—justification required

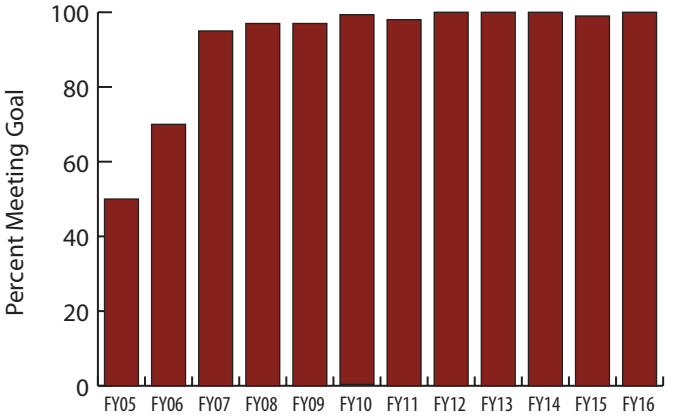
SECTION GOAL

ORNL has worked closely with DOE and ORO to right-size the ORNL vehicle fleet. In support of the 2012 fleet reduction initiative, ORNL reduced its fleet by 58 vehicles, bringing the total fleet count to 439. The vehicle inventory chart demonstrates how ORNL has reduced its fleet ceiling and maintained the current ceiling based upon mission criticality, as indicated in. All 439 vehicles are deemed to be necessary for the safe and cost-effective operation of ORNL facilities and missions and are assigned to critical functions. Additional reductions would adversely affect critical mission elements or the ability to provide a safe, secure, and environmentally sound work environment. ORNL is the largest DOE science and energy laboratory, conducting basic and applied research to deliver solutions to compelling problems in energy and security. These vehicles support a 50-square mile site with more than 4,700 employees and with another 3,200 users and visiting scientists coming to ORNL annually. Based on utilization being above 99.8% since 2012, ORNL has no plans to increase or decrease its fleet size during the next fiscal year.

ORNL has been aggressively and effectively managing its fleet since 2000. It has pursued vehicle reductions; converted to alternative fuels; and modernized the fleet. In addition, ORNL employees continue to utilize alternative modes of transportation such as taxis, electric and biodiesel LSVs, a fleet of shared bicycles, and convenient walking paths.



Reduction in fleet inventory



Vehicle mileage utilization FY 2016

IV. Funding

ORNL assesses the environmental, economic, and social benefits of proposed activities on an individual, project-specific basis. Through the Mission Readiness process, ORNL determines the ability of its facilities and infrastructure to accomplish mission objectives now and in the future. Projects are identified to further the safe, compliant, efficient accomplishment of mission objectives, including sustainable operations. Funding sources for projects are evaluated and established 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 SCI managed 25 dynamic roadmaps in FY 2016 all at varying stages of implementation. Each roadmap has specific fiscal year deliverables that are kept on schedule through regular review meetings held between individual roadmap owners and the SCI leadership. In addition, the F&O director, an SCI sponsor, has made success on these roadmaps a part of the directorate's performance plan. All roadmaps are also reviewed with the SCI sponsors (from the ORNL SCI Leadership Team) on a quarterly basis. This scheduled review also provides a forum for presenting new roadmap proposals developed by ORNL staff.

Opportunities for ECMs are routinely considered and are screened by facility managers and engineers before being selected. In addition to technical and energy savings feasibility, each project is analyzed in terms of financial return. Most of the projects considered good candidates for ECMs have a financial payback estimate of less than 2 years.

ORNL continues to apply an SPO-funded award received in early FY 2016 to continued progress in the area of HPSB. The project started in December 2015 with work scheduled for completion in October 2017. Both the SPO-funded portion and ORNL matching funds for this project were applied in FY 2016 and will continue in FY 2017.

ORNL applies the DOE Policy for Reinvestment of Cost Savings from Sustainability Projects as required by DOE Order 436.1 and related guidance issued to assure that all sites develop plans to reinvest monetary savings to fund ongoing sustainability projects that meet qualifying objectives. Funds for reinvestment can come from a variety of operating sources such as DOE, SPO, SC, and site F&O funds but not from third-party contracts such as ESPCs. ORNL SCI members led an informal working group with other DOE labs to strategize on ways to share ideas on how to effectively track projects and improve processes for the reinvestment of cost savings for sustainability projects.

ORNL Summary of Sustainability Project Funding ($K)			
Category	**FY 16 Actual**	**FY 17 Planned/Request**	**FY 18 Projected**
Sustainability Projects*	$ 641	$ 701	$ 800
Sustainability Activities Other than Projects	Captured in	Sustainability Projects	
ECMs (Energy/Water Efficiency)	$ 1,794	$ 1,900	$ 2,200
SPO-Funded Projects (SPO-Funded Portion Only)	$ 149	$ 102	$ 0
Site Contribution to SPO-Funded Projects	$ 71	$ 49	$ 0
ESPC Contract Payments	$8,004	$ 10,021	$ 13,350
REC Purchase Costs	$ 53	$ 111	$ 164
Total	**$10,712**	**$12,881**	**$16,514**

*Projects specifically funded to meet sustainability goals.

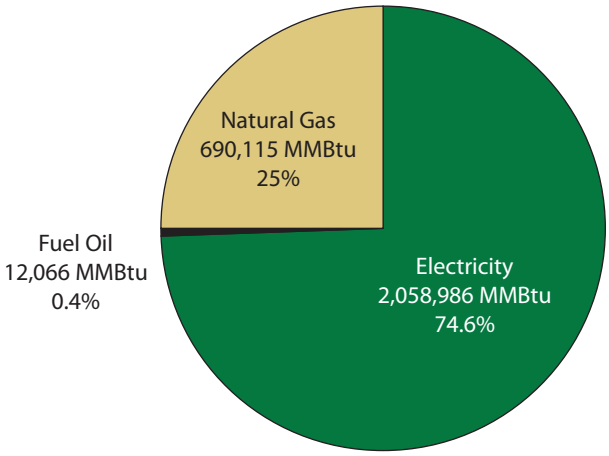
V. Electrical Energy and Utility Cost Projections and HEMSFs

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 usage supports mission-critical process applications as well as domestic water use, including restrooms and drinking water.

Utility Usage

Electricity is the largest energy commodity for ORNL, at 74.6% of the total energy consumption (see figure). Electrical services dominate ORNL's energy, primarily due to critical operations at HEMSFs. In FY 2016 the HEMSF buildings consumed 71.5% of ORNL's electrical energy; and current projections show an increase to peak at 82.8% by FY 2024 and then settle at 79.1% by the FY 2025 target/goal year. HEMSF buildings currently consume 50% of all ORNL water, and that number is expected to rise to 70% and then settle to 66% by FY 2025.

The Biomass Gasification Steam System was replaced by a dual-fuel boiler (natural gas and fuel oil) in September 2015. Two additional, similar boilers replaced two aging existing boilers in the fall of 2015. Natural gas is also used for the Melton Valley Steam Plant, the SNS, and other direct heating/research applications for a total of 25% of energy consumption. Fuel oil was used for steam generation during curtailment and maintenance periods as well as direct heating applications and emergency generator services for 0.437% of the energy consumed.

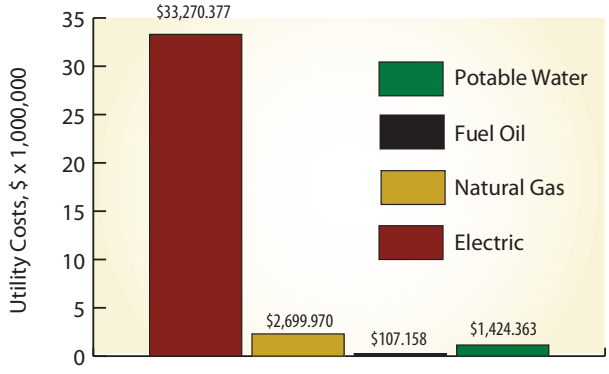


FY 2016 utility consumption—Million Btu of purchased energy/fuel

Utility Costs

As electricity is by far ORNL's largest purchased energy source, it is also the most costly at $33,270,377 in FY 2016. TVA offered a new strategic pricing plan (SPP) for customer's in October 2015 to better align the rate structure with their cost recovery activities and competitive pricing. ORNL is using the seasonal time-of-use manufacturing rate for the best value based on its high and consistent demand load. SNS uses TVA's SPP seasonal time-of-use rate to take advantage of process cycles and scheduling within the rate structure.

Natural gas and fuel oil follow electricity, with respective costs of $2,699,970 and $107,158. Water is the next largest purchased commodity at $1,424,363 in FY 2016.



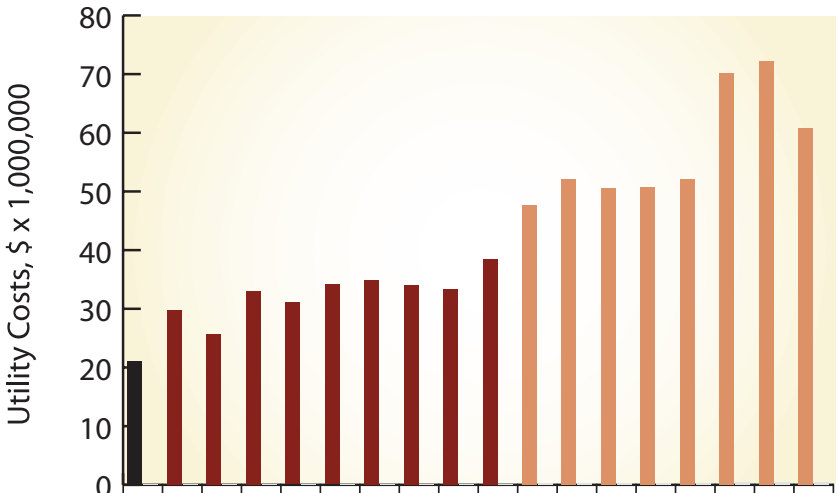
ORNL FY 2016 utility costs

SECTION GOAL

Electrical 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 also 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 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).



	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24	FY25
Proj Elec $M	21.0	29.7	25.7	33.0	30.9	34.0	34.9	34.0	33.3	38.5	47.7	52.1	50.5	50.7	52.1	70.1	72.2	60.8
REC Costs	0.02	0.02	0.06	0.06	0.05	0.07	0.08	0.06	0.05	0.15	0.20	0.21	0.25	0.26	0.31	0.38	0.39	0.43

Projected electrical energy and REC cost graph for both historical data and estimated cost by year

High-Energy Mission-Specific Facilities

ORNL has defined four facilities as HEMSFs. These facilities use a substantial portion of ORNL's total electrical power. In the DOE goal baseline year of FY 2008, they consumed 194,751 MWh, more than half of all ORNL power consumption. By the GHG reduction target year of FY 2025, ORNL's HEMSFs are projected to peak at 838,520 MWh and then settle to use 655,171 MWh, accounting for about 79.1% 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, all of which 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 HRIBF has been removed from the current HEMSF inventory due to a major reduction in mission, but is shown in the graph for historical comparison purposes.

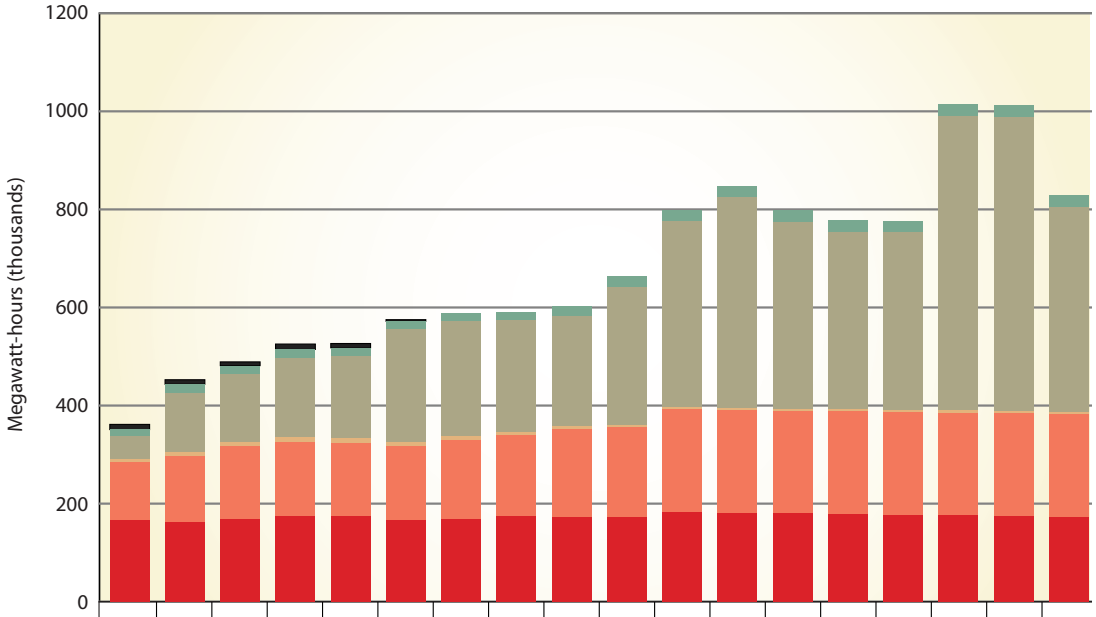
Identification of ORNL HEMSFs

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

SECTION GOAL

Beginning in FY 2018, significant growth is projected for the HPC areas. It anticipates an 84% boost in technical power by FY 2025 above FY 2015 power levels, showing a 66% growth rate by FY 2018 and peaking in FY 2024 at more than 150% of the FY 2015 power. Research activities at SNS are also expected to increase in FY 2018 and beyond. 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.



	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025
HRIBF	10,582	9,212	7,620	10,955	8,780	3,238	-	-	-	-	-	-	-	-	-	-	-	-
HFIR	13,557	17,611	18,298	18,700	17,233	17,102	17,546	17,981	19,520	23,001	23,001	23,001	23,001	23,001	23,001	23,001	23,001	23,001
HPC	45,586	121,470	138,293	161,465	168,460	230,067	233,882	228,706	226,605	281,369	379,924	430,860	381,423	362,633	362,633	601,781	601,781	418,434
CNMS	8,147	8,311	8,075	8,828	8,413	8,230	8,328	4,519	4,505	4,550	4,550	4,550	4,550	4,550	4,550	4,550	4,550	4,550
SNS	116,879	135,138	148,457	151,058	149,937	149,978	161,348	166,414	181,023	182,833	209,188	209,188	209,188	209,188	209,188	209,188	209,188	209,188
Base Site Usage	167,274	161,437	168,902	175,049	174,359	167,216	168,230	174,139	171,660	173,301	182,998	181,213	179,949	178,700	177,321	176,052	174,780	173,501

ORNL HPC growth trend and projection to FY 2025

High Flux Isotope Reactor

Operating at 85 MW, the High Flux Isotope Reactor (HFIR) provides one of the highest continuous fluxes of neutrons of any research reactor in the world, and its cold source is the brightest in the world. The neutron scattering research facilities at HFIR include 15 world-class instruments either in operation or planned, including two cold source instruments. The thermal and cold neutrons produced by 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

The HPC mission includes the Computational Sciences Building, part of the Oak Ridge Leadership Computing Facility (OLCF) established at ORNL in 2004 with the mission of standing up a supercomputer 100 times more powerful than the leading systems of the day. Since that time, ORNL has more than met that goal, producing a number of supercomputers, each bearing the title "world's fastest computer" in its time. In November 2012, Titan was named the world's fastest computer at 17.59 sustained petaflops—ten times faster than its predecessor. As of November 2016, a full four years after installation, Titan remains the third-fastest computer in the world in the Top 500 list. Equally important, Titan demonstrates very high energy performance of more than 2,100 megaflops per watt, one of the most efficient computers in the world for a system of its size.

As a result, OLCF gives the world's most advanced computational researchers an opportunity to tackle problems that would be unthinkable on other systems. The facility welcomes investigators from universities, government agencies, and industry who are prepared to perform breakthrough research in areas running the gamut of scientific inquiry. Because of its unique resources and capabilities, OLCF focuses on the most ambitious research projects—projects that provide important new knowledge or enable important new technologies and that cannot be accomplished anywhere else.

On November 14, 2014, Dr. Mason joined Energy Secretary Moniz and members of Congress on Capitol Hill for the announcement of DOE's newest supercomputers, Summit at ORNL and Sierra at Lawrence Livermore National Laboratory. The ORNL project includes both the acquisition of Summit, an IBM POWER9 system, and the construction of a new 20 MW computing facility. The facility construction is well under way, with substantial completion and commissioning scheduled for the summer of 2017. ORNL's IBM system is expected to be available to users in 2018. Summit will be at least five times as powerful as Titan while still maintaining a similar carbon footprint.

Spallation Neutron Source

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 is a versatile scientific tool that gives researchers more detailed snapshots of smaller samples of physical and biological materials than ever before possible. With resources that will eventually include 25 best-in-class instruments, scientists can count scattered neutrons, measure their energies and the angles at which they scatter, and map their final positions. SNS allows measurements of greater sensitivity, higher speed, higher resolution, and in more complex sample environments than had been possible at the existing neutron facilities. 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.

SECTION GOAL

Center for Nanophase Materials Sciences

The Center for Nanophase Materials Sciences (CNMS), co-located with SNS on the Chestnut Ridge part of the ORNL campus, offers expertise and instrumentation for user research in a broad range of disciplines that address forefront research in nanoscience, nanotechnology, and related phenomena. CNMS 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.

Appendix A: Excluded Buildings Self-Certification Process

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

TO: Sustainability Performance Office

DATE: December 2, 2016

SUBJECT: SELF-CERTIFICATION FORM FOR THE ENERGY INTENSITY GOAL OF EISA 2007

Each building or group of buildings excluded under the criteria for a Part G or Part H exclusion is/are metered for energy consumption and their consumption is reported annually.

No buildings have been excluded under Part H. If they had been, then all practicable energy and water conservation measures with a payback of less than 10 years would have been installed. A justification statement explaining why process-dedicated energy in the facility may impact the ability to meet the goal would have been provided in the FIMS Report 063.

I certify that the buildings listed on the Excluded Buildings List produced by FIMS as Reports 063 and 047 dated 22 November 2016 for Oak Ridge National Laboratory and listed on pages 59 through 61 below meet the exclusion criteria in Guidelines Establishing Criteria for Excluding Buildings published by FEMP on January 27, 2006.

Johnny O. Moore

_____
DOE Site Office Official – printed name

_____
DOE Site Office Official – signature

_____
Date

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

Name of Building(s) from FIMS data base (Property Name)	FIMS - Property Sequence Number	Part (check one)							Comments
		B	C	D	E	F	G	H	
National Energy Security Center	2040		X						Fully-Serviced Lease. Tennant cannot make changes to building infrastructure for energy reductions.
Biosciences Division	102GRAND		X						Fully-Serviced Lease. Tennant cannot make changes to building infrastructure for energy reductions.
Excessing and Surplus Sales	115UNV		X						Fully-Serviced Lease. Tennant cannot make changes to building infrastructure for energy reductions.
Battelle Washington DC Operations Office	BWO		X						Fully-Serviced Lease. Tennant cannot make changes to building infrastructure for energy reductions.
Commercial Storage Space	NTRCSTRG		X						Fully-Serviced Lease. Tennant cannot make changes to building infrastructure for energy reductions.
161 kV Substation	0980						X		This is a primary substation for ORNL electrical power. Electrical loss across transformers is inherent in their design. Energy loads are not influenced by conventional building energy conservation measures.
Computer Center (part of Multi-Program Research Facility)	5300						X		This is a relatively new (2008) high performance computing center in the Multi-Program Research Facility. Energy is required for computational science and other missions, and energy intensity in the data center is 13 times that of standard buildings at ORNL. Significant energy reductions are not practical without affecting mission operations.
Computer Center (part of Computational Sciences Building)	5600						X		This is a relatively new (2003) modern facility with a high performance computing center. Energy is required for computational sciences research missions (i.e., supercomputing), and energy intensity in the data center is 32 times that of standard buildings at ORNL. Significant energy reductions are not practical without affecting research operations.
161 kW Substation	7640						X		This is a primary substation for ORNL electrical power. Electrical loss across transformers is inherent in their design. Energy loads are not influenced by conventional building energy conservation measures.

Waste Processing Facility process buildings, as follows:	See comment at right:								The Waste Processing Facility (WPF) buildings listed below make up the process buildings required for transuranic (TRU) waste processing. Energy is required for the operations mission. The facility's energy intensity is about 60% higher that that of standard buildings at ORNL. Significant energy reductions are not practical without affecting TRU waste processing activities.
Waste Processing Facility	7880						X		--- see WPF comment above ---
WPF Control Room	7880D						X		--- see WPF comment above ---
WPF Boiler	7880E						X		--- see WPF comment above ---
WPF Air Compressor	7880F						X		--- see WPF comment above ---
WPF Electrical Equipment Building	7880G						X		--- see WPF comment above ---
Backup Air Compressor	7880S						X		--- see WPF comment above ---
High Flux Isotope Reactor Facility	7900						X		The energy is required to support the research mission. The reactor is an 85-MW isotope production and test reactor with the capability of performing a wide variety of irradiation experiments. When operating the energy intensity of the facility is about three times that of a standard building at ORNL. Energy loads are not influenced by conventional building energy conservation measures. Significant energy reductions are not practical without affecting research operations.
161 kW Substation	8912						X		This is a primary substation for SNS electrical power. Electrical loss across transformers is inherent in their design. Energy loads are not influenced by conventional building energy conservation measures.

Spallation Neutron Source (SNS) process facilities, as follows:	See comment at right:								The SNS buildings listed below make up the process buildings required for SNS operations. At full power, the SNS will provide the most intense pulsed neutron beams in the world for scientific research and industrial development. Completed in May 2006, SNS has ramped up to near full-power capability. Energy intensity is required for research missions. Energy loads are not influenced by conventional building energy conservation measures. Significant energy reductions are not practical without affecting research operations. (The Central Laboratory and Office Building at SNS are not exempt from energy goals, but only the buildings required for process operations.)
(SNS) Front End Building	8100						X		--- see SNS comment above ---
(SNS) Beam Tunnel	8200						X		--- see SNS comment above ---
(SNS) Klystron Gallery	8300						X		--- see SNS comment above ---
(SNS) Central Helium Liquifier Facility	8310						X		--- see SNS comment above ---
(SNS) Superconducting Rad Freq. Bldg.	8320						X		--- see SNS comment above ---
(SNS) RF Test Facility	8330						X		--- see SNS comment above ---
(SNS) HEBT Service Building	8340						X		--- see SNS comment above ---
(SNS) Ring HVAC Building West	8413						X		--- see SNS comment above ---
(SNS) Ring HVAC Building East	8423						X		--- see SNS comment above ---
(SNS) Ring Injection Dump	8520						X		--- see SNS comment above ---
(SNS) Ring Service Building	8540						X		--- see SNS comment above ---
(SNS) RTBT Service Building	8550						X		--- see SNS comment above ---
(SNS) Target Building	8700						X		--- see SNS comment above ---
(SNS) Target Building #1 Beam Line 1	8702						X		--- see SNS comment above ---
(SNS) Target Building #1 Beam Line 5	8705						X		--- see SNS comment above ---
(SNS) Target Building #1 Beam Line 7	8707						X		--- see SNS comment above ---
(SNS) Target Building #1 Beam Line 11	8711						X		--- see SNS comment above ---
(SNS) Target Building #1 Beam Line 13	8713						X		--- see SNS comment above ---
(SNS) Target Building #1 Beam Line 14B	8714B						X		--- see SNS comment above ---
(SNS) Helium Compressor Building	8760						X		--- see SNS comment above ---
(SNS) Laboratory Support Building	8770						X		--- see SNS comment above ---
(SNS) BL-11A Gas Cylinder Storage Building	8780						X		--- see SNS comment above ---
(SNS) Switch Yard	8911						X		--- see SNS comment above ---
(SNS) Central Exhaust Facility	8915						X		--- see SNS comment above ---
(SNS) Diversion Tanks	8918						X		--- see SNS comment above ---

Back Cover